Sustainable bioenergy feedstock production in rural areas of developing countries:

Social impacts and stakeholder dynamics in India and Uganda

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Abstract

Improving the availability of secure energy supplies for the poorest rural communities is central to development efforts. World-wide, climate change concerns have led to growing interest in renewable sources, including modern forms of bioenergy. Drivers behind its adoption are diverse, location and scale dependent, and result in multi-level trade-offs. Although impacts are context-specific, bioenergy production and use have a wider impact on issues including deforestation, biodiversity loss, water shortages and food price increases. At local levels reports of labour exploitation, loss of local land rights, market interference and resource depletion are alarming. However, bioenergy projects continue to be promoted and implemented for potential social, environmental and economic benefits, particularly in rural areas of developing countries. Efforts to ensure sustainable bioenergy at international levels are emerging, with varying success. Existing market and legislative efforts are often insufficient to ensure positive socio-economic and environmentally sound outcomes locally. **This thesis therefore aims to provide two approaches to incorporate socio-economic aspects in planning for sustainable bioenergy production in rural areas of developing countries.** The research uses India and Uganda as substantive case studies. Based on these experiences, and in order to better understand the social effects of bioenergy feedstock production, a straightforward two step methodology for assessing social effects of bioenergy projects in developing countries is proposed, intended to be embedded within a planning for sustainability framework. One of the main barriers to success has been effective multi-stakeholder consultation (MSC). To address this, a second approach is conceived, for identifying and understanding stakeholders and their dynamics (in terms of roles, requirements and risks). Initially this focuses on liquid biofuel production models in India using five *Jatropha curcas L.*-based biodiesel production models in Chhattisgarh State, where the significant distinctions between them are: land ownership and value chain; and market end use and route. When analysing social impacts locally the risks and responsibilities of different stakeholder groups must be considered. The approach is then trialled on eight predominately theoretical models of woody biomass for gasification in Uganda, where the main distinctions are land ownership and feedstock type. Key social issues vary by whether models are corporately or farmer/NGO led, and what production arrangements were in place. Scale of plantation and market size were found to be important; small, privately owned models are unlikely to benefit landless poor and could deplete resources without strategic planning, while larger projects employ more, but often have longer term natural resource impacts. Bioenergy initiatives which collaborate with the rural poor and landless are found to be most likely to result in socio-economic rural development, and one of the proposed Ugandan models which potentially offers social benefits is analysed in terms of additional outcomes. The analysis concludes it is: economically viable; will produce significantly less carbon than generators (dependent on plantation productivity); will not impact local water resources significantly (if converting rangeland); and requires capacity building and stakeholder participation from the outset to promote local ownership and troubleshooting ability. The importance of strategic planning and departmental coordination, and the need for a pilot case to allow the technology to be tested, are shown. It is concluded that participation of stakeholders in the sustainability planning process is crucial, and the approaches proposed in this thesis are robust facilitating tools. Context-specific assessments, such as these, are essential in planning for sustainable bioenergy production and would be expected to facilitate successful MSC and ultimately sustainability planning, improving its contribution to policy making.

Declaration

This thesis contains the result of research work carried out between November 2006 and April 2011. The work is original and no part of it has been submitted in support of an application for another degree of qualification at this or any other university or institute of learning.

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I start with Ian Calder. Without his unfailing optimism, enthusiasm and conviction that I could do it, I would not be in this position. He was my professor, boss, supervisor and, above all, a great personal friend. Ian tragically lost his battle with Motor Neurone Disease in May 2009. It was so hard to say goodbye, but I hope that I've made him proud. It doesn't end here though, the lessons Ian taught me will stay with me whatever discipline I end up in.

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Abbreviations

AHP	Analytic Hierarchy Process
CREDA	Chhattisgarh Renewable Energy Development Authority
CSR	Corporate Social Responsibility
EC	European Commission
EIA	Environmental Impact Assessment
EKC	Environmental Kuznet's Curve
EC	European Commission
EU	European Union
EVI	Extremely Vulnerable Individual
GBEP	Global Bioenergy Partnership
GHG	Greenhouse gas
ha	hectare
IAIA	International Association for Impact Assessment
IDB	Inter-American Development Bank
IDP	Internally Displaced Persons
iLUC	Indirect land use change
INR	Indian Rupees
IOC	Indian Oil Corporation
kWh	Kilowatt hour
LCA	Life Cycle Assessment
MBIPL	Mission Biofuels India Private Limited
MCA	Multi-criteria Analysis
MDG	Millennium Development Goals
MNRE	The Ministry of New and Renewable Energy, Government of India
MSC	Multi stakeholder consultation
MSP	Minimum support price
MWh	Megawatt hour
NEMA	Ugandan National Environmental Management Agency
NGOs	Non-Governmental Organisations
NREGS	National Rural Employment Guarantee Scheme (India)
odt	Oven dried tons
OMC	Oil Marketing Company
PPPP	Policy, plan, programme or project
RCA	Responsible Cultivation Area
RED	Renewable Energy Directive (of the European Commission)
RESP	Uganda Rural Electrification Strategy and Plan
RLS	Reliance Life Sciences Limited
RSB	Roundtable on Sustainable Biofuels
SA	Sustainability Assessment
SADC	Southern African Development Community
SEA	Strategic Environmental Assessment
SIA	Social Impact Assessment
SPGS	Sawlog Production Grant Scheme
SRC	Short rotation coppice
TBO	Tree-borne oilseed
tC	Tons of carbon dioxide
NFCCC	United Nations Framework Convention on Climate Change
UNHCR	United Nations High Commissioner for Refugees

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Chapter 1.

Bioenergy and Development

This Chapter introduces the key areas and previous studies which have inspired, contributed to and shaped the research for this thesis through sections 1.1 to 1.4. Based on this understanding, and the identified research gaps, sections 1.5 and 1.6 will specify the context, aim and objectives, and then outline the structure of the thesis.

1.1 The importance of energy for development

Mitigating and adapting to a potentially changing climate, effective management of natural resources, adapting to volatile political scenarios, providing food security, economic development, pledges towards poverty eradication and social wellbeing – all of these have one significant common component: the need for energy security (Kanagawa and Nakata, 2008; Goldemberg and Lucon, 2010). It is commonly agreed that sustainable development does not rely simply on a country or region's economic performance; in fact for many years indicators of development have incorporated the social features of the population at all levels as well as the divide between rich and poor (UNDP, 1990; Goldemberg and Lucon, 2010). Box 1.1 provides a definition of poverty which is used throughout this thesis, transcending the traditional concept of purely financial indicators and covering many aspects of development.

Box 1.1: Defining poverty

Poverty can mean the basic state of being poor – i.e. not having enough money to take care of basic needs such as food, clothing and housing – but can also refer to someone who is lacking or deficient in something[1]. It is not enough to talk about development and poverty in terms of purely financial capital. Poverty in the context of development covers the lack of decision-making power, access to sufficient affordable nutrition, safe drinking water and sanitation services, healthcare, land or housing tenure, sustained and fair employment opportunities, civil freedom and availability of affordable modern energy services (Rogers *et al*,. 2008). Shortage of any of the above categories, and variations therein, can result in poverty and constrain development, without the individual or community necessarily being poor in a monetary sense. Therefore, in this context, poverty refers to any deficiency which could be considered a barrier to development.

[1] Encarta Dictionary Online, accessed 02/12/2010 at: http://encarta.msn.com/dictionary

It has long been appreciated that there is a direct link between insufficient energy supply and low levels of development (Kammen *et al*., 2002; Goldemberg and Johanssen, 2004; Modi *et al*., 2006). As a result policies, programmes and projects to improve the availability of secure energy supplies for the poorest and most remote individuals and communities have been central to development efforts, and are considered prerequisites to achieving the Millennium Development Goals (MDGs) set by the UN (Monroy and Hernández, 2005; Kanagawa and Nakata, 2008). Even for 'Goal 7: Ensure Environmental Sustainability', the provision of sustainable forms of energy is important, as for example the high extraction of forest biomass for fuelwood has knock-on effects on development opportunities and can result in biomass, ecological and even food crises as depicted in Figure 1.1 and discussed in section 1.4.

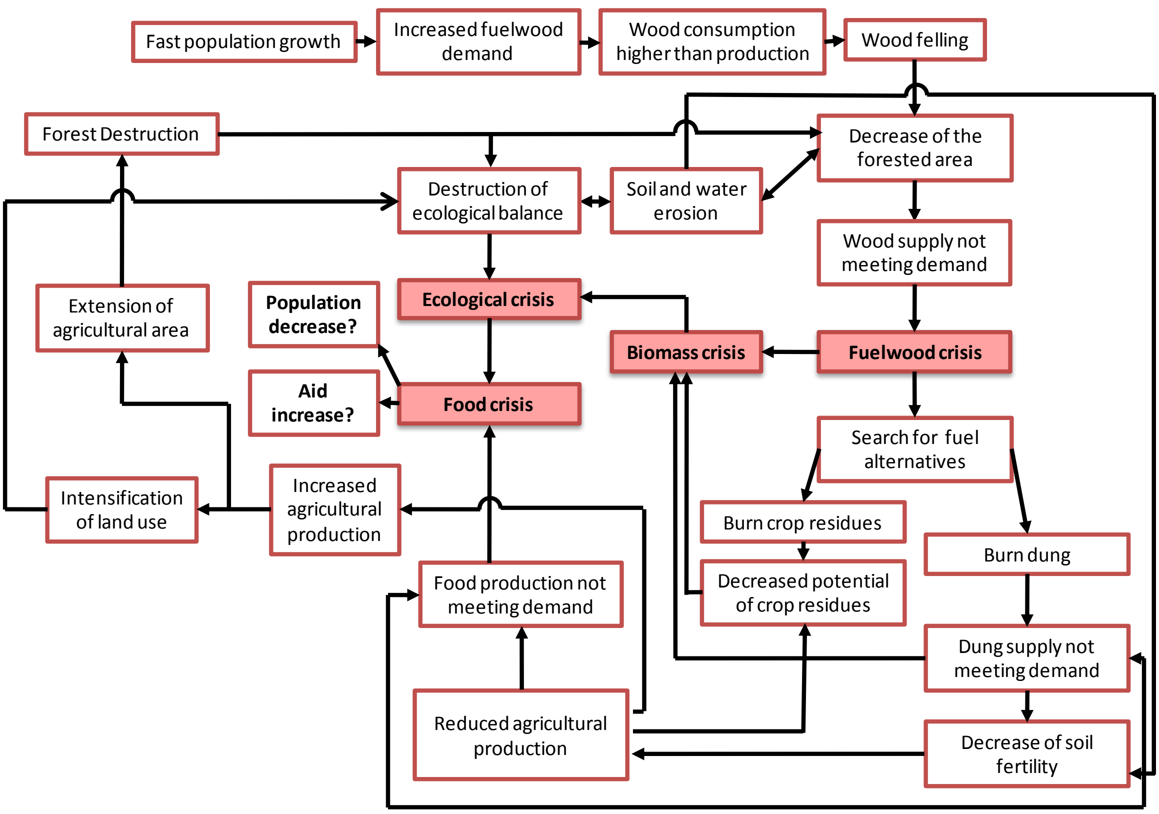


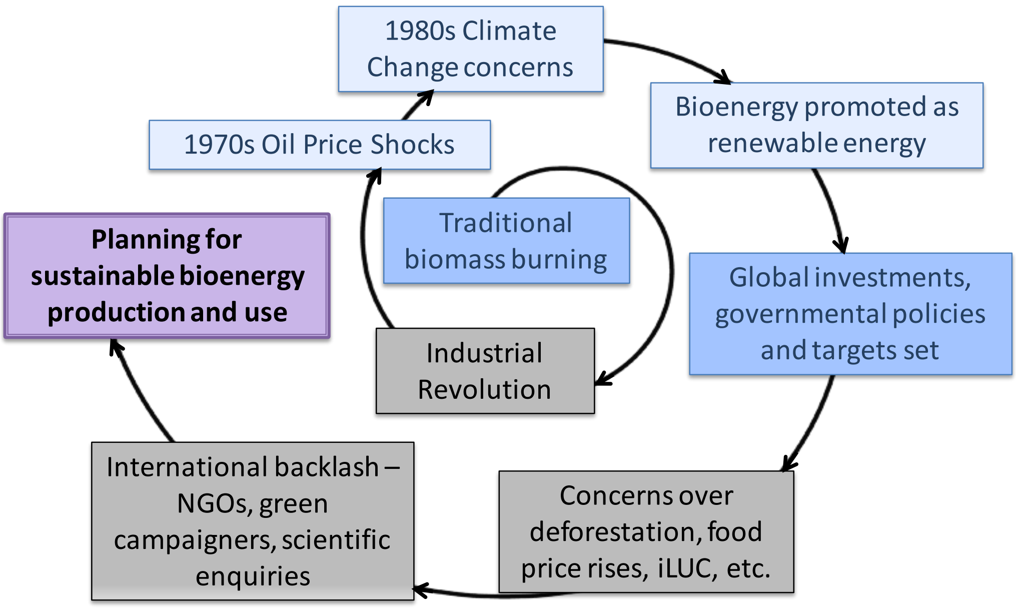
Figure 1.1: Cycle of poverty, biomass and ecological crisis in developing countries, after Rady (1992).

Increasingly, over recent decades, there has been a drive towards decentralised, renewable provision of energy which relies on local resources rather than trying to improve and extend existing national grid infrastructure (Rady, 1992; Buchholz and Volk, 2007). In many developing countries the national grid is already struggling to cope with existing demand and the increased requirements of growing populations are likely to further compound this situation; added to which the cost of maintaining an extended grid infrastructure, particularly in remote rural locations, is prohibitive. A study carried out for Kenya (Parshall *et al*., 2009) did conclude that extending grid connection might be cheaper than providing decentralised energy sources, however doubts remain over the capacity to maintain the infrastructure and provide the additional energy to meet increased demand, as well as the lack of local troubleshooting capability with centralised supplies.

1.2 Bioenergy: a spiral of popularity

Within this context of energy provision for sustainable development in developing countries, and the growing interest in decentralised, renewable options, the use of modern forms of biomass for energy (bioenergy) has been proposed as a suitable alternative to the use of fossil fuels and traditional biomass. Biomass is a term which describes all forms of organic matter derived from plants, trees, crops or algae (Mousdale, 2008). It can be used in solid, liquid or gaseous form to provide energy when combusted. This energy is collectively referred to as bioenergy, whichever form it may take (Demirbas, 2007; WBGU, 2009). Traditionally, biomass has been used in its solid and untransformed state on three-stone fires for centuries, and this continues to be the main source of energy in many developing countries. This is a highly inefficient combustion process which requires a substantial biomass supply and is harmful to health, as the fires are generally indoors and closely tended (Bhattarcharyya and Abdul Salam, 2002; Chaturvedi, 2004). The term ‘modern bioenergy’ refers to efficient and potentially commercial forms of electricity generation and heat production, as well as transportation fuels, from agricultural or forest residues and solid waste (Goldemberg and Coelho, 2004). In this thesis the term is used to represent either liquid biofuels, in particular biodiesel for use in combustion engines or electricity generators (Demirbas, 2007), or woody biomass for gasification to use in cooking or electricity generation (Buchholz and da Silva, 2010). There are other forms of modern bioenergy, however those which are particularly significant and important in the countries in which I have worked – India and Uganda – have been selected.

The increased interest in the use of bioenergy has not been straightforward. Figure 1.2 represents, very simplistically, the uneven, ‘spiralling’ popularity it has experienced over human timescales. Traditional biomass was the first source of energy and so this is where the spiral begins. The Industrial Revolution around the second half of the 18th Century saw the introduction of fossil fuels and a reduction in the use of bioenergy in industrialising nations (Grubler, 2008). The interest in modern forms of bioenergy began to receive attention in the developed world following the first oil price shock in the 1970s (Mork and Hall, 1980; FAO, 2008) and the emergence of concerns regarding anthropogenic contributions to climate change around the 1980s (Townsend *et al.*, 2008; Earley and McKeown, 2009). Since this time, bioenergy has been on the agenda of governments worldwide (Mandal, 2005; Abea *et al.*, 2007; Fischer *et al.*, 2007) and formed the basis of global investments by Oil Marketing Companies (OMCs) and multi-national corporations (Kammen *et al.*, 2002; Röser *et al.*, 2008; Heinimö and Junginger, 2009; van Dam *et al.*, 2009). This has led to rapid growth of feedstock cultivation for bioenergy production, in terms of solid biomass, liquid biofuels and biogas, particularly in developing countries where there is more room for agricultural expansion and cultivation is relatively cheap (Berndes *et al.*, 2003; Schoneveld, 2010).



Starting from the centre, blue represents high or increasing level of use, grey is decreased popularity. Purple shows current efforts to design sustainable bioenergy projects, and where my research fits in.

Figure 1.2: The spiralling popularity of bioenergy. Author's own.

Bioenergy is an adaptable resource which can, in many cases, be used either directly or in blend with existing energy infrastructure. For example, liquid biofuels are able to be used to directly replace petrol and diesel in engine powered vehicles, which avoids the need for major new investment in transport energy supply infrastructure (Demirbas, 2008) and could enable sellers to tap into the lucrative petroleum market (Slingerland and van Geuns, 2005). The increased global interest and level of production has attracted the attention of scientists, campaigners and journalists concerned over the potential impacts of such large scale land use and livelihood changes (Eccleston, 2007; Chakrabortty, 2008). Such impacts are thought to include deforestation, food price increases and indirect Land Use Change (iLUC), which will be discussed further in section 2.1.1(a) (page 22). Reports of these negative impacts arising from large scale bioenergy feedstock production have resulted in an international backlash against it, and liquid biofuels in particular which are seen to be a major contributor (Glastra *et al*., 2002; Bailey, 2008). These concerns have initiated international efforts to ensure sustainability in bioenergy production and use, such as market-based certification mechanisms, which will be discussed in more detail in Chapter 2. There are many models of feedstock production which exist or, in the case of planned projects, will exist outside of the influence of such measures. Therefore, if bioenergy production in developing countries is to be sustainable, then **context-specific mechanisms are needed**. This is becoming a critical issue and is a central focus of my research, with case study-specific approaches presented in Chapters 3 to 6.

1.2.1 *Drivers of bioenergy transitions*

In summary, the main global and national level drivers for more modern forms of energy generation from biomass include (FAO, 2008):

- Possibility of reduced carbon emissions and meeting climate change commitments through both sequestration of carbon during biomass growth, and avoided emissions through reduction in fossil fuel consumption;
- Rural development through employment and increased livelihood and market opportunities;
- Security of energy supply through local production and/or processing; and
- Technological development, whereby bioenergy could be used to bridge the gap between current reliance on fossil fuels and future technologies.

Nonetheless, for many developing countries traditional forms of bioenergy still make up the dominant proportion of the energy balance as they have for thousands of years with little modernisation (Chaturvedi, 2004; Demirbas and Demirbas, 2007). In the majority of cases more modern and efficient outputs from energy sources, such as electricity, are available but are either too expensive, unreliable, or unevenly distributed so that people in more remote areas cannot access them (Goldemberg and Lucon, 2010). In these situations the research interest is increasingly focusing on moving directly from this scenario to more modernised, highly efficient economies in order to bypass the global environmental damage caused by carbon-intensive industrialisation which has occurred across much of the developed world (Jiang *et al*., 2010; Sawangphol and Pharino, 2011). Modern bioenergy use is one option suggested for progressing this transition, and supporting policies are being drafted and discussed (Rajagopal and

Zilberman, 2007). Parts of Africa, Latin America and Asia have been identified as areas with high potential for feedstock production by international companies looking to supply bioenergy to developed countries (FAO, 2008; Gallagher, 2008; Jumbe *et al*., 2009), which has subsequently provided stimulation for feedstock cultivation and/or bioenergy production in these regions. It is typically socio-economic drivers, such as prospects of rural development, foreign exchange, national economic development, fuel self sufficiency and improved trade balance rather than climate change mitigation that attract these countries to bioenergy production (Earley and McKeown, 2009). At the micro (household, community, perhaps up to village cluster) scale, the drivers are likely to include, for example, livelihood diversity; employment opportunities and cash crop profits (Woods *et al*., 2006a; Buchholz and da Silva, 2010). At the regional or district (meso) scale, meeting national targets, attracting investment, and increasing land productivity/output become more important (Ravindranath and Balachandra, 2009). With such diverse and cross-cutting drivers in terms of both scale and sector it is clear that, to some extent, trade-offs are inevitable, particularly as the level of production increases (Domac *et al*., 2005; Ewing and Msangi, 2009; Mathews and Tan, 2009). **Improving the understanding of the stakeholders involved and the expected outcomes from bioenergy projects is needed to help manage these trade-offs**. In this thesis a suitable framework within which to structure this management (Chapter 2), and targeted approaches to facilitate stakeholder understanding (Chapters 3 to 6), are presented.

The nature of the drivers behind individual projects will ultimately have a major influence on whether all or a selection of the expected positive outcomes can realistically be achieved in specific cases. The local rural development outcomes often expected from modern bioenergy projects depend heavily on the success of feedstock cultivation, but also very much on the political or market structures and degree of planning behind the project implementation (Dalal-Clayton *et al*., 2003; Tiwari *et al*., 2010a). The main consumers, therefore biggest markets and arguably most significant influences, are in the USA and Europe (Ewing and Msangi, 2009; Heinimö and Junginger, 2009). However, in accelerated-growth economies such as India and China there are already targets and mandates relating to liquid biofuels. Meeting these could potentially require vast amounts of feedstock (Weyerhauser *et al*., 2007; Kumar Biswas *et al*., 2010). Liquid biofuel is a distinct form of bioenergy which has emerged as a significant part of the global debate. This is due in particular to the possibility for reduced greenhouse gas (GHG) emissions in vehicular transport, contributing towards climate change mitigation, but also in place of petroleum products more generally with the potential to reduce global political unease surrounding oil supply security.

1.2.2 *Liquid biofuels – global commodity*

The production and use of liquid biofuels in particular has been promoted now for over a decade by net energy consumers such as the European Union (EU). The setting of mandatory biofuel blending targets by the EU, which will increasingly be met through imports (EU, 2009; Swinbank, 2009), has been influential in the establishment of a global biofuels market (EC, 2007). The United States' policy on biofuels has also been globally influential, but for different reasons, as the main driver of this policy is energy security (FAO, 2008). American import tariffs on ethanol, alongside substantial subsidies for domestic corn-based production, have rendered Brazilian ethanol unable to compete despite being more cheaply and efficiently produced (Kessler, 2010). Expected benefits to developed countries in general include increasing the share of renewables in line with global climate agreements, reducing dependency on fossil fuels and, initially at least, providing an assured market for farmers through domestic energy crop production with an expected boost to rural development. The role of the developed world markets on biofuel feedstock production in developing countries will be considered further in Chapter 2. Nonetheless, it can be said here that the increase in feedstock cultivation for biofuel production is likely to have a significant role to play in developing countries as it will often be considered an export commodity (Heinimö and Junginger, 2009). In such scenarios there are undoubtedly local gains to be had by producers, and some crops could become equivalent to cash crops if the market takes off. However, if serious detrimental social impacts are to be avoided then lessons from previous crops need to be learned, and **policy makers must be aware of potential negative social impacts if they pursue biofuel feedstock production as a driver for rural development**. Chapter 3 presents a methodology to enable better understanding of social impacts in bioenergy projects, intended to assist policy makers and developers in such decisions.

There are, of course, multiple situations in which liquid biofuel feedstocks will not be produced for export, but local consumption. It is important to identify that the impacts arising from this very different production scenario are unlikely to be similar to those from export oriented projects (Schoneveld, 2010). There are still expected to be consequences and potential trade-offs which should be accounted for if such a model were to be repeated as a sustainable example. The distinctions between the two types, and the differing impacts these are likely to have on stakeholders, will be discussed for specific examples in Chapters 4 and 5. Whether or not feedstock for liquid biofuels would be produced for export or to satisfy internal demand, this thesis does not consider their viability as a substitute for petroleum based transport fuel. This is an ongoing global debate, contributing to which is not the aim of this research. For whatever reason particular crops or feedstock types are produced, there needs to be better understanding of the context-specific trade-offs, stakeholders and socio-economic impacts. Improving these aspects, and their inclusion in the planning phase, is the intention here.

1.3 Rural development and social impacts from bioenergy

The drivers behind these projects, whether liquid biofuels or other forms of bioenergy, are often related to perceived socio-economic and rural development benefits, particularly for developing country producers (Domac *et al*., 2005; Altenburg *et al*., 2008). This section will broadly review the literature and existing initiatives to evaluate whether this is a realistic expectation of bioenergy feedstock production in developing countries. Specific examples will be considered in more detail in later Chapters.

1.3.1 *Social impacts of modern bioenergy use in developing countries*

It is thought that increased competition for rural energy supplies is a major barrier to alleviating rural poverty, and bioenergy is increasingly seen as an opportunity to reduce that competition (Chaturvedi, 2004). Other advantages in rural areas are said to include income and employment generation, possible reduction of costs for agricultural overproduction (though this is predominantly only the case in Europe and other developed continents), and lower risk of market collapse in developing countries because of high global demand; all in all stimulating the world's rural economies (Sims and El Bassam, 2004; Domac *et al*., 2005; Block, 2008; Lunnan *et al*., 2008). Whether or not employment alone can be counted directly as a rural development indicator, it is commonly agreed that higher wages generally have indirect benefits locally (Domac *et al*., 2005). Individuals with more money will have stronger purchasing power, which supports other local supply industries, whose employees will in turn be better off and are likely to spend their income within the community or region (Townsend *et al*., 2008). It has long been perceived that rural development projects provide vital opportunities for financially induced growth and major changes (Cernea, 1985); and bioenergy, in part due to the fact that proximity to feedstock is economically significant, represents an opportunity for increased local security of energy where central supplies might otherwise not be reliable or available (FAO, 2008; Lunnan *et al*., 2008). It has been suggested that volatility associated with agricultural commodity prices could be reduced by the liquid biofuels market in particular (see section 1.2.2). This may increase and stabilise demand from the traditional food, feed and fibre markets, thus reducing the risk for poor farmers in developing countries (Clancy, 2008).

In 2005, 81% of renewable energy sources worldwide (which accounted for 12% of the world's total primary energy demand) came from biomass due to its widespread non-commercial use in developing countries (IEA, 2007). Here, in 2006, traditional forms of cooking and heating accounted for approximately two-thirds of total global biomass consumption (IEA, 2006). Around half of the global population live rurally (NCSU, 2007) and the majority of the 2 billion people without access to adequate energy supplies live in remote rural areas of developing countries (Modi *et al*., 2006). As well as being focal points for international poverty reduction and sustainable development activities, these areas are often targeted for bioenergy plantations, therefore any negative outcomes have global significance (Chaturvedi, 2004). Forests and agricultural crops can (if not over exploited) provide flexible and renewable sources of fuel. Biomass can supply energy in the locality, where it can meet a range of needs, be stored for longer term fuel security, or exported as feedstock, all of which could potentially benefit individual farmers (Sims and El Bassam, 2004; Röser *et al*., 2008). Rural diversification is also considered a possible outcome of bioenergy projects, due mostly to the cumulative effects of employment and income generating opportunities associated with them (Elghali *et al*., 2007). All of these are seen as the desired socio-economic results of bioenergy feedstock production, however questions are increasingly being asked around the incidence of alternative results (Bailey, 2008). The possibility of perverse outcomes is increasingly being reported and will now be reviewed.

1.3.2 'Real world' examples and 'Food versus Fuel'

The actual social impacts from biofuel production in developing countries have been seen to be complex, with positive benefits coming through the promotion of rural and national development, and consequences for local livelihoods (Cotula *et al*., 2008). Most modern bioenergy projects are recent and there is limited consolidated research on impacts. In addition feedstocks such as oil palm, sugar cane or soybean are grown predominantly for food, so case studies on these plantations could relate to either food or fuel as end markets. Despite these difficulties in clearly attributing outcomes to bioenergy production, there are some cases where specific projects have been directly linked to adverse social impacts. In particular large scale, corporate, monoculture plantations would seem to have the potential to cause adverse social effects when not well managed (*ibid*.). Consequences have included people being removed from farmland, labourers needing to travel far and work long hours leaving insufficient time for subsistence, or workers being imported into the area with resultant social cohesion tensions (*ibid.*). The weak tenure arrangement in many developing countries means that individuals are particularly vulnerable to losing land or resources due to expansion of bioenergy feedstock (*ibid.*). Corrupt local authorities, including even traditional ones, can exacerbate this by supporting bioenergy development despite it having detrimental impacts on some community members. Some projects have been initiated with limited or no consultation with affected land users. For example in Tanzania, although community members have received compensation from international investors setting up large scale biofuel feedstock plantations, it is argued that it is trivial compared to the real value of the land (Gordon-Maclean *et al*., 2008; Sulle and Nelson, 2009). Traditional forest dwelling communities in Malaysia and Indonesia have also been displaced by oil palm expansion (Marti, 2008; Phalan, 2009). Whilst bioenergy production may result in job creation, they do not necessarily go to the displaced people, and in some circumstances total number of jobs may be actually reduced overall (Bickel and Dros, 2003). In addition the labour is mostly hard, unskilled and badly paid, though there are mixed reports on labour treatment which include positives. In Brazil, sugar growers receive higher wages than the agricultural norm, though sugar cane harvesting is often low paid in other developing countries (Assad, 2007; Worldwatch Institute, 2007; ICTSD, 2008; Smeets, 2008). Taking a national perspective, the Washington based think tank, the International Food Policy Research Institute (IFPRI), have published results from a modelling exercise indicating that biofuels could have significant positive impacts on economic growth and poverty reduction in Mozambique (Arndt *et al*., 2008). The possibilities of producing alternative crops may also contribute to the creation of new markets in developing countries as has been suggested in the PISCES project (Practical Action Consulting, 2009). Whether or not bioenergy projects have always resulted in negative social consequences, the need to account for potential social impacts is evident, and it is clearly important that they can be identified and minimised or eradicated where possible prior to implementation. **The inclusion of these considerations in policy and project planning is a key focus of this thesis**, so the approaches presented in Chapters 3 to 6 are intended to facilitate this process.

A further social concern relates to the suggested link between bioenergy, particularly in the form of liquid biofuels, feedstock production and increasing global food prices, often termed '*the food-fuel debate'* (Gallagher, 2008; Royal Society, 2008; Fischer *et al*. 2009). Scale again plays a part in the distribution of impacts. Nationally, food security of the poor could be threatened as agricultural land or resources get diverted to biofuel feedstock production (FAO, 2008; Rosegrant *et al*., 2008). Locally, low paid wage labour may replace crop growing activities, raising concerns that wage labour may not compensate for food security from previous household crop production (Haywood *et al*., 2008). However, studies have shown that the biggest impacts on food prices are reported to be high oil prices (Pfuderer *et al*., 2010) and grain production decreases resulting in less excess (particularly in major exporting countries such as Australia and Canada) (FAO, 2008). The food-fuel debate is not clear-cut, with counter arguments that bioenergy production may stimulate rural economies, particularly those of poorer countries, which will in turn potentially promote agricultural production. In addition a rise in food commodity prices could stimulate developing world agriculture, which has been suppressed by subsidised food surplus exports from Europe and America (Cotula *et al*., 2008; Rossi and Lambrou, 2009). In West Africa the region has the land, resources and demand to improve its agricultural and bioenergy production. According to the West African Economic and Monetary Union (UEMOA), policy changes which improve productivity and get more arable land into sustainable use have the potential to improve both food and fuel production (UEMOA, 2008).

This food-fuel issue will not be considered in much more detail because of its complex and globalised nature, whereas my work focuses on context-specific planning and assessment. It could still figure at the micro scale in terms of local reliability of food supplies in particular cases where a bioenergy project might compete with food production, and this will be taken into consideration where appropriate. The importance of this international debate is acknowledged. Ongoing, impartial monitoring is recommended to keep informed of the problem.

1.3.3 *The role of modern bioenergy in rural development*

Taking rural development as a driver for bioenergy crop cultivation, where energy provision is a secondary consideration, relies on it being socially and economically beneficial (and sustainable) within the community. It has been argued, however, that this will be the case only where robust political frameworks are in place, socio-cultural barriers are removed, techno-economic constraints are overcome, environmental implications are understood and effective market strategies exist (Wilkins, 2002). Whilst most authors would agree with these assertions, it is perhaps not agreed that meeting all of the conditions above would automatically result in a community benefitting from bioenergy cultivation. New technology and skills might be culturally unacceptable; the costs of setting up biomass projects are often too great and too risky for poor farmers; and a lack of long term assistance with the running of machinery can put projects out of operation at great personal and financial expense to those involved (Lwin, 2004). In fact the long term viability of decentralised rural electrification projects is commonly thought to be most greatly affected by financial sustainability and competitiveness (Monroy and Hernández, 2005). Despite these potential failings it is thought that, through careful management and policy formulation to ensure environmentally friendly and sustainable production, modern bioenergy programmes can play an important role in rural development (Chaturvedi, 2004). Enabling this process and **including socio-economic considerations in policy making through a planning for sustainability framework is a central theme of this thesis**. Nonetheless, environmental aspects and concerns in planning for sustainable bioenergy feedstock production are still important and not seen as being less significant than socio-economic impacts. The following section will briefly outline the positioning of this research within the context of environmental issues.

1.4 Environmental concerns

There are complex trade-offs and numerous potential environmental concerns relating to bioenergy production which often take priority over social issues globally (Domac *et al*., 2005). Variables such as the type of feedstock and the farming model used for feedstock production, for example large scale corporate-owned, mono-cropped plantations versus small scale farming with mixed cropping systems, can significantly alter the nature of the impacts and the potential for environmental sustainability (Rosegrant *et al*., 2008; Searchinger *et al*., 2008; Schoneveld, 2010). Reports of negative impacts arising from bioenergy feedstock production focus on, for example, the clearance of millions of hectares of primary rainforest in countries like Brazil and Indonesia to make way for soybean bioenergy crops (Eccleston, 2007; Grunwald, 2008); and the poor performance of some biofuels' production in the USA in carbon terms because of the significant amounts of energy employed in their cultivation (Bourne, 2007). There are also concerns over the potential for water resource pollution from transesterification and fermentation processes (Gasparatos *et al*., in press). 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 bioenergy, and petitioning governments to revise their targets and put measures in place to ensure it is truly benefitting local communities before implementation (WWF, 2007; Greenpeace, 2008). The real potential for bioenergy projects to contribute towards a reduction in GHG emissions, and the likelihood of major impacts on biodiversity of large scale monoculture plantations, have both been discussed extensively in the literature and public media. Both will be briefly considered here.

1.4.1 *The potential for carbon sequestration from bioenergy projects*

The actual climate change mitigation potential of bioenergy, in particular liquid biofuels, has been intensively debated, with many studies suggesting marginal or even negative impact (Fargione *et al*., 2008; Royal Society, 2008; Searchinger *et al*., 2008). It has been suggested that in crops such as maize the energy required in feedstock cultivation may approach or exceed that from the biofuel product, though in crops such as sugar cane and oil palm there are relatively large energy gains (Macedo, 2005; Searchinger *et al*., 2008). Direct and indirect land use changes can incur large carbon debts, particularly where deforestation occurs or peatlands are drained. Repayment could theoretically take hundreds of years depending on the efficiency of the feedstock crop and the amount of carbon released during land clearing. Oil palm plantations have been blamed for vast environmental degradation in the form of pollution of streams and groundwater through mill effluent, deforestation, peatlands drainage and methane emissions; however if planted on abandoned lands and appropriately managed they can rapidly repay their carbon debt (Fargione *et al*., 2008; Gibbs *et al*., 2008; Wu *et a*l., 2010). Soybean has also been linked to large scale direct and indirect deforestation and, since it has low yields, is very slow at paying back its carbon debt; though accounting for co-products greatly improves the GHG balance (Morton *et al*., 2006; Fargione *et al*., 2008). Brazilian sugarcane, when grown and processed in Brazil, has limited direct deforestation impacts and most lifecycle assessments suggest comparatively low carbon emissions (Rodrigues and Ortiz, 2006; Smeets *et al*., 2007; Fargione *et al*., 2008; Gibbs *et al*., 2008; Macedo and Seabra, 2008; Smeets, 2008). In addition to carbon, other gases such as methane, N_2O (nitrous oxide) and NO_x (Nitrogen dioxide) may also be released, or changes in albedo could occur as a consequence of bioenergy production and use, all of which have climate forcing impacts (Schwaiger and Bird, in press). In general, developing countries have low carbon emissions, with per capita emissions one to two orders of magnitude lower than developed countries (IEA, 2009). Though most of these countries have contributed little to global GHG emissions, they are likely to be the most affected by climate change (MA, 2005a). As a result it is often **difficult to clearly distinguish environmental from social effects** because inevitably they are interlinked and many knock-on impacts of environmental change are socio-economic. This relationship is explored further in Chapter 6.

1.4.2 *Biodiversity and sustainability in bioenergy projects*

Another issue of global concern is biodiversity loss (Koh and Wilcove, 2008). Due to their typically tropical locations, developing countries tend to have higher biological diversity than developed countries, with the degree of transformation and biodiversity loss relatively low due to low levels of industrialisation and agricultural development (MA, 2005b). Alarmingly, rates of deforestation and land use change are rapidly increasing in some developing regions, driven in part by expansion of bioenergy feedstock production, though other reasons include subsistence food production and energy needs (Morton *et al*., 2006; Drigo *et al*., 2009). Both direct and indirect land use change will have biodiversity impacts, particularly so where virgin afforested land is transformed, but even secondary forest and rangeland have high levels of biodiversity that could be significantly impacted (Schoneveld, 2010). However, in some cases feedstock cultivation may help reclaim degraded land and have an enhancing effect. Direct removal of biodiversity is not the only threat associated with bioenergy, there is also potential introduction of invasive alien plant species (IUCN, 2009). Though conservation is of concern to many developing countries, and most are signatories to the UN Convention on Biological Diversity, biodiversity may have lesser local importance than economic development given the pressing challenges of poverty eradication. In the case of biodiversity (as with those of other reported environmental impacts including changes to water quality and quantity, water and air pollution) local stakeholders might not perceive environmental issues as having the same level of impact on them as social or economic effects; though changes to resources are likely to result in negative consequences for local communities. The importance that stakeholders are prepared to attach to environmental issues is expected to increase as their social situation improves (Grossman and Krueger, 1995). This relationship will be explored further in section 6.1 (page 128), but **the thesis will predominantly focus on the inclusion of socio-economic aspects**.

1.5 Research aim

1.5.1 *Working within Re-Impact*

The increasing uncertainty surrounding whether bioenergy feedstock production does contribute towards sustainable rural development has been the focus of a €2.3 Million research project funded by the Europe Aid Cooperation Office Programmes on 'Environment in Developing Countries' and 'Tropical Forests and Other Forests in Developing Countries'. This initiative, entitled *Re-Impact* (Rural Energy Production from Bioenergy Projects: Providing regulatory and impact assessment frameworks, furthering sustainable biomass production policies and reducing associated risks)[2], ran for 40 months from May 2007. *Re-Impact* provided a platform from which the research for this thesis has been possible, as well as a wider planning for sustainability framework (Haywood *et al*., 2010) within which the approaches proposed are embedded (see Chapter 2). The project worked actively in four case study countries, namely India, Uganda, South Africa and China, with specialist partners in each. The multi-disciplinary project team, of which I was the coordinator, gained international recognition for the methodologies produced, and aspects of the work are being considered for incorporation into

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[2] Re-Impact, forest based bioenergy for sustainable development, website: www.ceg.ncl.ac.uk/rempact

policy making procedures[3] which is highly sought-after in interdisciplinary research (Oughton and Bracken, 2009). In my position as Project Manager and lead researcher on the social theme I was able to travel to all four countries and collaborate with the international experts from the partner organisations, as well as benefit from introductions to other stakeholders in the case study countries. As a result many of the activities described in the following Chapters are from collaborative pieces of work, so I will highlight my individual contributions where relevant.

As planning and assessment of bioenergy projects was identified as a strategic issue, *Re-Impact* allowed me to develop my research on successfully incorporating local level socio-economic issues into planning and assessment of bioenergy projects, taking India and Uganda as detailed case studies. The access to field sites, international and local experts, and stakeholders at all levels provided a strong basis for the Ph.D. research in these two countries, as they contain a suitable range of representative bioenergy feedstock production types. The work in this thesis was mostly completed as an additional activity to the project, outside the original remit, although all of the published material has been listed as project outputs because of their relevance to policy making in the four countries. My research did not depend on the project, but benefitted from it nonetheless.

1.5.2 *Working in rural areas of developing countries*

It is important that, before I present the specific research aim and objectives of my thesis, I briefly introduce the reasoning behind my focus on rural areas of developing countries. To do this I must also explain, in short, what I mean by developing countries. The World Bank definition (Soubbotina, 2004) refers to the economic structure or the official opinion of the government, and includes several countries with transition economies (including India) based on their low or middle levels of per capita income. The greatest proportion of the world's poorest (in purely financial terms) people live in South Asia and Sub-Saharan Africa (2007 figures, Rogers *et al*., 2008), and these regions are therefore considered to be developing. It can be seen from the selection of basic statistics included in Table 1.1, that India is the relatively more developed of my two case study countries from these regions, but both are still classed as low-income and have a high proportion of abjectly poor population.

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[3] Positive feedback from the Food and Agriculture Organization of the UN (FAO), the Southern African Development Community (SADC) and the International Union on the Conservation of Nature (IUCN). Interest from the Chhattisgarh Biofuel Development Agency (CBDA), the State Government of Madhya Pradesh, the European Union Delegation to Uganda, the Sawlog Production Grant Scheme (SPGS), and the Centre for Research in Energy and Energy Conservation (CREEC) at Makerere University.

Table 1.1: Selected relevant statistics for the case study countries India and Uganda (Soubbotina, 2004; Bhattacharyya, 2006; Dornburg *et al.*, 2009).

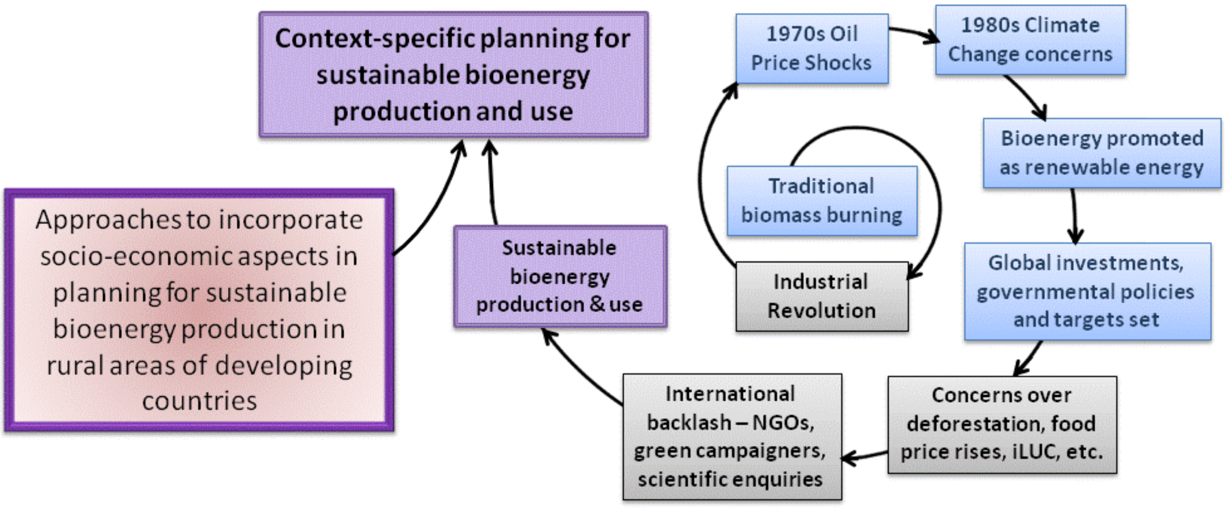
	Poverty		Urban Dwelling	CO_2 emissions		Forest area	Human Development Index		Traditional Biomass Use		
	% of people living on less than $1 per day		% of total population	total, million, metric tons	per capita metric tons	1000 sq.km	Score	Rank	% of population relying on traditional fuels		
Country	Year		1999	1996	1996	1995	1998	1998	Rural	Urban	Total
India	1997	44.2%	28	997.4	1.1	650	0.563	153	64.23%	7.77%	72%
Uganda	1992	36.7%	14	1.0	0.1	61	0.409	179	91.3%	22.1%	82%

My interest in studying developing countries in the context of sustainable bioenergy feedstock production is due to the high percentage of the population in these cases who rely on traditional fuels. Table 1.1 shows that in both India and Uganda the reliance on traditional fuels is significantly greater in rural areas. There is a need to meet multiple demands in this situation, including: (i) improve access to modern forms of energy; (ii) provide decentralised supply because of the remoteness of these communities or inadequacy of the national grid; (iii) reduce pressure on surrounding forest resources which are being rapidly degraded; and (iv) lower the unit cost of electricity (where available) as often poor rural households pay more than in urban areas. There have been a number of authors who suggest that meeting sustainable development goals, including energy provision, poverty alleviation and environmental degradation, cannot be achieved without improving the circumstances of the rural poor in developing countries (Dalal-Clayton *et al.*, 2003; Goldemberg and Lucon, 2010). Therefore this research is ideally placed to contribute to ongoing international efforts.

1.5.3 *Research aim and objectives*

Taking into account the fluctuating history of bioenergy production and use as depicted in Figure 1.2, and the importance of understanding the socio-economic drivers and consequences of bioenergy feedstock production in particular contexts, **this research aims to provide two approaches to include socio-economic aspects in planning for sustainable bioenergy feedstock production in rural areas of developing countries, taking India and Uganda as representative case studies**. Figure 1.3 shows the incorporation of this aim into the bioenergy popularity spiral from Figure 1.2. There have been many arguments around the benefits or disadvantages of bioenergy production and use globally, many of which have successfully highlighted specific aspects of the crops and technologies that need to be considered. However, there seems to be a lack of objective research using the knowledge gained and providing practical advice on planning and assessment for real world application. During *Re-Impact*, work on planning for sustainability and Social Impact Assessment (SIA), a key area requiring contribution, was identified. **Enabling stakeholders to get their roles in, requirements and risks from bioenergy projects (referred to as their dynamics) understood before policy implementation was found to be particularly important**.

In addition, ensuring that the stakeholders are equitably represented in the multi-stakeholder consultation (MSC) required for successful sustainability planning is difficult and, in developing countries, relatively untested. Improving this, through methodological developments and detailed case study investigation, is a major driver of my research.



The purple edged box represents the approaches proposed in this thesis and shows how they contribute to the wider bioenergy debate. I return to this Figure in later Chapters.

Figure 1.3: The contribution of this thesis towards improving sustainability in the bioenergy debate through approaches to incorporate socio-economic aspects. Author's own.

On the basis of a wide ranging literature review, this thesis considers the key assumption that there are certain situations in which bioenergy production and use could provide a genuine opportunity for sustainable rural development in developing countries, (i) meeting the needs and requirements of stakeholders, (ii) reducing environmental degradation, and (iii) potentially bridging the gap between existing and more sophisticated energy supply technologies. Regardless of these opportunities, there are many potential negative effects which need to be understood, accounted for and mitigated, and the reality is that there will be many situations in which bioenergy feedstock production is **not** the right mechanism to achieve sustainable rural development in developing countries. In order to investigate this possibility, and achieve the aim of the research, three main objectives have been identified. They are as follows:

[A] **Methodology assessment and development** – building on traditional Social Impact Assessment (SIA) and case study information, design straightforward yet robust and context-specific methodologies specifically for identifying social impacts of bioenergy projects and understanding stakeholder and production model dynamics.

[B] Through substantive results from **case study interrogation** in (i) India and (ii) Uganda – identify existing or proposed examples of bioenergy feedstock production (referred to as models) and comprehensively analyse their individual contributions to national and local objectives, particularly in terms of socio-economic outcomes.

[C] **Evaluate the wider applicability of the approaches and analysis** presented in order to assess whether bioenergy production can result in sustainable socio-economic development in rural areas of developing countries, and provide insights into how future planning could be targeted towards achieving this.

1.6 Outline of thesis and approach

The aim and objectives of the research map onto the chapter structure as shown in Figure 1.4. The objectives are addressed and achieved as follows:

a) Proposed approaches for assessing social impacts and understanding stakeholder dynamics are trialled and improved in the case study countries. Where appropriate this has been carried out in collaboration with *Re-Impact* partners and related experts to ensure the methodologies are as robust, practical and applicable as possible.

b) Selection of one feedstock production type which is identified to have potentially promising social impacts from the initial analyses. A range of sustainability aspects investigated through *Re-Impact* and other related initiatives are considered in more detail at to see whether such a production type could meet the development needs of the local population in a sustainable way. Planning and implementation procedures based on stakeholder consultation are suggested to contribute to a successful and sustainable outcome.

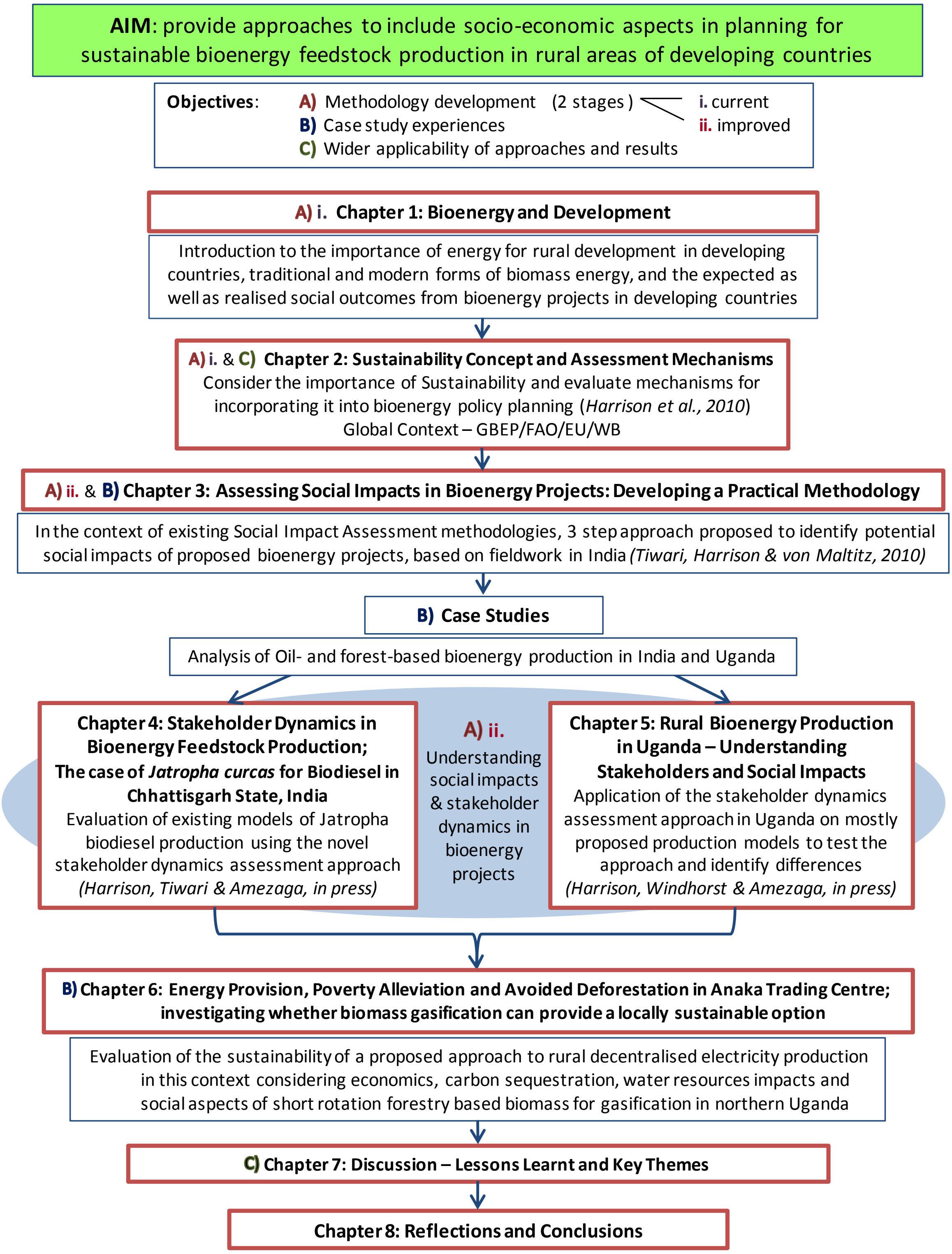


Figure 1.4: Flow chart of the research project and thesis Chapter structure, based around overall aim and objectives.

c) Conclude on the usefulness of sustainability planning as a framework, and the contribution of the approaches to assessing social impacts of bioenergy projects and understanding stakeholder dynamics as tools within that framework. Consider further work.

This research has been carried out within the *Re-Impact* project, which considered the impacts of bioenergy plantations on the water resources, biodiversity, greenhouse gases (carbon) projects, and society in its four Action Countries (India, Uganda, China, South Africa). Cooperation in all work packages has provided me with an insight into the different aspects of sustainability in the Action Countries, and methodologies for assessing them. The cooperation has also led to involvement in, and in many cases leadership of, a number of peer-reviewed publications and outputs which have contributed significantly to this thesis (see Figure 1.4). My individual contribution in each case will be highlighted at the beginning of relevant Chapters, as well as on Figures, Tables and Plates where appropriate.

Chapter 2.

The Sustainability Concept and Assessment Mechanisms in Biofuel Feedstock Production

The sustainability of liquid biofuels is a contentious and highly complex issue which was touched upon in the previous Chapter. Global, national and local concerns are involved, particularly in light of international debates over the impacts of feedstock cultivation on food prices. Climate forcing has tended to dominate the environmental sustainability debate, but for developing countries this is generally less of a concern, with issues of rural and economic development being of far greater importance. For the foreseeable future biofuel feedstock production will be a feature of global land use, so the debate is widening from simply whether they should be promoted or not and towards how to maximise their sustainability when they are proposed. If sustainability of biofuel feedstock production and use is to be achieved in different contexts, a multitude of strategies will be required, with no single one being a panacea for solving all problems (Harrison *et al*., 2010).

In Chapter 1 the need to include socio-economic considerations in policy making for bioenergy production was introduced, and planning for sustainability suggested as a supporting framework. In this Chapter sustainability planning and assessment will be considered in the wider context of other available mechanisms for driving sustainability in liquid biofuel feedstock production. It is important that the approaches which will be presented in later Chapters are incorporated within a suitable framework, because they are not intended to be standalone. This Chapter is largely based on work published in 2010 in collaboration with a wider team from *Re-Impact* and associated experts (Harrison *et al*., 2010), with the focus being on liquid biofuels because of their potential to be traded globally as transportation fuels (a lucrative market which must be properly regulated) and therefore subject to international market and trading regulations. I was lead author of this review; the contributions from the other authors were invited following a discussion with Graham von Maltitz from the Council for Scientific and Industrial Research (CSIR), South Africa, who was influential in identifying the need for this study. Lorren Haywood provided a contribution on Sustainability Assessment and planning; Annie Sugrue brought insider knowledge from the Roundtable on Sustainable Biofuels and the Global Bioenergy Partnership (RSB and GBEP); Rocio Diaz-Chavez has worked as an Environmental Impact Assessment (EIA), Social Impact Assessment (SIA) and Strategic

Environmental Assessment (SEA) practitioner on bioenergy and other projects; and Jaime Amezaga has experience of policy making and planning. Graham and I collated the inputs from these various specialists, then I constructed the narrative of the paper and worked with Graham again to frame the conclusions. I have rewritten and framed it specifically for this Chapter to meet the objectives of this thesis, although the underlying message remains the same.

2.1 Approaches to driving sustainability

Figure 1.3 (page 17) shows the current drive for ensuring sustainable bioenergy. Here, a number of the market-based and legislative mechanisms, as well as research and monitoring, specifically for liquid biofuel production and trade are considered as potential tools and decision-making frameworks. Their relative appropriateness and constraints are discussed below, beginning with market-based certification which is increasingly being applied directly to traded biofuel products. Alternative legislative approaches including national laws and guidelines, specific biofuel policies, planning and zoning, and impact assessment efforts will then be covered to see how these country specific options are being used. Finally, development and sustainability planning are considered as frameworks within which different tools, including those presented in the methodological Chapters 3 to 6, can be used for sustainability planning and monitoring.

2.1.1 *Market-based approaches*

Market-based approaches are those driven by the end users and generally rely on a product being controlled for a specific purpose such as quality, origin, or sustainability. Produce which has not met the criteria of that market will not be eligible for sale under a particular title or in that market. This can result in consumers being able to choose whether they buy the controlled goods (in the case of voluntary schemes), or in some cases the parameters are set at a higher level so that governing institutions will only allow products which meet certain criteria to be imported or sold under their jurisdiction (national standards). Certification is the predominant market-based approach, and has been adapted and used specifically for trade of liquid biofuels.

(a) Certification

There has been a recent proliferation of certification schemes responding to concerns about the impact of biofuel feedstock production (van Dam *et al*., 2008). Certification schemes cover a variety of issues, but individually none cover all feedstocks. Examples of voluntary certification schemes relating broadly to biofuels are: The Sustainable Agriculture Network (SAN) and Good Agricultural Practices (GAP) covering agricultural production; the Forest Stewardship Council

(FSC) targeting forestry; and Fairtrade labelling focusing on labour aspects and pricing. Within the biofuels sector a number of initiatives have been founded: the Round Table on Sustainable Palm Oil (RSPO) focuses on all palm oil products (biofuels specifically were added later); the Round Table on Sustainable Biofuels (RSB) is a generic standard covering all first generation feedstocks but limited to liquid biofuels; the Round Table on Responsible Soy (RTRS) focuses on soy; and the Better Sugar Cane initiative (BSI) addresses issues relating to sugar cane cultivation.

National standards have also been developed. In the UK the Renewable Fuels Agency started to verify imported biofuels under the Renewable Transport Fuel Obligation from April 2008[4], and this was in fact the world's first operating system. The Dutch government initiated the Cramer Committee for Sustainable Production of Biomass in 2006 which produced the 'Cramer Criteria' intended to improve the sustainability of biofuels. The German government released its Biofuel Quota Law in 2007, whereby a biofuel can only contribute to the quota if it satisfies certain legal requirements. Elsewhere, the California Low Carbon Fuel Standard focuses on carbon emissions in an attempt to reduce overall transport emissions. The European Commission (EC) published its Renewable Energy Directive (RED) in June 2009 mandating that 10% of energy used in transport in the region will be renewable by 2020. The biofuel target was the most controversial, with concerns raised regarding the impacts (particularly indirect) of biofuels and the need to ensure that they meet specific requirements (Gallagher, 2008). As a result of the controversy, the issues are still being debated and the EC held a consultation to report on ways to mitigate impacts which was concluded at the end of 2010. The Institute for European Environmental Policy reported in April 2010 that the report to review the impact of indirect land use change (iLUC, discussed below) on GHG emissions and addressing ways to minimise that impact was delayed, potentially undermining the credibility of the EU scheme (Bowyer and By, 2010). The main focus of the RED sections dealing with biofuel feedstock production is to prevent loss of biodiversity, avoid using land with high carbon content and achieve greenhouse gas (GHG) emission reductions. The social and economic impacts of most standard schemes refer to working conditions (wages, child labour, child and forced labour), land use rights, health and safety, and gender. Some aspects of criteria may be of greater relevance in developing countries (such as in Brazil and a number of African countries). However, some also apply to EU

[4] The Renewable Transport Fuel Obligations Order 2007 (2007 No. 3072) ("the RTFO Order") legally obliges fossil fuel suppliers for road transport to produce Renewable Transport Fuel Certificates (RTFCs) demonstrating that an amount of renewable fuel has been supplied which is equivalent to a specified percentage of their total fuel sales.

Member States, particularly from Eastern Europe (Diaz-Chavez and Rosillo-Calle, 2008). There are technical standards of biofuel characteristics in Europe (CEN standards48) and work has been initiated on CEN (European Committee for Standardization) sustainability standards as well as another initiative from the International Standards Organisation (ISO) (Diaz-Chavez, 2010a).

Pros and cons of certification

It has been stated (Hausman and Wagner, 2009) that "*certification is an economically sound tool to tell apart products with different attributes"* (page 18). Hausman and Wagner also acknowledged that, whilst certification of a product can show that a specific goal was achieved in that particular case, it does not protect against any of the issues on a country-wide basis. For example, while certification of one operation means that child labour was not used in the production of that specific biofuel, it does not mean that child labour is absent in the country (Hausman and Wagner, 2009). This can be extrapolated to include other issues such as deforestation, food security or biodiversity loss. One of the most controversial issues in the biofuel debate is that of iLUC impacts, which can have consequences for global and local economies, food prices, carbon emissions and biodiversity (Dehue *et al*., 2009; Hennenberg *et al*., 2009). Most certification schemes do not have the capability to include iLUC impacts although the need to do so has been globally identified (Mathews and Tan, 2009; McCormick and Athanas, 2010). iLUC issues are best addressed globally to avoid 'leakage' (whereby impacts are felt outside the country of origin and therefore discounted), but this becomes difficult when many of the countries involved suffer from weak governance. The EU and RSB are trying to work out ways in which to assess iLUC factors, and the topic is under review by different European and American organisations including the Global Bioenergy Partnership (GBEP)[5].

Certification is most effective in an environment where other related laws and policy already exist, because to achieve national or global sustainability of biofuels requires a range of local and global policy input. Some experts such as Hausemann and Wagner (2009) argued that the best way to protect forests might be to pay people to do so, rather than certifying products that have avoided deforestation. Where state capacity is inadequate, certification schemes requiring significant measurement and assurances could bias industrial development against poor

[5] "GBEP allows partners to organize, coordinate and implement targeted international research, development, demonstration and commercial activities related to production, delivery, conversion and use of biomass for energy, with a focus on developing countries", website: www.globalbioenergy.org

countries. Other experienced professionals have cautioned that use of too many Standards could constrain the development of a global biofuels market (Devereaux and Lee, 2009). Where governance is weak, certification needs to be stringent to ensure that the product has achieved the goals set for sustainable production. The RSB has developed an approach to deal with the risk factors of certifying in countries with poor state regulation. RSB self risk assessment considers factors such as land tenure, state governance and food security status (if the producer is operating in an environment with weak state governance, high food insecurity and risky land tenure, for example, they will fall into a higher risk category). The outcome of being in a higher risk category is that more frequent auditing is required, which therefore means higher costs. In addition there are costs of measuring products against the criteria set for certification schemes. Reliable indicators are proving difficult to identify, and performance-based indicators require measurement by producers themselves in the absence of accurate in-country databases. This acts as a producer tax in higher risk countries, potentially making them uncompetitive against those with more readily available data and favourable environments. This may be unavoidable if the integrity of the certification process is to be retained and its goals achieved (Harrison *et al*., 2010).

Certification and environmental issues

Two further issues of concern to developing country producers are: i) biodiversity protection and ii) GHG assessment requirements, both of which are important global concerns as introduced in section 1.4 (page 12). It is argued in many international *fora* that developed nations should pay for biodiversity protection in developing countries (Huberman and Gallagher, 2006; Fisher and Treg, 2007). Conversely, certification schemes require operators to maintain biodiversity at a cost to the producer. Similarly for GHG emissions, some biofuel certification schemes and governments require producers to measure and report on their own emissions. Limits are generally defined; requiring the biofuels to match, or improve on, emissions from fossil fuels. If the product does not meet these requirements it cannot be used to fulfil quotas, such as those which exist in the UK, Germany and the European Union. Complying may have certain financial benefits in markets like the EU, but if these do not offset the additional costs accrued to comply, the producer may be unfairly disadvantaged. If producing for national or less regulated markets, however, these concerns become less relevant and the strength of certification in addressing global environmental concerns is limited. Under the United Nations Framework Convention on Climate Change (UNFCCC) developing nations are not required to reduce their GHG emissions, thus certification schemes for them may go beyond what is considered fair under international treaties.

Some of the shortcomings of certification, such as a requirement for a project-based rather than a broad countrywide approach to sustainability, could be overcome if the majority of producers in a country participate. Thus issues, such as land use change, protection of high conservation value areas and retention of sufficient land for food production, could be dealt with at a broader and more efficient level. However, to achieve this requires strategic regional coordination that goes beyond the planning boundary of individual projects. It is also unlikely that any but the larger developing nation producers will participate as the costs of certification are high. The market is currently being driven by wealthy nations with a stronger, more politically driven environmental focus than developing nations which tend to focus more on social issues i.e. job creation and improved livelihoods (see section 1.2.1) (page 5). It is notable, however, that poor countries are increasingly using the sustainability criteria developed by the voluntary certification schemes to inform policy. For instance, the Southern African Development Corporation (SADC) has developed a draft set of sustainability criteria, largely based on those of certification schemes. Enforcement will nonetheless require the development of supporting policy and legislation across the various sectors including labour, water, agriculture, forestry and land. Countries with weak state governance may be tempted to require producers to participate in certification schemes, thus offloading the regulatory requirements. If this occurs too early in the development of the biofuel industry, it could prevent the sector from growing. Conversely, if the sector is not regulated soon the damage to forests, biodiversity and livelihoods could be irreversible.

2.1.2 *Legislative approaches*

Ideally, national legislation should be the key driver of sustainability in a country's biofuel development. As discussed below, however, the national legislative route is often insufficient in developing countries because of weak governance and an inability to enforce in some countries. Laws should reflect national priorities and be country-specific, in principle ensuring that these priorities are being met. This section will consider general legislation, the development of certain biofuel policies, and instruments including impact assessments and land use planning.

(a) National Legislation

Biofuel development raises issues which cut across numerous sectors and departments. Table 2.1 shows different legislations applicable to the biofuels sector, many of which are generic.

Laws referring specifically to biofuels, and in particular strategic plans for biofuel, should also be introduced. Legislation typically operates by providing incentives and disincentives, though could also be used to formalise processes such as strategic environmental assessment or land use zoning. Most countries have extensive laws and guidance to which biofuel projects should be adhering as a first priority; however there are known gaps which developers have been known to exploit.

Table 2.1: Examples of key legislations that would have applicability to the biofuel sector and issues of concern to be covered in law and decision-making (Harrison *et al*., 2010).

Sector	Legislations and Issues	
Environment	Impact assessments (these should be mandatory for any significant scale land use change or large industry development) Strategic Environmental Assessments (should be mandatory before a industrial sector is introduced) Pollution legislation (including climate change and GHG Emissions) Biodiversity legislation	
Agriculture, rural development, forestry and social	Soil conservation Land transformation Agricultural-forestry zoning Invasive alien species introductions Subsidies and incentives	Norms and standards Forestry policy Livelihood protection Food security Outgrower schemes
Investment and treasury	Forging investment policy Tax policy Strategic growth strategies Import/export policy	
Industry	Industry norms and standards Company legislation	
Labour	Labour wages Labour conditions Child labour	Gender equity Mechanisation and labour intensity Decent work
Land tenure	Security of tenure	
Energy	Fuel blends Petroleum standards Energy content	
Water	Water rights Catchment hydrology Stream flow Pollution Strategic allocation (e.g. agriculture vs. human need)	

A critical weakness in many developing countries is land tenure arrangements; in many cases large tracts of land are in customary or national tenure with land users having weak, or no, tenure rights (Cotula *et al*., 2008; Sulle and Nelson, 2009). Tenure reform is proposed or ongoing in a number of countries but remains a key issue in the developing world. The rights of minority groups, such as forest dwelling communities who often receive insufficient legal protection, are also linked (Marti, 2008; Phalan, 2009). In cases where the legal aspects of land tenure are in place, enforcement is crucial to protect these rights (Diaz-Chavez, 2010b). Biofuel production is an emerging sector, bringing new challenges that may not be fully covered by existing legislation. It is therefore appropriate to develop specific policies guiding its development, taking into account national priorities.

National legislation, as a means to ensure sustainable biofuel production, may suffer other limitations when used as a mechanism to drive sustainability in developing countries. These include:

- The inability of some countries to enforce it;
- Ineffective, dictatorial or corrupt government i.e. not representing national interests, or those of minority groups;
- Corruption of government officials allowing inappropriate investment, or condoning bad management practices. Bribery of government officials involved in granting development permits is a key issue of concern, particularly in countries with poor checks and balances;
- Lack of capacity to formulate appropriate laws;
- Slow and difficult processes for updating legislation. For instance, biofuel projects in many African countries have preceded relevant policy development;
- Difficulties in developing policy operating across ministries, and ministry-level vested interests;
- Potential conflicts between national policy imperatives and local community rights and needs;
- Insufficient public participation in policy formulation, and or poorly constituted, disempowered civil society pressure groups.

The existing legislation relating to biofuels and bioenergy in India and Uganda, and associated issues, will be discussed in detail in later Chapters as it is important in understanding the context of these case studies.

(b) Development of National biofuels policies

Given the vast quantities of available arable land, labour and favourable climatic conditions; some African, Latin American and Asian countries are currently being targeted for biofuel feedstock production (see section 1.2.1, page 5). Different areas within these regions are underdeveloped, with Sub-Saharan Africa having 34 of the world's 50 poorest countries; characterised by low income, low production, poor markets, low skills, poor access to information and high child mortality (UNFPA, 2005). In addition, traditional biomass is used extensively in all three regions. Biomass accounts for 5% of North African, 15% of South African, and 86% of sub-Saharan (minus South Africa) consumption (EIA, 2008). With notable exceptions such as Brazil, countries in developing regions tend to place low emphasis on the global drive for renewable energy. Instead, key drivers include provision of affordable domestic and industrial energy sources or the stimulation of economic growth (Mangoyana, 2009), such as in India where biofuel development has been used primarily to drive rural development and secure internal energy supplies (Reddy and Tiwari, in press). There has been an Indian Biofuels Programme for over 60 years, and India was among the first countries to develop a specific biofuels policy which, though delayed in its draft stages, was formally published in December 2009 (*ibid.*). The Indian policy will be discussed in more detail in Chapters 4 and 5. Most of the national energy policies/strategies within African countries have been developed over the last five years with many still in process (Jumbe *et al*., 2009). Biofuels do not feature prominently in many energy policies nor national development frameworks, being mentioned only in passing or discussed under broad areas such as renewable and non-renewable energy sources (*ibid.*), such as in the case of Uganda which is examined in Chapter 5. Only in the last few years has large scale biofuel production been seriously considered in developing regions, and this is mainly a direct result of pressure from foreign investors. Many developing countries are extremely underprepared due to the lack of legislation and regulation around renewable energy, thereby rendering them unable to adequately protect their natural resources and citizens' interests when foreign investors embark on large-scale biofuel exploitation (Ewing and Msangi, 2009; Jumbe *et al*., 2009).

Key to any biofuel policy is the identification of the country's strategic intent from its production, i.e. whether the intention is to promote or retard the development of a biofuel sector; and the expected strategic benefits if it is to be promoted. Policy is then required to ensure that these benefits are achieved. The key issues which need to be incorporated in biofuel policies include: regulatory frameworks and strategies to protect the poor, taking advantage of opportunities, lowering trade barriers to biofuels and ensuring environmental sustainability (Dufey, 2006; Jumbe *et al*., 2009). Some countries, such as Mozambique, initially experienced such pressure from foreign and local investors that regulations have been quickly developed in order to foster large scale biofuel production without a comprehensive national strategy (Hoyt *et al*., 2008; Schut *et al*., 2010; Amigun *et al*., 2011). Most policies have been formulated without analysing the impact of sector development on employment, food security and the environment as this information is not readily available. The development of a viable biofuel sector requires a strong, supportive policy and a firm legal, regulatory and institutional framework to ensure that measures are put in place to harness the contribution to socio-economic development whilst safeguarding rural livelihoods and the environment (Jumbe *et al*., 2009). A key limitation of biofuel policy development globally is the lack of reliable data on sustainability of biofuel feedstock production and use, as well as low country-level capacity to undertake the required background studies on feasibility and trade-offs. Even where capacity exists, the recommendations might in any case be overruled by national economic development imperatives.

(c) Planning and Zoning

Strategic land use zoning is potentially a powerful yet simple mechanism to ensure that biofuel development does not take place in socially or environmentally sensitive habitats. Zoning of areas where feedstocks must not be cultivated (no-go areas), and then leaving developers to decide where they can cultivate is more practical in many regards than identifying where cultivation should take place. For example, in 2008 the Planning Commission of India produced maps showing the 'marginal' land in each State which was identified as suitable for cultivation of biodiesel feedstock crops. This has not stopped them being grown in other areas, and in addition the remote and prescriptive nature of the land demarcation has not accounted for local allocation and existing use of these marginal areas (more information in Chapters 3 and 4).

Zoning can either be geographically specific or formulated against set criteria. It could be used to incorporate the possibilities of producing food and bioenergy crops separately, although to date this has not been used extensively. Examples of no-go areas for biofuel crop production include those of high biodiversity value (including but not limited to formal conservation areas and ranked according to both international and national interpretation); those areas with high carbon sequestration capacity; of historic or cultural importance; identified for urban expansion; or important for food crop production. Historically, conservation areas are not always aligned with local conservation priorities and, whilst almost all countries have defined such areas, strategic conservation plans based on detailed biodiversity assessments (such as those in South Africa) are less common (Driver *et al*., 2004). Protecting certain areas which meet specific criteria (i.e. those with high national conservation value) is excellent from a purely protectionist point of view, but could restrict the potential for sustainable activities suited to particular locations in contributing towards national development. In order to mitigate this, identification of globally accepted no-go zones such as those with high conservation value (including for instance primary forests, wetlands and areas with significant biodiversity) should be supported by additional activities. This is often called ground-truthing and involves local level mapping using participatory techniques to further classify areas and ensure that those with potential are not disregarded without good reason (Watson, 2010).

National level zoning covers only one aspect of biofuel sustainability, so other processes are also required. In most developing countries there are insufficient resources to carry out detailed site-specific assessments across the country, though this would be desirable. Zoning is therefore a broad-based approach to ensure that biofuels are not grown in sensitive areas, but it in no way negates the need for detailed site-specific investigations in the vicinity of proposed development locations.

(d) Impact Assessment

Currently, long established techniques such as Environmental Impact Assessment (EIA) are mandatory in many countries prior to any large scale project which is thought to have the potential to threaten the receiving environment (Abaza *et al*., 2004). EIA is not a planning tool, rather an assessment methodology to provide decision-making information based on the level of acceptable impact , or that which can be managed through mitigation (Carroll and Turpin, 2002; Morrison-Saunders and Fischer, 2006). It is particularly useful, once land use planning has been done and no-go areas excluded, to assess a particular project in a specific location. As well as national mandates, impact assessments are also compulsory from many funding agencies and finance institutions for projects meeting their criteria, for example on size or potential perceived impact. Each country and institution will have specific variables or criteria that trigger an assessment. The type of initiatives that might be traditionally subject to EIA would include macro hydropower and big infrastructure projects, therefore biofuel feedstock production and processing are unlikely in any but the largest examples to meet the criteria to require an EIA. This is an issue in itself because even smaller scale projects are expected to have a range of impacts. Even where biofuel projects would be subject to EIA, there are doubts regarding its ability to single-handedly foster sustainable development activities. These will now be discussed, followed by alternatives or complementary approaches developed to address them.

The laws on impact assessment are customarily made at the national level, often as a result of international conventions (Hacking and Guthrie, 2008). Since the introduction and uptake of EIA as an assessment tool, it has been responsible for bringing environmental concerns into project level development and has had many advocates. However there have also, particularly within the past decade or two, been some opponents who suggest that its success in promoting sustainable development has been limited (Becker, 2001; Gibson, 2006; Harrison *et al*., 2010). The criticisms of the approach include that it is traditionally only completed after project design and can therefore have minimal overall influence, instead strategies to reduce environmental impacts that are likely as a result of implementation are suggested. In developing countries where legislation, strategic planning and land use mapping to support biofuel development is often limited, EIAs are thought to be less effective due to the insufficient data availability on: biodiversity, ecosystem type, available water resources, carbon sinks, climate variability, local community reliance on natural resources, and likely future threats to ecosystems. Equally, the rigour of EIA is undermined if there are insufficient civil society pressure groups capacitated to mobilise environmental and social concerns. EIA has a limited integrative nature; ecological, social and economic effects are considered separately and potential cumulative effects that could manifest over time are not addressed. Therefore, in practise, it tends to provide only a snapshot which gives little or no attention to the range of social impacts that can be caused by such projects (Noble, 2000; Tiwari *et al*., 2010b). These issues and the use of EIA in the Indian case study will be discussed in Chapter 3. Such evaluations have resulted in many alternative (some complementary, others competing) approaches to improving the overall sustainability of programmes, policies and projects (Barrow, 2000; Dalal-Clayton and Sadler, 2005; Gibson, 2005), the most relevant of which will be discussed here.

Strategic Environmental Assessment (SEA)

Strategic Environmental Assessment (SEA), sometimes referred to simply as Strategic Assessment, is a participatory framework that has been used over the past 20 years to improve the incorporation of environmental issues into development policy, plans and programmes, and consider the probable impacts that planned developments will have on the social, environmental and economic aspects of a host area (Dalal-Clayton and Sadler, 2005). This approach represents an attempt to address one of the main limitations of EIA, namely that economic, social and environmental issues are addressed in isolation of each other, by evaluating concerns from a strategic perspective and thus integrating them into planning (*ibid.*). SEA proposes to ensure that considerations broader than only those applicable to individual projects are taken into account during planning. It considers the three aspects, or pillars, of sustainability (environment, economy and society) and has represented a real step forward in its incorporation into policy frameworks (Hacking and Guthrie, 2008; Jay, 2010). Recent developments in the form of 'Objectives-led SEA' and 'Objectives-led Integrated Assessment' have been composed; the latter seeks to integrate economic, social and environmental concerns in the assessment process and both are based on a common shared vision set out in the planning process by the stakeholders (Haywood *et al*., 2009).

Sustainability Assessment (SA)

Sustainability Assessment (SA) is a third generation tool that has evolved from EIA and SEA (Hacking and Guthrie, 2008). The main difference is that SA focuses on attaining the most sustainable outcome for the context, rather than simply assessing a proposed intervention. Although the SEA process has contributed towards incorporating environmental concerns in development planning, it does not necessarily assure sustainable outcomes, as it is driven by the strategies formulated for individual projects at its core rather than sustainability (Haywood *et al*., 2009). The practical developments, in terms of objectives-led SEA approaches, have represented important steps towards modern SA where the desired outcome is sustainability itself, rather than simply being to mitigate or minimise potential adverse environmental impacts (Haywood *et al*., 2010). In addition the approach is inherently integrative, participatory, positive and future-oriented (Gibson, 2006; Pope and Grace, 2006). The first and crucial step is for all stakeholders to jointly define an integrated sustainability goal (or vision), i.e. the desired outcome/s upon which the planning for the intervention should be focused (Gibson, 2006). Secondly, in order to assess whether the proposed intervention is sustainable or not, sustainability principles and criteria need to be defined to determine whether or not the goal has been met. These criteria need to be context-specific; taking into account local economic, social and environmental conditions, as well as the relationships between these components for the given set of stakeholders. Therefore, the SA process has to be iterative so that the learning generated at each of the steps can be fed back in, allowing for criteria to be revised as necessary. The SA approach is clearly a challenging one, both practically and theoretically, but is considered to be a fundamental requirement if sustainability is to become the key driving element in the development planning process (Pope and Grace, 2006). Initiatives such as *Re-Impact* have also favoured approaches driven by sustainability, stressing in particular the importance of locally-focused, evidence-based assessments conducted in, and led by, developing countries (Haywood *et al*., 2010). The intention is not to oppose the high level activities discussed earlier in this Chapter, rather promote the employment of parallel efforts from both top-down and bottom-up approaches in order to maximise the benefits from each.

Hacking and Guthrie have put forward a very useful framework for comparing and/or reconciling emerging forms of assessments focusing on sustainable development (Hacking and Guthrie, 2008). In this approach a spectrum has been drawn up with three axes to distinguish between the different assessment methods, namely:

1. Comprehensiveness – how fully the sustainable development themes (environmental, social and economic) are covered;
2. Integratedness – to what extent the different themes are aligned / connected / compared / combined;
3. Strategicness – whether the focus or perspective of the approach is narrow and short term or broad and future-oriented.

The framework shows clearly that none of the approaches considered ('traditional' EIA, Strategic Assessment, Triple Bottom Line, Integrated Assessment and Sustainability Assessment) are able to cover the whole spectrum. An additional assessment methodology considered specifically for this Ph.D. research is Social Impact Assessment (SIA), Figure 2.1 shows how this fits in with Hacking and Guthrie's framework.

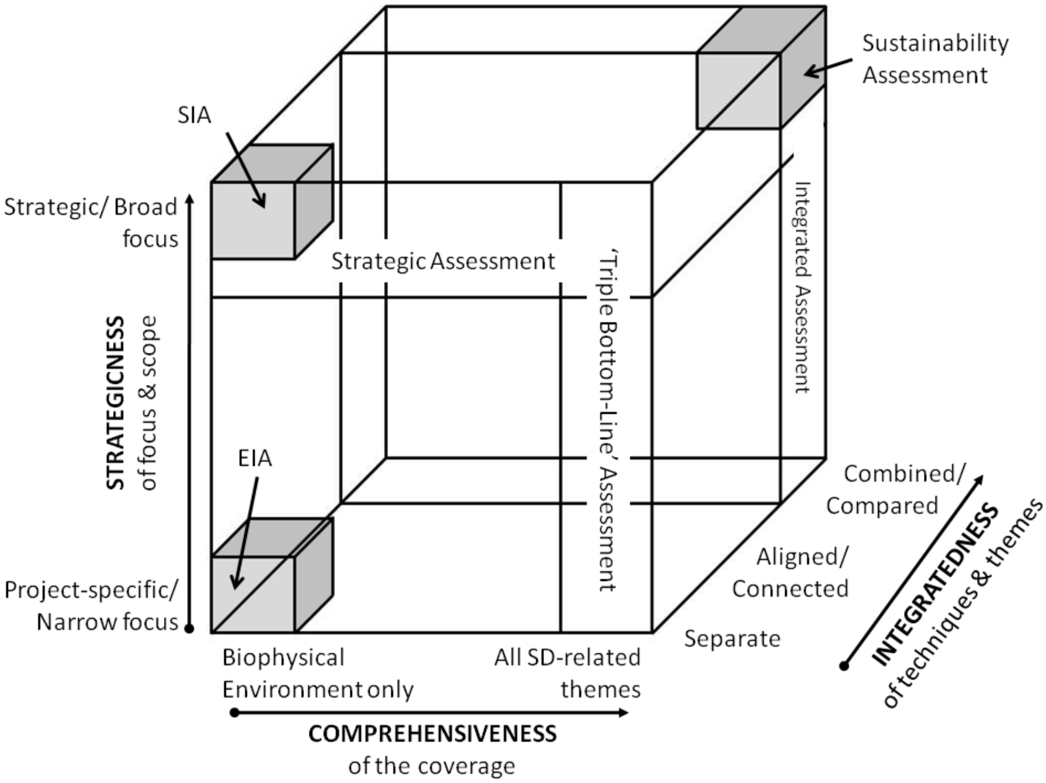


Figure 2.1: Spectrum of multiple impact assessment procedures across 3 axes, after Hacking and Guthrie (2008). This will be considered again in Chapter 8.

2.2 Development planning

It has been suggested that the rural planning process in developing countries is more often than not a top-down one (Dalal-Clayton *et al*., 2003). This essentially means that the policy making and planning takes place at central government level and is implemented according to national mandate, without the involvement of the locals who would be affected if there were to be negative social or environmental consequences (Hartter and Ryan, 2010). This practise is well established in many countries, including India and Uganda, and allows for strategic, national level, long term planning (whether this actually occurs is very situation-specific).

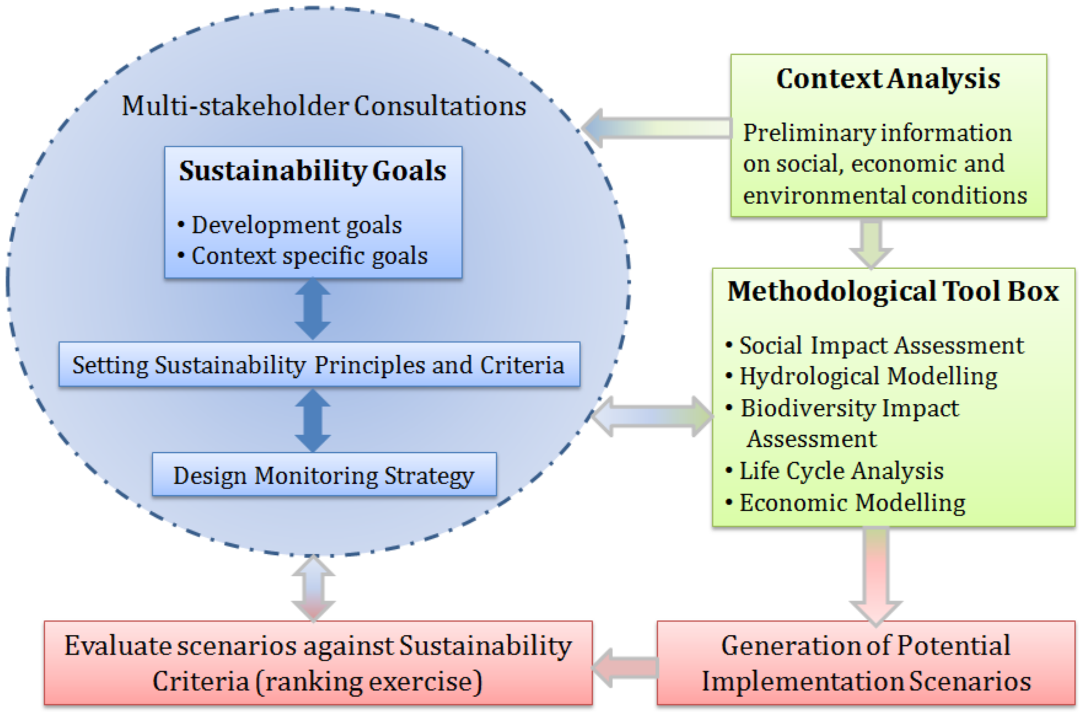
In contrast, bottom-up planning is described as that which is locally initiated and actively involves the community from the identification of development priorities right through to the implementation. Whilst proponents of planning for sustainable development demand that this sort of participatory decision-making is necessary for successful programmes; there are certainly many difficulties and barriers which must be overcome in order to achieve it fully (Dalal-Clayton *et al*., 2003). Chapters 3 and 4 will present approaches to facilitate stakeholder involvement and understanding with the intention of improving the likelihood of accomplishing participatory decision-making. Firstly, planning for sustainability is explored as a potential framework for applying these approaches.

2.3 Planning for Sustainability

Biofuel developments are outpacing normal planning and feasibility evaluation such as those described in previous sections. Sustainability Assessment is a tool that can be used expressly to prepare and design a biofuel development policy, plan, programme or project (PPPP) with sustainability as the desired outcome, rather than merely to prevent or mitigate potential environmental impacts (Pope *et al*., 2004; Pope and Grace, 2006). This is termed planning for sustainability. Since sustainability is an integrative concept, this should also be an integrative process that provides a framework for better, long lasting decision-making at all levels of development planning (Gibson, 2006; Haywood *et al*., 2009). These relationships need to be characterised and explored early in the assessment process to inform the accurate generation of appropriate criteria for measuring or monitoring the sustainability of a PPPP. Scorecards and certification systems are promoted as sustainability tools, however a process that promotes vigorous sustainability planning for the life span of the biofuel production right from drafting of policy is thought to be more effective and therefore could help strengthen trade agreements, both within and outside markets requiring certification (Haywood *et al*., 2008). This will be discussed further in section 3.2.1 (page 49). At a local level the perception of principles that need to be considered for sustainable production may also differ from international initiatives. For instance, as discussed in section 1.2.1 (page 5), GHG emission reduction is not considered to be a top priority issue in many developing countries, whereas the participation and opinion of the community and the conservation of local resources, particularly water, is highly regarded (Diaz-Chavez, 2010b). Despite the potential for it to manage these sorts of trade-offs through adaptive planning, sustainability planning is a new and developing science which currently lacks an institutional, legislative and funding framework.

2.3.1 *Tools for sustainability planning and monitoring*

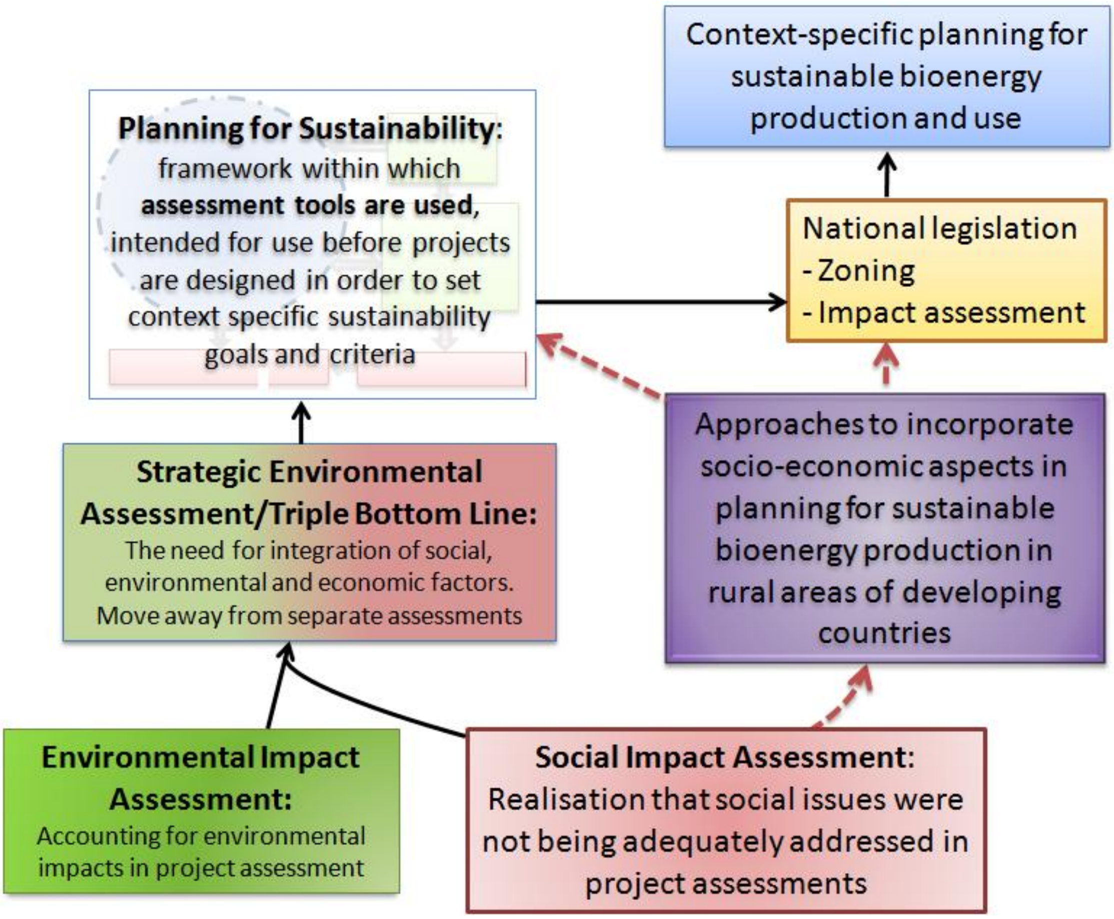
Within the framework of planning for sustainable bioenergy projects proposed under *Re-Impact* (see Figure 2.2), which I was involved in formulating during a brainstorming session with project colleagues, a number of targeted methodologies have been selected and developed as tools for assessing different aspects of bioenergy projects in particular.



Blue section: stakeholder participation (feeds into all other aspects), green: expert-led procedures (need direction from stakeholders), red: formulation and evaluation of scenarios (using tool box and stakeholders' sustainability principles and criteria)

Figure 2.2: *Re-Impact* sustainability planning framework for bioenergy projects (adapted from Tiwari *et al.*, 2009).

This framework was conceived during a collaborative session around the Indian case in which I was taking notes and afterwards drew up the initial prototype. This was then shared with colleagues and refined before I completed the colour version. A number of the tools developed will feature in the case study Chapters 3, 4, 5 and 6. This framework, which was developed along with *Re-Impact* project colleagues, has been found to provide a valuable context within which to structure my research because of its transparency and wide applicability, but also its inclusion of the targeted methodologies which can be employed to inform specific aspects of a stakeholder interaction for setting goals, principles and criteria. Figure 2.3 demonstrates very simply how the methodologies discussed in this Chapter fit together and have been drawn upon to provide a basis for assessment of bioenergy projects.



Green represents consideration of environmental impacts, red is social impacts. SEA combines aspects of EIA and SIA. Planning for sustainability shows the Re-Impact framework from Figure 2.2, drawing on lower levels of assessment tools. Orange are techniques discussed specifically in relation to bioenergy projects in Chapter 2. This Figure is revisited later in the thesis to see where my approaches fit.

Figure 2.3: The relationship between methodologies driving sustainability in land use planning, author's own.

2.4 Key messages and implications from Chapter 2

In order to achieve the aim of this thesis it was necessary to consider a suitable framework within which my approaches (to including socio-economic aspects in planning for sustainable bioenergy feedstock production in rural areas of developing countries) would be based. There are many useful mechanisms for driving sustainability in bioenergy projects; this Chapter has reviewed a number of them relating specifically to liquid biofuels production. As the focus here is on developing countries and the need for local rural socio-economic development opportunities, then planning for sustainability is the most appropriate framework for incorporating my approaches. From now on, whether implicit or explicit, it is intended that they would be carried out within the wider context of Figure 2.2.

Although sustainability planning is used in this thesis as the structure within which to frame the proposed approaches, from the review carried out in this Chapter it is thought that, globally, sustainable biofuel production should be driven primarily through sound national policy and legislation. Certification is also a powerful mechanism, but with some constraints that might not result in best land use, resource use, energy generation or development potential. In addition, if there are markets without certification requirements then biofuels produced unsustainably will be diverted there. Certification should provide useful for driving sustainability in countries where policy and enforcement are weak, though remains applicable in areas with sound policy arrangements, and may therefore be a useful tool for both national and international markets. Context-specific approaches are required to improve planning and implementation on the ground, rather than just 'one-size fits all' type procedures. If the EU is determined to use certification to ensure sustainable supply, it must invest in developing countries to support strong national policy and decision-making as well as practical technology support, grants, transfer of skills and more. This would allow planning for sustainability and certification to be used simultaneously and complement one another, which would greatly facilitate sustainable worldwide production and trade of biofuels. However, whether or not liquid biofuels or bioenergy as a whole are a globally sustainable option is not the focus here, instead the following Chapters will look in more detail at specific examples in India and Uganda and consider how to improve national planning and how it is locally implemented. Learning from the improved understanding of socio-economic impacts and stakeholder dynamics in particular bioenergy projects in certain situations will be used to refine approaches to including these considerations in planning for sustainable bioenergy production in rural areas of developing countries.

As discussed in Chapter 1 there is clear disjuncture and tension between the drivers for biofuel production from developed and developing nations. Countries facing extreme poverty and food insecurity must prioritise developmental issues. Short-term economic growth and the sustainability of livelihoods therefore tend to command greater attention than long-term environmental sustainability. Even within a single developing country there is potential conflict between national development and local social or environmental concerns. To achieve sustainability it needs to be understood that there are clear 'no-go' areas for development and these must be avoided at all costs. The trading of environmental capital for social benefit and vice versa may be justifiable, though there could be unintended consequences (e.g., climate change was not foreseen during the early years of fossil fuel use). When considering sustainability the question therefore is how, and from whose viewpoint, it is defined. High level (top-down), remote (whether geographically or in terms of political standing) and unsubstantiated (not ground truthed) definitions are largely insufficient for bioenergy projects, which tend to have very context- and case-specific impacts. Clearly, participation of stakeholders (most importantly local ones) is key to achieving sustainability; but this must be done in a framework of sound, evidence-based research so that decisions are not emotive, but based instead on reliable empirical data. Sustainability planning aims to define and measure success according to criteria set by, and in collaboration with, local stakeholders. The development of tools to facilitate this is a priority, and is the intention of the approach detailed in Chapters 4 and 5. From a developing country perspective, ensuring secure livelihoods is a key concern and, unless this is achieved, other aspects of sustainability are unlikely over the long term. Chapter 3 will look at these aspects in more detail.

Understanding the direct and indirect consequences of bioenergy, in particular of liquid biofuel initiatives, is extremely complex. Detailed planning is needed, based on sound scientific evidence as proposed in the sustainability planning framework for bioenergy projects (Figure 2.2). In addition, careful monitoring is required to ensure there are not unintended negative consequences. A key concern is around indirect impacts that may occur in unrelated sectors or spatially separated areas. The approach presented in the following Chapter aims to consider both indirect and cumulative social impacts, and help to incorporate these into planning and monitoring procedures. Clearly, though, no single tool can solve all problems in bioenergy production, as is the case with most other land use options. Feedstock cultivation, management, location and country specific issues all need to be considered. A multi-faceted assessment approach is required including, but not necessarily limited to, the mechanisms and issues outlined in this Chapter as well as possibly new ones yet to be identified. This does not mean that individual projects or policies cannot be developed or assessed using specific tools, rather that the global sustainability of biofuel, and indeed bioenergy, production cannot be achieved using one model.

In the following Chapter the development of a methodology for assessing social impacts of bioenergy projects in specific locations is described. It is important to understand that this methodology is not proposed as a tool to guarantee sustainable bioenergy feedstock production, it is intended to identify potential social impacts arising from proposed projects, and assist decision makers in designing ways forward to eliminate or reduce those identified impacts. It should be viewed as a component of the sustainability framework for bioenergy projects in Figure 2.2. Chapter 4 then goes on to document the development of an additional tool which provides a structured approach to understanding stakeholder dynamics in bioenergy projects. This approach is expected to improve the likelihood of successful multi-stakeholder consultation (MSC) as required for setting a sustainability planning goal and associated criteria. It also leads on to creating a typology of production models for that particular context with expected positive and negative impacts of each, gained through SIA and stakeholder interactions. The two approaches build on the existing assessment procedures described in this Chapter. They contribute towards meeting thesis objective [A]: "designing straightforward yet robust methodologies specifically for identifying social impacts of bioenergy projects and understanding stakeholder and production model dynamics" (page 18). It is intended that the context-specific approaches described in the next four Chapters would be incorporated into government planning procedures to allow the inclusion of socio-economic aspects in planning for sustainable bioenergy feedstock production in rural areas of developing countries.

Chapter 3.

Assessing Social Impacts in Bioenergy Projects: Development of a Practical Methodology

In Chapter 2 an overarching framework of sustainability planning for bioenergy projects, developed under the *Re-Impact* project, was presented for evaluation and development in this thesis. The framework, in Figure 2.2 (page 36), is intended to be a broad structure within which the approaches to incorporating socio-economic considerations in planning for sustainable bioenergy feedstock production in rural areas of developing countries presented in this thesis can be framed. The case study presented in this Chapter focuses on examining the individual and synergistic social impacts or effects of a variety of *Jatropha curcas L.* (commonly referred to as Jatropha) biodiesel feedstock production models across India. Substantive results from the case are presented, followed by the outline of a more widely applicable approach, designed in collaboration with *Re-Impact* colleagues as a result of the Indian experience.

The research and methodological application has generated valuable information on the Indian case, contributing towards thesis objective [B]: improving understanding of feedstock production models and social outcomes in the case study (page 18). Whilst the methodology followed is based loosely around the process of Social Impact Assessment (SIA), it has been used specifically for predicting the impacts of bioenergy feedstock production, using recently existing examples, and so is not a straightforward application of the traditional process. Working within the wider planning for sustainability framework, this Chapter contributes significantly to thesis objective [A]: "methodological assessment and development in assessing social impacts". This methodology was developed initially for the Indian context in collaboration with the *Re-Impact* SIA expert partners at Winrock International India. My role was to lead the academic side of the research in terms of using the correct terminology and literature, whilst taking direction and learning from experienced Indian practitioners with excellent knowledge of the field sites and issues. The methodology for wider application has been reviewed and published as a chapter in an edited volume (Tiwari *et al*., 2010b), to which I contributed the majority of the scientific background and collaborated on designing questions, populating tables and identifying the range of stakeholders. I also edited and finalised the work, before presenting it at international conferences in India and South Korea. It forms the basis for the approach to understanding stakeholder dynamics in feedstock production, the development of which is described in

Chapter 4. In addition, certain aspects are used in the assessment of the social impacts of potential bioenergy production models in Uganda in Chapter 5.

In the following sections, the background to the need to understand social impacts and a brief history of the development of SIA are outlined. The importance of assessing social effects in planning bioenergy projects and policies is then detailed, together with an in-depth evaluation of what social impacts are regularly expected, reported and likely to arise from bioenergy feedstock production. Sections 3.3 to 3.4 set out the process followed in India and results in detail. Based on this application, a higher level methodology intended to be flexible enough to be applicable in other situations is presented in section 3.5. The discussions and implications are summarised in the final section, alongside a reflection on the usefulness of the approach.

3.1 Social Impact Assessment

Before detailing the process followed here, existing practices in SIA will be presented and reviewed because of their relevance and contribution to its inception. This review includes consideration of the need for such approaches, the impacts and variables covered, and the development of the research area of SIA over time.

3.1.1 *Social Impacts*

It is necessary to understand what is meant by social impacts before trying to assess them. The Inter-organizational Committee on Guidelines and Principles for Social Assessment defines them as: "*the consequences to human populations of any public or private actions that alter the ways in which people live, work, play, relate to one another, organise to meet their needs, and generally cope as members of society*" (ICPGSIA, 2003, page 231). Put more simply, they are considered to be the impacts of developmental interventions on the human environment and cover a much broader range of issues than might be assumed. The International Association for Impact Assessment (IAIA) proposes a way of conceptualising social impacts, which refers to the adjustment to one or more of the following (IAIA, 2003):

- **people's way of life** – how they live, work, play and interact with one another daily;
- **their culture** – shared beliefs, customs, values and language or dialect;
- **their community** – its cohesion, stability, character, services and facilities;
- **their political systems and institutions** – how much people are able to participate in decisions affecting their lives, the level of democratisation, and resources provided for this;
- **their environment** – quality of surrounding environment, access to/control of resources;

- **their health and wellbeing** – health is a state of complete physical, mental, social and spiritual wellbeing and not merely the absence of disease or infirmity;
- **their personal and property rights** – particularly whether people are economically affected, or experience personal disadvantage which may include violation of civil liberties;
- **their fears and aspirations** – perceptions about safety, fears about the future of their community, and aspirations for their future and the future of their children.

These social impacts or effects can be categorised as: direct effects that relate to the proposed action; indirect effects that occur as a result of the proposed action and the changes brought on by the direct effects; and cumulative effects that occur over time as changes build up from the proposed action and all other knock-on consequences (Becker, 2001). Whilst undertaking a SIA, efforts need to be made to cover all three categories. In practice, predicting indirect and cumulative impacts by SIA is difficult and it can be possible to gain a sense of false security from an assessment, particularly where insufficient time or resources were allowed (Barrow, 2000).

3.1.2 *An Introduction to SIA*

Social Impact Assessment methodologies were developed in the early 1970s with the aim of identifying and managing social consequences of developmental initiatives (Vanclay, 2005a). Since then the approach has evolved considerably. Typically, SIA has been embedded within the longer established Environmental Impact Assessment (EIA) process and has not often been undertaken as a stand-alone exercise. This practice has fuelled the misunderstanding that assessing social impacts is only necessary when they result from environmental impacts (Du Pisani and Sandham, 2006). Since around the turn of the 21st Century there has been a change in perception regarding the use of SIA. It is increasingly being considered as a separate, specialised, and important exercise that needs to be undertaken for an improved and holistic understanding of the various interconnected impacts of different developmental activities (Barrow, 2000). It is important to note here that these impact assessments help in identifying the likely positive (synergies) as well as negative (trade-offs) impacts of proposed policy actions, and thus facilitate informed decision-making (CGG, 2006). There are several approaches to SIA but, by and large, they are based on five social variables covering the full range of social impacts, see Box 3.1. These five categories of variables guide the SIA process but need to be tailored to the specific situation being assessed. Depending on the case, some of them may be more affected by the intervention than others, and would therefore need to be emphasised accordingly.

1. **Population Characteristics** including present population and expected change, ethnic and racial diversity, and influxes and outflows of temporary residents as well as the arrival of seasonal or leisure residents.
2. **Community and Institutional Structures** including the size, structure, and level of organisation of local government including linkages to the larger political systems. They also include historical and present patterns of employment and industrial diversification, the size and level of activity of voluntary associations, religious organisations and interests groups, and finally, how these institutions relate to each other.
3. **Political and Social Resources** including the distribution of power and authority, the interested and affected publics, and the leadership capability and capacity within the community or region.
4. **Individual and Family Changes** involving factors which influence the daily life of individuals and families, including attitudes, perceptions, family characteristics and friendship networks (commonly labelled as social capital). These changes range from attitudes toward the policy to an alteration in family and friendship networks to perceptions of risk, health, and safety.
5. **Community Resources** including patterns of natural resource and land use; the availability of housing and community services to include health, police and fire protection and sanitation facilities. Key to the continuity and survival of human communities are their historical and cultural resources. Under this collection of variables possible changes for indigenous people and religious sub-cultures are also considered.

Box 3.1: The five social variables categories used as the basis for SIA (CGG, 2006).

3.1.3 *The methodological evolution*

The basic approach to SIA has evolved since its inception. This can be roughly gauged by the changes that its definition has undergone. The Inter-organizational Committee on Guidelines and Principles for Social Impact Assessment (ICPGSIA) stated in 1994:

"*We define social impact assessment in terms of efforts to assess or estimate, in advance, the social consequences that are likely to follow from specific policy actions (including programmes and the adoption of new policies), and specific government actions (including buildings, large projects and leasing large tracts of land for resource extraction), particularly in the context of the U.S. National Environmental Policy Act of 1969.*" (ICPGSIA, 1994, page 1).

This reflects the 'technocratic' and US-centric type of approach which was followed until the 1990s. Vanclay (2005b) considered this to be inherently limiting as it was regulatory in nature and did not recognise the role for the management, mitigation, and monitoring of impacts or the contribution of other stakeholders towards the redesigning and participation in decision-making about what constitutes an appropriate project. It was felt, therefore, that this approach to SIA was not conducive to engaging communities, achieving sustainable development or even ensuring good project design; because impacted people might not be outwardly indicating change, but may learn and react differently in future as a result of the intervention.

As the SIA discipline continued to develop it began to move away from this traditional and technocratic understanding towards a more inclusive or ‘participatory’ definition. In 2003, the IAIA’s revised definition was proposed as part of the development of International Principles for Social Impact Assessment:

“*Social Impact Assessment includes the processes of analysing, monitoring and managing the intended and unintended social consequences, both positive and negative, of planned interventions (policies, programmes, plans, projects) and any social change processes invoked by those interventions. Its primary purpose is to bring about a more sustainable and equitable biophysical and human environment*” (IAIA, 2003, page 2).

Beyond involving the local communities that could be affected by the change, this revised statement defines SIA as a tool that offers assistance in the evaluation, management and understanding of the process of social change, which is one of its main advantages. It ensures that development interventions are: (i) informed and take into account the key relevant social issues; and (ii) incorporate a participation strategy for involving a wide range of stakeholders. Since 2005 there has been increasing demand for SIA to be ‘integrative’ and more broadly focused (Tassiopolos and Johnson, 2009). This has also been the case with Environmental Impact Assessment (EIA) since the 1980s, hence the inclusion of SIA and even Strategic Environmental Assessment (SEA), which were all discussed in Chapters 1 and 2. It has even been suggested that SIA can be used to identify natural resource conflicts before they occur (Barrow, 2006).

It is important to stress that SIA is a primarily qualitative technique which cannot be 100 percent predictive or accurate. This is because it relies on the objectivity of the assessor and the knowledge or honesty of the stakeholders involved. In addition the success, or effectiveness, of an SIA procedure depends very much on the objectives behind its employment (O’Faircheallaigh, 2009). Social impacts, particularly indirect and cumulative ones, are complex to predict. There are many reasons for this, for example people often respond in different ways to those which might be expected or how others in the same situation might react (Upham *et al*., 2007). SIA relies on perception and expectations of the future, though in many circumstances respondents have imperfect information on the actual outcomes that may be reached. For instance, in the case of the biodiesel feedstock crop *Jatropha curcas L.*, there is limited data on the yields that will be achieved, the production costs and labour that will be incurred or the market price for the seeds. All of this makes it difficult for stakeholders to formulate a clear perception of likely consequences.

Becker (2001) identifies three types of SIA: micro, meso, and macro. Type 1 (micro-SIA) focuses on individuals and their behaviour; Type 2 (meso-SIA) focuses on organisations and social networks (including communities); and Type 3 (macro-SIA) focuses on national and international social systems. The three types can be found in different settings; sometimes exclusively focused on social impacts, while at other times they are integrated with other forms of impact assessment (Becker, 2001). Identifying the scale at which planning, decision-making and assessment or monitoring is made is crucial for understanding the impacts that an intervention might have on communities. In this case, the proposed methodology for understanding the social effects from bioenergy feedstock production projects (such as Jatropha seeds for biodiesel in India which is discussed here), falls largely within the Type 1 and 2 categories but also touches upon Type 3 as well.

3.1.4 *Social Impacts as a component of Sustainability Planning and Assessment*

Whilst in most countries SIA is conducted under the established legislation and procedures of EIA, there is a growing awareness regarding the need for understanding social aspects separately (Barrow, 2006). This involves assessing a wider range of parameters with a focus on social issues of justice, poverty and sustainable development alongside environmental concerns. It is important to remember that SIA is focused predominately on just one of the three central components or pillars (social, environmental and economic) of sustainable development. Project design should therefore be embedded within an overarching sustainability planning framework that is specific to it and includes techniques to consider other relevant aspects (Haywood *et al*., 2010) (see section 2.3.1 and Figure 2.2, page 36). SIA is a particularly beneficial tool for planning as it provides a robust mechanism by which stakeholders are involved and assists in framing the sustainability goal towards which development is directed. Achieving sustainability is a core challenge for most development programmes. This challenge can only be met if, at the planning and implementation stage, there is as clear an understanding as possible of the expected and potential impacts of the intervention – both positive and negative (Bell and Morse, 2008).

3.1.5 *Adapting to different contexts; putting people first*

The importance of understanding likely social consequences of interventions is highlighted by du Pisani and Sandham (2006) who, referring to Baines *et al*. (2003), state that one of the most important contributions of SIA is to "*move the focus of the policy debate away from the notion of a technical problem to be solved to a social issue to be managed*" (page 708). Here, SIA is recognised as a planning tool for mitigating adverse social impacts, as well as one that would facilitate the management and monitoring of interventions themselves. This calls for a shift in the manner in which projects are designed, executed and assessed; and to 'put people first'. While assessing projects or programmes it is important to recognise that there are many issues to consider and that little can be taken for granted. The regulatory, cultural or religious context can vary, as can the social and economic priorities for development (IAIA, 2003). Therefore, there is not a universal blueprint for assessment, even in a specific field such as bioenergy feedstock plantations. There are guiding principles, approaches and tools, but in each case these need to be appropriately adapted to the specific context and location that is being assessed.

3.2 Social impacts in bioenergy projects

It has been conventionally considered (Huttenen, 1999) that assessing social effects should be one of the components of the EIA process. In general, as explained in Chapter 2, EIAs have not been undertaken for all developmental interventions that require a significant change in land use, particularly if it is already under some form of agriculture (as is the case with many bioenergy plantations), but only for large initiatives, e.g. construction of dams, highways, ports, or large scale deforestation (Hacking and Guthrie, 2008). Gradually, over the last decade or two, more countries (including the UK, Australia, South Africa, Uganda) have been revising their impact assessment procedures. These revisions are largely taking place in developed countries as, whilst in developing countries there is an opportunity to undertake development 'differently' to the path followed in the majority of industrialised countries, these procedures are yet to be altered. This can be gauged by taking bioenergy projects as an example, in this case liquid biofuels, as in Chapter 2. Liquid biofuels programmes for petroleum and diesel replacement, or more commonly blending, were initially and mainly developed in response to global climate change, fuel security and oil price concerns. The United States is using food-based crops (maize and soybean) for the development of biofuels, whilst in Europe the focus so far has been on biodiesel production from oilseed rape and sunflower (Dien *et al*., 2002; Fischer *et al*., 2007). In developing countries such as India, and some others in Asia and Africa, efforts are being made towards developing biofuel feedstocks using different species, institutional models and approaches. However, 'red flags' are beginning to be raised globally and locally regarding the impacts that these plantations are having. These include social impacts such as on food security, water availability, poverty levels, and the rights of local communities (Bailey, 2008) in addition to environmental issues such as biodiversity impacts (Fisher and Treg, 2007), which were discussed in sections 1.3 and 1.4 (pages 8-14).

In early 2008, the then EU Environment Commissioner Stavros Dimas announced that it may be better for the EU to miss its target of reaching 10% renewable content in road fuels by 2020 than to risk compromising the environment and human wellbeing through the policy if its impacts were questionable (Vermeulen *et al*., 2008). The Science Council of the Consultative Group on International Agricultural Research (CGIAR) developed a policy statement on the challenges related to the global community's renewed interest in and attention to liquid biofuels, and what the likely implications of this development are for the poor and the environment. This report found that "*within developing countries, there are still trade-offs and distributional effects that must be considered, between rural and urban, and between well endowed and poorly endowed groups. Whether a reasonable share of the benefits from biofuels development can accrue to small-scale actors in the biofuel production system chain is still a question*" (CGIAR, 2008, page 19). A report by Oxfam (Bailey, 2008) found that, whilst biofuels may offer some genuine opportunities for development in poor countries, "*the potential economic, social and environmental costs are severe and decision makers should proceed with caution*" (page 1). The report also stated that 30% of the recent increases in food prices were attributable to biofuels, jeopardising the livelihoods of nearly 100 million people worldwide and dragging 30 million into poverty (*ibid.*). The contribution of biofuels to food price increases is, however, highly contentious, with alternate studies refuting these impacts, and pointing out that long term effects may well differ from short term impacts (FAO, 2008; Pfuderer *et al*., 2010).

In the case of developing countries, Biofuels Programmes are anticipated to provide significant rural employment opportunities (Domac *et al*., 2005), as discussed in section 1.3 (page 8). This is true on the whole as levels of mechanisation are low and most of the work needs to be undertaken manually. However, an Indonesian analysis concluded that existing smallholder agriculture in West Kalimantan supported almost 260-times as many livelihoods as plantations that could be used for biofuel production (Renner and Mckeown, 2010). Elsewhere, soybean in Brazil displaces many ranching livelihoods for each biofuel job created (BWC, 2008); numerous locals who engaged in the palm oil production industry in Indonesia have ended up indebted and in poverty, with their land tied to monoculture by contract (Glastra *et al*., 2002); and the profitability of Jatropha to farmers has been questioned (Borman *et al*., in press). Therefore, there are several unknowns regarding the social impacts arising from the development of Biofuels Programmes that need to be further investigated, but one certainty is that there will continue to be social trade-offs involved in their production and use as alternatives to fossil fuels (Glastra *et al*., 2002; Vermeulen *et al*., 2008).

3.2.1 *International efforts to ensure socially sustainable bioenergy production*

What the examples of the social concerns from developing countries highlight is the need for the SIA process to inform policy makers and developers in their promotion and execution of bioenergy projects so as to ensure long term sustainability. There have been concerted efforts at the international level towards achieving this, as discussed in Chapter 2. For example, the Responsible Cultivation Area (RCA) initiative is a private sector initiative coordinated by the consultancy ECOFYS in collaboration with Non-Governmental Organisations (NGOs). These NGOs include the World Wide Fund for Nature (WWF) and Conservation International, as well as industrial parties such as Shell and Neste Oil. The initiative provides a set of criteria that together define the requirements for RCAs, and a methodology for their identification (Cornelissen and Dehue, 2009).

The 'Sustainable Energy and Climate Change Initiative' and the 'Structured and Corporate Finance Department' of the Inter-American Development Bank (IDB) created the IDB Biofuels Sustainability Scorecard[6] based on the sustainability criteria of the Roundtable on Sustainable Biofuels (RSB). This is a market-based approach as discussed in section 2.1.1(a) (page 22). The Scorecard is aimed specifically at liquid biofuel projects instead of bioenergy as a whole. Its main objective is to encourage higher levels of sustainability in these projects, by providing a tool to think through the range of complex issues associated with biofuel production from the field to the tank. The Scorecard includes general environmental and social criteria. It begins with background information then proceeds to more specific details; and covers the cultivation, production, and distribution phases of biofuel projects. This Scorecard was first launched in 2008 and was revised a year later in 2009. It is viewed as 'work-in-progress' and is to be continually updated and revised as necessary (Ismail and Rossi, 2010).

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[6] Last accessed 01/02/2011 at URL: http://www.iadb.org/biofuelsscorecard/index. cfm?language=English

These are some examples of initiatives at the international level seeking to facilitate the process of building in parameters of sustainability into biofuel projects and programmes. Here, social aspects form one of the key components. It is clear that biofuel projects have social impacts; both positive and negative. It is also important to recognise that different sectors of society are impacted differentially, and whilst some individuals might clearly benefit, this could be at the expense of others living in the vicinity. Therefore not only net benefit, but also equity and fairness in benefit distributions need consideration. It is important to identify all impacts, particularly the negative ones and those adversely affected, and to devise mitigative strategies where necessary. These approaches all have particular objectives, as discussed, and merits in how they achieve those objectives. Their importance is evident, considering the level of concerns relating to the social sustainability of bioenergy production. However, from research and fieldwork carried out to date there does not appear to be any method which specifically takes account of the context-specific nature of impacts arising from bioenergy projects and assesses expected social issues (both positive and negative) in depth. This would not replace existing mechanisms, but be intended for use in planning projects and policies to minimise or avoid negative social consequences.

3.2.2 *A new approach*

The following sections present a case study of analysing the social impacts of the use of *Jatropha curcas L.* as a biofuel (primarily biodiesel) feedstock in India. Jatropha is a shrub which bears seeds of varying oil content. It is described as being hardy and well adapted to dry climates, and has become increasingly popular for biodiesel production as a mechanism to achieve rural development (Francis *et al*., 2005; Achten *et al*., 2010). This is primarily due to suggestions that it will grow productively on marginal land, thus avoiding competition with food production, and even help to rehabilitate such areas (Brittaine and Lutaladio, 2010). These claims have been robustly refuted (Jongschaap *et al*., 2007) and it seems that the actual effects will be extremely site-specific. This case therefore presents an interesting subject for an in-depth social assessment because of the need for a flexible, adaptable approach rather than a 'one size fits all' mechanism which could miss nuances of different projects.

A variant on the standard SIA methodology was developed under my academic direction in the *Re-Impact* project as a result of the work on the Indian case study and is presented in this Chapter to provide a context-specific tool which can be used in planning. This approach is specifically intended to identify the range of social impacts associated with bioenergy projects in different cases and, where possible, address the concerns raised about equity, cumulative and indirect impacts. In the Indian case, the Biofuels Programme had already been initiated and a Biofuels Policy developed by the Indian government (Reddy and Tiwari, in press). As a result, this exercise is not a traditional SIA (which should take place in advance of project planning) but rather as an assessment of the social impacts arising from biofuel projects in the country. Nonetheless, its results can be used towards improving the design and implementation of these projects to maximise social benefits, as well as informing the SIA process for future applications.

3.3 A Methodology for Assessing Social Impacts of Biofuel Projects

Modern bioenergy development must be viewed within the context of the existing socio-economic conditions and prevalent resource management systems i.e. the economic, social and environmental conditions and their interrelationships. The methodology used here draws on the SIA approaches suggested by Becker (2001) and the Centre for Good Governance in India (2006). In order to adapt it for bioenergy interventions, initial learning from extensive scoping work across India and one-to-one interactions with relevant national level government officials and key research institutes have been incorporated. The following sections will detail the fieldwork that was undertaken and the results obtained. These insights have been used, alongside an in depth literature review, to produce a two step methodology (presented in section 3.5) for assessing the social impacts of bioenergy feedstock production.

3.3.1 *Indian fieldwork process*

The first activity was a thorough literature search which provided a preliminary understanding of the Indian context, in particular with relation to biofuel feedstock production. This included identifying the major policy drivers and strategies as well as relevant global economy and other factors that do (or could) influence its outcomes. From this an outline of the baseline situation and how it could potentially be affected was derived, as well as a first set of stakeholders to approach for interview and other forms of interaction. In addition, it provided a useful appreciation of the drivers behind biofuel development in the country, any expectations and concerns already documented.

Once this background research was completed, the first round of interviewing and interacting with the identified stakeholders could commence. Initially, *Re-Impact* project partners Winrock International India set up a number of high level appointments with Ministry level stakeholders in Delhi, State level policy makers in Chhattisgarh and representatives from commercial enterprises involved in biofuel feedstock production and use. These interactions took the form of semi-structured interviews, which are discussions based around getting answers to pre-defined questions but through facilitated, two-way dialogue rather than a traditional question and answer formal interview format (FAO, 1990). The questions used in this case as a semi-structured interview schedule, listed in Box 3.2, were defined along with *Re-Impact* colleagues based on the initial literature review (referred to as the Situation Analysis) and revised where necessary as new issues were highlighted during subsequent interactions. The stakeholders interviewed included those designing, planning and operationalising projects and policies, so that from the start there was a clear end-user for the methodology involved and contributing to the process.

Issues	
Who owns the land? What was the previous land use? Who funds establishment? Who makes plantation management decisions? Who manages the crops? Who funds management activities? Who has feedstock harvesting rights? Who has rights to purchase the produce?	Who gets access to by-products? Who sets the purchase price? What livelihood benefits are available to poor/landless? Who carries the risk if projected yields are not realised? Is there possibility for vertical integration? What ecosystem services are gained or lost?

Box 3.2: Broad questions around which the semi-structured interviews were based, agreed in collaboration with *Re-Impact* partners at Winrock International India and the CSIR South Africa.

During the first round of interactions, which were conducted during my first trip to India, each interviewee was asked to recommend several other key individuals and/or organisations that they either worked with or knew of. This meant that the cross section of stakeholders was built up through a form of snow-ball sampling, whereby key people were identified from the initial high level contacts (Reed *et al.*, 2009). This represents a type of purposive sampling selection (see Robson, 2002) of the representative range of stakeholders as discussed in section 4.2.1, (page 79), and their involvement in the Indian Biofuels Programme. The need for a fully representative range of stakeholders was identified from the literature, and so care was taken that additional efforts were made to contact particular groups such as marginal farmers, landless and women, who were not always introduced by other means. Additional opportunities to interact with different stakeholders, such as academics, activists and consultants, arose through attending conferences and similar events in Delhi and Raipur. I travelled to India four times during this research, spending more than ten weeks there in total. Progressively more field time was taken in the later two trips because of the identified need to interact with the more remote, rural communities who I had begun to realise were important stakeholders because of their role in, requirements of, and impact of failure from, biofuel projects.

As well as the individual semi-structured interviews, two focus group discussions were conducted with local communities. The intention was to increase participation from a wider group, around the same issues in Box 3.2. More information on the focus groups and their outputs is given in Appendix 1. During all of the interviews and focus groups, English was spoken where everyone was a fluent speaker, but in many situations this was not the case, particularly with the villagers, farmers and NGO workers. In these cases, translation into Hindi was provided. Wherever possible I initiated the interviews with a brief dialogue using my very limited knowledge of the language. This helped to put them at ease and provided a good opener for discussion. In some cases, Hindi was not the first language of the participants, which could have affected their ability to communicate effectively (though it was widely known and understood). In Narayanpal in Bastar District (Table 4.2, page 86), the villagers did not speak Hindi and so a local translator had to be sourced. Time was always allowed for questions that the participants would like to ask us in return, which again relieved the formality of the occasion and encouraged them to be open and engaged. Throughout all of the interviews, group discussions and other stakeholder interactions I took very detailed shorthand notes which I wrote up into transcripts every evening as a record of the event. These were shared and verified with whoever had been present from the team. This practice meant that my own understanding of the events was constantly enriched by the additional perspectives of my colleagues (Yin, 1994). The summary of the stakeholder analysis carried out through the interactions outlined above is presented in Table 3.1. The stakeholders have been categorised according to the level at which they operate i.e. national; state/province; community. Table 4.1 (page 85) provides a summary of the interactions with specific stakeholders. During collaborative sessions with project partners, matrices were drawn up for each of the three examples around assessing the degree of influence of the biofuel projects across social variables (Table 3.2), and potential direct, indirect and cumulative social impacts (Tables 3.3 and 3.4). The results and outputs of this Indian case study fieldwork will now be presented and discussed, beginning with the national context as devised through literature and elaborated through stakeholder interactions.

3.3.2 *Context: A Brief Introduction to the Jatropha Biodiesel Programme in India*

The Indian Biofuels Programme began over 60 years ago but has gained significant momentum only since the beginning of the 21^{st} Century. Until 2000, the major focus was on ethanol in blend with gasoline. In 2003 the National Biodiesel Mission was established by the Planning Commission, reflecting a move towards biodiesel. The Mission identified *Jatropha curcas L.* (see Plate 3.1) as the most suitable tree-borne oilseed (TBO) for the production of biodiesel.

Table 3.1: Stakeholder Identification and Intial Analysis for the Indian Biofuels Programme

I visited all of the stakeholders listed and led the interactions (through translators where necessary), then the table was compiled in collaboration with project colleagues during an interactive session.

Stakeholder	(Potential) Role in the project	Motives for participation in bioenergy projects	Assumptions on which expected outcomes are based
National Level			
Ministry of New and Renewable Energy	• National biofuels policy development • National nodal agency for implementing the Biofuels Programme	• Promoting renewable energy sources	• Biofuel is a viable renewable energy option
Ministry of Rural Development	• Member of the National Biofuels Coordination Committee and the Biofuels Steering Committee	• Rural employment generation • Productive use of wastelands • Rehabilitating wastelands	• Effective targeting of beneficiaries • Appropriate identification and acquisition of wastelands • Wastelands not under significant productive use
Ministry of Petroleum and Natural Gas & its Oil Marketing Companies	• Production of feedstock, refining, distribution and marketing of biofuels • Establishing purchase price for biofuels	• Saving foreign exchange • Promoting energy security in the country	• 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 • Promoting energy security in the country	• National and State Governments implement the Biofuels Programme effectively
National Oilseed and Vegetable Oil Development Board	• Identification and development of superior planting material • Developing improved post harvest technologies • R&D inputs to the Biofuels Programme	• Superior bioenergy germplasm available across the nation (seeds with higher oil content) • Improved post harvest and processing technologies of oil seeds	• Improved germplasm and available technologies would facilitate the upscaling of the of the Biofuels Programme

Stakeholder	(Potential) Role in the project	Motives	Assumptions
State Level			
Biofuels development authorities	• Production of biodiesel feedstock and biodiesel	• Bioenergy feedstock available • Local communities benefit from employment opportunities provided • Energy & environmental security • CDM benefits	• Wastelands / marginal lands are available for bioenergy plantations • Yields of bioenergy plants under wasteland conditions would be sufficient to support a commercially viable biodiesel enterprise
Forest Department	• Using degraded forestlands for bioenergy plantations	• Promoting environmental security • Meeting climate change commitments	• Bioenergy plantations are a viable option for the rehabilitation of degraded forestlands • No impact on biodiversity
Civil society organisations	• Social watchdogs – 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 contributes towards rural development • Environmental security maintained	• 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 a potential livelihood option for local communities
Private corporations	• Production of bioenergy feedstock, refining and sale to OMCs or for export (only extracted oils)	• Feedstock generation • Profits • Rural development (in some cases)	• Bioenergy plantations are a viable business proposition • Predicted yields would be realised under field conditions • Farmers / local communities willing to enter into a formal or 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	• Food crops not displaced • Risks to farmer are minimal • Access to relevant information and technical inputs are available to the farmers
Poor / landless / resource users	• Participate in plantation establishment and management	• Income generation though locally available labour	• Specifically involving the poor and landless is part of the bioenergy intervention strategy

Plate 3.1: *Jatropha curcas L*. (commonly referred to as Jatropha) in India. Top left: Jatropha seeds and electricity supply running on Jatropha oil, Ranidehra village. Top right: Jatropha being used as a hedge to keep browsing animals away from crops, Bastar district. Bottom: Government-owned Jatropha plantation near Raipur. All Chhattisgarh State (see India map in Figure 4.1). Source: author's own, February 2008 and March 2009.

It was expected that fossil diesel would be substituted up to 20% by 2011-12, and any degraded land rehabilitated by subsequent improvements in water retention capacity (India Planning Commission, 2003). This target has since been revised with ratification of a national policy on biofuels and indicative target of 20% biofuel blending by 2017 proposed (MNRE, 2009). Essentially, there is now a significant policy driver for biofuel feedstock production to satisfy this internal need, outside the control of market-based mechanisms such as certification. The Government of India's focus is to use waste and degraded forest lands for undertaking biofuel plantations and to promote rural development. Plantation activities are presently undertaken under different central government schemes such as the National Rural Employment Guarantee Scheme (NREGS) (Jha *et al*., 2009). A few proactive states such as Chhattisgarh (discussed in detail in Chapter 4), Karnataka and Uttarakhand have set-up Biofuels Boards, announced policies to promote biofuels in their respective States, and declared a minimum support price (MSP) for oil seeds to provide a fair price to the farmers. The responsibility of storage, distribution and marketing of biofuels presently rests with publicly owned Oil Marketing Companies (OMCs). In brief, the work carried out up to 2011 in biodiesel development consists of research into high oil-yielding varieties of Jatropha and other TBOs (by organisations such as the National Oilseeds and Vegetable Oils Development Board, Department of Biotechnology research institutes, and private companies), plantation of Jatropha by government-sponsored agencies, setting up of pilot transesterification plants, and running tests with locomotives and road vehicles using up to 5% biodiesel blends. The Government of India's Ministry of New and Renewable Energy (MNRE), is the nodal agency for the implementation of the Biofuels Programme with support from other ministries and autonomous government bodies. The major drivers for the Indian national policy on biofuels are outlined in Box 3.3.

- 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 3.3: Identified drivers behind the Indian Biofuels Policy (MNRE, 2009).

There are concerns regarding the suitability of Jatropha, a crop which has been around in India for many decades but only recently harvested on an industrial scale for its oil, in providing these benefits (Burley and Griffiths, 2009). However, despite being in consultation for almost three years, the draft Biofuels Policy was unchanged when it was mandated in December 2009. In 2008 it was suggested by independent researchers (Altenburg *et al*., 2008) that there are three systems for the production of biodiesel from Jatropha in India (i) government-centred cultivation: which includes initiatives of various State governments individually or as a Joint Venture with OMCs on government owned land, (ii) farmer-centred cultivation: Jatropha plantations undertaken by individual farmers of their own accord or with facilitation by civil society organisations on generally private and at times on common lands, and (iii) corporate-centred cultivation: on private lands through contract farming. This distinction is further interrogated in section 4.4.4 (page 89) but is sufficient for the purposes of the Situation Analysis.

3.3.3 *Issues and Concerns*

Civil society organisations have raised a number of issues and concerns regarding the implementation of the Indian Biofuels Programme (Tiwari *et al*., 2010b). These include:

- The lack of 'real' wastelands in India and the fact that most land with any productive capacity is already in use, especially by the very poor who are dependent on these lands;
- The negative impacts that monocultures of biofuel plantations could have on biodiversity and correspondingly on the livelihoods of the poor;
- The high external inputs (fertilisers, irrigation) necessary to achieve economical rates of TBO seed production, possibility of diverting good agricultural land for biofuel production;
- The unreliability of existing plant material and the long lag period in Jatropha seed production;
- Insufficient market support leading to TBO cultivators incurring major losses;
- Concern that biofuel plantations on government land will be used as a mechanism for preventing community members from expanding their tenure into marginal areas.

Both the goals being pursued by the Government of India (Box 3.2) and the issues and concerns raised by civil society organisations are valid. The drivers for the Indian Biofuels Programme represent areas of national interest whilst the cautionary responses by civil societies highlight local level welfare. Without an acceptable degree of harmony between the impacts at both national and local levels there exists the chance of only partial success and/or a number of undesired consequences at either level. Further, since the Biofuels Programme cuts across sectors (*viz*. energy, natural resources, rural development) at various scales, it is all the more important to ensure that one does not develop at the cost of the other. What is therefore needed, as with any other developmental intervention, is a Biofuels Programme which considers economic, social and environmental concerns within a sustainability planning framework throughout its design and implementation. It is also important to retain a degree of flexibility, accepting that future technologies and alternative species may prove more successful and provide more sustainable outcomes overall. Therefore the *Re-Impact* sustainability planning framework for bioenergy policies and projects incorporating the approaches suggested in this thesis are thought to be particularly relevant in the Indian context. This is due to the tensions between stakeholders and potential trade-offs already identified in the early phases of Biofuel Policy implementation. It is proposed that this may also be the case in a number of other developing countries, such as Uganda (used as a case study in Chapters 5 and 6), which are currently yet to finalise or fully implement their policies.

3.3.4 *Social Impact Assessment in India; flexibility required*

In India, EIA is most widely used for large development programmes such as river basin planning, highways, thermal power plants, and mining. It is not administered in the case of other land use change interventions such as large scale plantation activities e.g. Jatropha plantations. Ultimately, there is no legislation in place that makes it mandatory to undertake an Environmental or Social Impact Assessment of bioenergy projects. Even where they are undertaken, a common critique (understood from discussions with practitioners) is that they are largely focused on technical aspects and are therefore often beyond the comprehension of the lay person, with minimal regard to social issues. They are also, typically, carried out in a non-participatory manner. In addition, EIAs are snapshots that capture only part of the picture and not the whole (effects over time) which have a bearing on the sustainability of the proposed intervention. In India SIA is a component of EIA and is most often not given the importance it deserves, even for the larger development projects for which it is actually mandated. Because of the potential for negative social and environmental outcomes from these projects (discussed in sections 1.2 (page 3), 1.3 (page 8) and 3.2), I consider it vital that Indian policy and implementation plans do include a framework for sustainability planning and monitoring. The *Re-Impact* framework outlined in Chapter 2 (page 36) incorporates methodologies for assessing social, environmental and economic aspects, and is therefore ideally suited. There is also a potential institutional home with State level planning and implementing agencies.

Doubt around the yield and profitability of Jatropha, as well as the true short and long term costs of production, leads to a larger degree of uncertainty around the potential social impacts than might be expected. In extreme cases this could affect whether the impact will be positive or negative overall. Using unsubstantiated assumptions on the agronomics and economics of the crop’s production can therefore affect, to some extent, the outcome of the SIA. In this situation the flexibility in the process becomes even more important and, until the research and development around the long term performance of Jatropha is more advanced, the full range of agronomic and economic scenarios must be considered. The results from this approach should therefore be regarded as a first level of social impact analysis, given the existing lack of validated information on key determinants such as yield and profitability.

3.3.5 *System Analysis*

There are four main phases of the biofuel production chain, namely, (i) production of biomass feedstock through cultivation; (ii) conversion of the feedstock to fuel (or electricity); (iii) distribution and retailing of finished fuels; and (iv) bioenergy consumption. Figure 3.1 highlights the need for effective institutional mechanisms for the management of biofuel plantations, without which the remainder of the production chain effectively collapses. For the System Analysis in India I focused on the first phase i.e. production of biofuel feedstock through cultivation, as it is at this level that biophysical (e.g. land use changes) and institutional (e.g. tenurial rights) changes could potentially have the most significant social impacts.

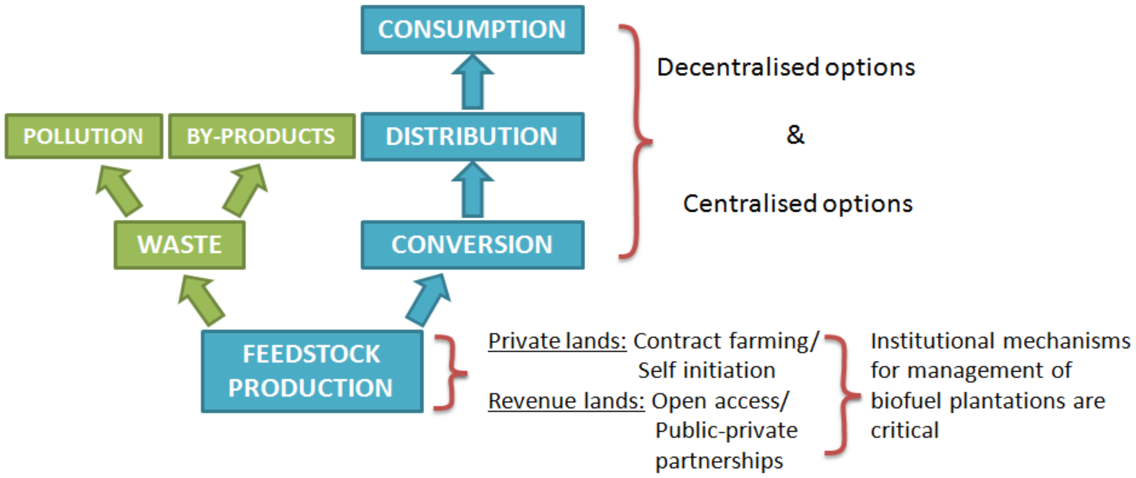

Figure 3.1: Phases of the biofuels production chain (after Tiwari *et al.*, 2010a).

The various approaches to the cultivation of Jatropha-based biodiesel in India can be categorised under three broad value chains, namely government-centred, farmer-centred, and corporate-centred, as stated in section 3.4.1 (Altenburg *et al.*, 2008). One example of each was identified for further investigation and piloting of the proposed methodology.

1. **Government-centred**: the Joint Venture between the Chhattisgarh Renewable Energy Development Authority (CREDA) and the OMC Indian Oil Corporation (IOC) in the central Indian State of Chhattisgarh. Indian Oil CREDA Biofuels Ltd. (IOC-CREDA) was formed to enable IOC to straddle the complete biofuel value chain. In this Joint Venture IOC has an equity holding of 74% and CREDA has 26%. IOC-CREDA is carrying out farming, cultivating, manufacturing, production and sale of solid biomass, liquid biofuels and allied products and services; in 2009 they initiated the establishment of Jatropha plantations in selected districts of Chhattisgarh.

2. **Farmer-centred**: Reliance Life Sciences Limited (RLS), as part of its Biofuels Programme, has been working with NGOs and farmers to promote the cultivation of biofuel crops on marginal lands. It aims to promote a multi-culture agronomy by standardising agronomic practices of Jatropha, *Pongamia pinnata* and other TBOs along with intercrops such as

mango, vegetable crops and medicinal plants in different agro-climatic conditions and under rain-fed and irrigated conditions[7]. In the Bastar District of Chhattisgarh State, RLS has promoted Jatropha plantations on the marginal lands of farmers. Although RLS is a corporate entity, the approach of its Biofuels Programme has been farmer-centred and formed out of a Corporate Social Responsibility starting point. RLS assures a buy-back of the biofuel feedstock but does not enter into a formal contract with the farmers.

3. **Corporate-centred**: Mission Biofuels India Private Limited (MBIPL), a subsidiary of Mission NewEnergy Limited, was established in 2007 for the upstream Jatropha feedstock production business and wind energy projects. MBIPL is involved in large scale Jatropha cultivation, nurseries and procurement centres in several States[8]. In its operational areas MBIPL, through its extensive network, identifies suitable farmers and enters into a 30 year contract with them. These farmers are given a buy-back guarantee, technical and financial assistance; the latter on a loan basis where MBIPL facilitates the process of farmers gaining a loan from the corporate banking sector, failing which, it extends a loan to them directly.

The outcomes from all of the processes detailed above will now be presented and discussed. Based on the improved understanding of the social impacts anticipated from biofuel production in India gained through this study, I will then go on to outline a more widely applicable approach to investigating social effects which could be trialled elsewhere.

3.4 Results and Discussion

The initial literature searching, stakeholder identification, interaction and analysis (termed Situation Analysis) has shown that there are many actors involved in the biofuels production chain in India, as well as numerous directly or indirectly related groups such as charcoal producers and kerosene sellers, each with their own interests and stakes. This implies that there needs to be a high degree of coordination and cooperation among them since, broadly at least, they are working towards the same overall goal. This therefore presents a significant institutional challenge as collective action is required. Efficient institutions, which can be fundamental in solving collective action problems, can reduce the uncertainty in the behaviour of individuals and create incentives towards greater levels of collaboration (Bravo, 2002).

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[7] Reliance Life Sciences Ltd website, http://www.rellife.com/, last accessed on 03/02/2011

[8] Mission Biofuels India Pvt Ltd website, http://www.missionnewenergy.com/MissionBioFuelIndia.php, last accessed on 03/02/2011

However, achieving this level of coordination and cooperation is not a simple task (Bates, 1988). The approaches presented in this Chapter and Chapter 4 are intended to provide information and improve understanding of social effects and stakeholder dynamics in order to facilitate the process of collective action and ultimately of including socio-economic considerations in planning for sustainable bioenergy projects. Beyond providing background information for undertaking a full Social Impact Assessment, this first step also enabled the identification of three different cases that could be further investigated through a form of System Analysis.

3.4.1 *Assessing Degree of Influence of the Biofuel Intervention across Social Variables*

The degree of influence of the three bioenergy feedstock production models across specific components of each of the five social variables (Box 3.1) is assessed, using the matrix provided in Table 3.2. The purpose of this exercise is to rank and map out, in terms of the degree of influence (i.e. high/medium/low/none), the social impacts that the proposed intervention is having, or potentially could have, on the populations affected by the project. For example if the production model's strategy was to use only locally available labour for the establishment and management of the plantations, then the impact in terms of 'influx of labour from outside the area' would be 'none'. It would be 'low' if the implementing agency agreed to hire external labour only if and when the local labour potential has been saturated. Following the research and fieldwork, each of the listed impacts were categorised as 'positive' or 'negative' and a score ranging from + (plus) 3 to +1 was accorded to positive impacts depending on their degree of influence, i.e. a 'high' degree of influence was given a +3 score, 'medium' +2, and a +1 score to 'low'. Similarly, negative impacts were scored from - (minus) 3 for high degrees of influence to -1 for low impacts. Where there were no impacts, a score of zero was given. The scores were totalled separately for each of the five social variables, as well as cumulatively to assess the overall social impact. Across the five social variables each of the scores were given equal weighting. In future iterations this weighting could be revisited, because in reality the stakeholders may apply emphasis to certain variables which they feel more strongly about. The completed matrix in Table 3.2 indicates areas where actual or potential social impacts would be higher for that particular intervention. This type of weighting can be numerically represented, this has been done on a different case in Chapter 6 (Table 6.2, page 145).

As can be seen in Table 3.2, all three production models are predicted to have an overall positive social impact. Based on this framework the ideal score would be 39. The farmer-centred model scores the highest at 22, followed by the corporate-centred example (16), and the government-centred finally, which gets the lowest score of 5.

Table 3.2: Assessment of the degree of influence of the biofuel projects across social variables

Social Variables	Type of Impact	(1) IOC-CREDA Joint Venture					(2) Reliance Life Sciences					(3) Mission Biofuels				
		Degree of Influence				Score	Degree of Influence				Score	Degree of Influence				Score
		High	Medium	Low	None		High	Medium	Low	None		High	Medium	Low	None	
Population change																
Relocation of people (e.g. from encroachments)	Negative		✓			-2				✓	0				✓	0
Influx of labour from outside, seasonal or permanent	Negative	✓				-3				✓	0				✓	0
Migration (outflow – seasonal or permanent)	Negative				✓	0				✓	0				✓	0
Sub-total						**-5**					**0**					**0**
Community and institutional structures																
Voluntary associations	Positive				✓	0	✓				3	✓				3
Job / income opportunities	Positive			✓		1		✓			2		✓			2
Employment equity of disadvantaged groups	Positive			✓		1			✓		1			✓		1
Local-Regional-National links	Positive			✓		1		✓			2			✓		1
Industrial/commercial diversity	Positive	✓				3	✓				3		✓			2
Sub-total						**6**					**11**					**9**
Political and social resources																
Distribution of power and authority	Positive				✓	0		✓			2			✓		1
Varying stakeholder interests and concerns accounted for	Positive			✓		1	✓				3		✓			2
Local leadership development	Positive				✓	0	✓				3		✓			2
Inter-organisational cooperation	Positive		✓			2		✓			2			✓		1
Sub-total						**3**					**10**					**6**

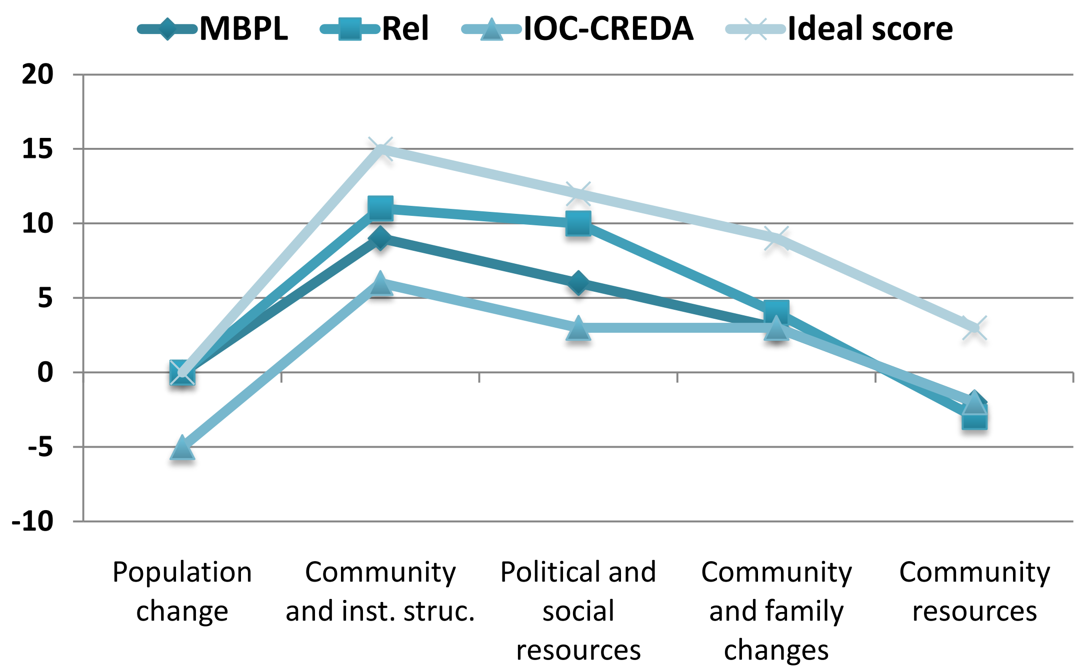
Social Variables	Type of Impact	(1) IOC-CREDA Joint Venture					(2) Reliance Life Sciences					(3) Mission Biofuels				
		Degree of Influence				Score	Degree of Influence				Score	Degree of Influence				Score
		High	Medium	Low	None		High	Medium	Low	None		High	Medium	Low	None	
Community and family changes																
Perceptions of risk (e.g. poor yields / loss of food crop / debt)	Negative		✓			-2		✓			-2		✓			-2
Trust in the political and implementing institution	Positive		✓			2		✓			2		✓			2
Positive attitudes toward proposed action	Positive			✓		1		✓			2		✓			2
Concerns about social well-being	Positive		✓			2		✓			2			✓		1
Sub-total						**3**					**4**					**3**
Community resources																
Change in community infrastructure (common lands for grazing / fuelwood collection)	Negative	✓				-3		✓			-2				✓	0
Optimal utilisation of land resources	Positive		✓			2		✓			2		✓			2
Labour displacement within the community	Negative			✓		-1			✓		-1			✓		-1
Displacement of food crops	Negative				✓	0		✓			-2	✓				-3
Sub-total						**-2**					**-3**					**-2**
GRAND TOTAL						**5**					**22**					**16**

This table was compiled in collaboration with project colleagues during an interactive session, based on the interactions detailed in Table 3.1.

Whilst the first two have no impact in terms of the ‘population change’ variable, as they involve engaging with individual farmers, the government-centred model involves plantations on barren lands that were previously used by local communities for a variety of purposes such as grazing, usufructs (term used in India to describe non-timber forest products and services), and at times agriculture (although legally all these were classed as encroachments). Further, labour from outside the area is also brought in to work on the biofuel plantations, thereby reducing employment opportunities of the resident population. Due to these factors the government-centred approach has a negative score (-5) for the population change social variable.

In terms of the following three social variables *viz*. ‘community and institutional structures’, ‘political and social resources’, and ‘community and family changes’ all three models have a positive score. The farmer-centred model performs best, recording a percentage score (of the ideal score) of 73%, 83% and 44% respectively. The corresponding figures for the government-centred model are 40%, 25% and 33%; and those of the corporate-centred model are 60%, 50% and 33%. The main reason for the disparity between the farmer-centred and corporate-centred models is the difference in the ‘purpose of engagement’ with the local farmers in the farmer-centred model, encouraging a high level of their participation in decision-making processes. Whilst the corporate approach has a fixed agenda and activities, the farmer-centred approach is more flexible and attempts to respond to local needs and to balance these with its own, meaning its social impacts are likely to be less severe.

With regards to the ‘community resources’ variable, all three models are predicted to result in negative scores. This is because they each have an impact in terms of displacement of labour or food crops. Managing Jatropha plantations is labour intensive and would therefore necessitate a displacement of labour or human capital that could have been directed towards food crops. Furthermore, in India marginal lands are used for cultivating low value food crops such as pulses and lentils which either provide a source of income or an important supplement for household diets, in some cases the main source of protein. Figure 3.2 depicts the performance of the three models across the five social variables and how each compares to the ideal score. The scores in Table 3.2 clearly indicate that all the three models have scope for improvement in terms of their social effects. It also provides information on specific parameters that would need to be strengthened in each of the three models of biofuel feedstock production to be considered socially sustainable.



Scores accorded as detailed in Table 3.2

Figure 3.2: Graph showing the results of assessment of the biofuel initiatives across the five social variables.

3.4.2 *Assessment of Potential Direct, Indirect and Cumulative Social Impacts*

The breakdown provided in Table 3.2 and Figure 3.2 can be further substantiated by assessing what the potential direct, indirect and cumulative social impacts of each these models may be. The consideration of cumulative impacts is particularly important and has not always been considered in great depth previously. For the different examples outlined in section 3.3.5, I have attempted to identify and categorise the potential social impacts, both positive and negative, based on the stakeholder interactions and subsequent discussions with colleagues. The matrix presented in Table 3.3 and Table 3.4 facilitated this process. The research team collaborated in populating these tables following the interactions, and social impacts were then assessed in terms of expected 'direct', 'indirect' and also anticipated 'cumulative' impacts.

Table 3.3 examines the impacts of the IOC-CREDA Joint Venture. Since RLS is also a corporate agency it has been combined with MBIPL in Table 3.4. However, impacts specifically attributable to either one of these agencies have been duly indicated with RL and MB respectively. The two tables summarise the key social issues in Indian biodiesel feedstock production, indicating that there are both positive and negative social impacts which could be anticipated.

Table 3.3: Assessment of potential direct, indirect and cumulative social impacts for the IOC-CREDA Joint Venture.

This table was compiled in collaboration with project colleagues during an interactive session, following the interactions detailed in Table 3.1.

Issues	Land ownership type (govt. / communal)	Potential Social Impacts		
		Direct	Indirect	Cumulative
Who owns the land?	Leased to private companies by Government	• Loss of informal rights	• Privatisation of common lands	• Potential inter and intra village conflicts
What was the previous land use?	Common – used for grazing, collection of NTFPs, typically degraded wasteland, low productivity	• Access to grazing lands, source of fuelwood & other usufructs denied • Land productivity enhanced • Land quality improved • Alternative source of income created	• Existing livelihoods, e.g. marginal communities, negatively affected • Encroachment elsewhere – e.g. forestlands (indirect land use change)	• Degradation of forestlands – increased fuelwood demands • Vulnerability of marginalised groups enhanced • Reduction of wastelands
Who funds establishment?	National / State Government / IOC	• Infrastructure developed (e.g. tubewells for irrigation of plantations) • No financial burden on local communities	• Agricultural practices and productivity enhanced – technical inputs and water availability	• Improved agri-infrastructure
Who makes plantation management decisions? **Who manages the crops?**	Agency selected by IOC	• Communities not involved in decision-making	• Communities lose control over previously self managed lands	• Improved wasteland management • Reduced role of communities in management of waste/common lands
Who funds management activities?	IOC	• Enhanced viability of successful implementation • Recurrent livelihoods created • Increased local job opportunities	• Labour displacement from existing livelihood options	• If expected yields are realised this is a long term livelihood option for local communities
Who has feedstock harvesting rights?	Hired agency for IOC	• Community rights divested • Communities not affected by losses in case of low yields • No real role for communities in the bioenergy value chain	• Monopoly of common lands and of products from them	• In case of crop failure, livelihood option lost

Issues	Land ownership type (govt. / communal)	Potential Social Impacts		
		Direct	Indirect	Cumulative
Who has rights to purchase the produce?	Hired agency for IOC	• Established market Monopolisation of produce	• Food crop lands brought under bioenergy plantation	• Privatisation of benefits from previously common lands
Who gets access to by-products?	Seed cake would belong to IOC, any others could be accessed by community	• Pruned branches and dried leaves available for fuel and manure use by communities	• Reduction of drudgery in collection of leaf litter and fuelwood • Possible availability of cheap fertiliser equivalent (seedcake)	• Resource removal leading to slower revival of wastelands
Who sets the purchase price?	IOC – CREDA	• (None, as communities not actively involved in the biofuel value chain)		• Breaking down free market principle
What livelihood benefits are available to poor/landless?	Employment opportunities	• Locally available job opportunities • Minimum wage as defined by local government is potentially assured • Potential exploitation of poor / landless by hired agencies to maximise their own savings • Hired agencies contract cheap external labour, denying resident communities job opportunities	• Labour hired from outside the area • Change in population characteristics in the area • Labour diverted away from agriculture	• Income of poor / landless enhanced and secured to a greater degree • Increase in migration by local communities
Who carries the risk if projected yields are not realised?	Hired agency & IOC	• Low risk livelihood opportunity for local communities		• Loss of livelihood option for local communities in case projected yields not realised and activities discontinued
Is there possibility for vertical integration?	Currently none	• Benefits for local communities limited to labour opportunities		
What ecosystem services are gained or lost?	Lost: grazing / fuelwood & usufruct collection. Gained: groundwater tapped / soil condition & water infiltration improved / reduced runoff. Unknown: impact on water supply/biodiversity	• Access to water resources for agriculture • Over exploitation of groundwater if usage not regulated	• Enhanced agriculture yields • Chemical agriculture intensification & corresponding pollution of water and soil resources	• Increased income from agriculture • Soil and water quality degraded • Potential of loss of biodiversity

Table 3.4: Assessment of potential direct, indirect and cumulative social impacts for the Reliance Life Sciences and Mission Biofuels Private Ventures.

This table was compiled in collaboration with project colleagues during an interactive session following the interactions detailed in Table 3.1.

Issues	Land ownership type (Private)	Potential Social Impacts		
		Direct	Indirect	Cumulative
Who owns the land?	Individual farmers	• In case of contract farming, land locked for a period of 30 years • If no contract, then farmer free to change land use	• Alternative land use options restricted (MB) • Markets for other crops e.g. vegetables / NTFPs available (RL)	• Regular source of income for farmer
What was the previous land use?	Under-utilised farm lands (MB & RL) Barren lands (RL)	• Food crops diverted especially indigenous crops • Access to grazing lands, source of fuelwood other usufructs denied • Land productivity enhanced • Land quality improved • Alternative source of income created	• Potential of nutritional deficiency due to reduced availability of indigenous crops • Encroachment elsewhere (iLUC) – e.g. forestlands	• Greater dependence on cash crops and associated implications on food security in the face of climate change • Degradation of forestlands – increased demands • Vulnerability of marginalised groups enhanced • Reduction of wastelands
Who funds establishment?	Farmer's own equity Banks / company loan schemes Govt programmes tapped	• Working capital available to farmer • Loan burden on farmer	• Opportunities to diversify income sources available to farmers • Debt risk	• Credit-worthiness of farmers enhanced • Loss of assets in case unable to repay loan
Who makes plantation management decisions? **Who manages the crops?**	Farmer with technical support from associated company (RL & MB) Farmer	• Capacity building of farmer • Improved land and crop management practices • Potentially higher yields realised • Income from inter-cropping during lag period	• Increased income from agriculture	• Improved wasteland management • Reduced role of communities in management of waste/common lands
Who funds management activities?	Farmer	• Additional input costs to farmers (Rs. 2500-3000 / acre / year) • Labour displacement from existing livelihood options	• Increase in indebtedness in case further loans need to be taken to meet fertiliser/other costs	• Ability to take financial risks for food crops is potentially reduced

Issues	Land ownership type (Private)	Potential Social Impacts		
		Direct	Indirect	Cumulative
Who has feedstock harvesting rights?	Farmer	• Harvesting controlled by company demand /need (MB)	• Monopoly of private lands and of products from them (MB)	• (unknown)
Who has rights to purchase the produce?	Open market (RL) Company to whom contracted (MB)	• Established market • High dependence on single market point • Monopolisation of produce (MB)	• Food crop lands brought under bioenergy plantation	• Increased amounts of food croplands brought under bio-energy plantations resulting in food insecurity
Who gets access to by-products?	Seed cake would belong to company, any others could be accessed by community (MB) Farmer (RL)	• Pruned branches and dried leaves available for fuel and manure • Seed cake available to farmer for fertiliser, commercial us (RL)	• Reduction of drudgery in collection of leaf litter and fuelwood • Possible cheap fertiliser equivalent (seedcake)	• Resource removal leading to slower revival of wastelands / low productivity lands
Who sets the purchase price?	Contracting company (MB) Possibility of market prices (RL)	• Assured returns • Price aligned with 'minimum support price' so farmers not exploited	• If price favourable, then more farmers attracted to undertake bio-energy plantations – greater land use change	• Breaking down free market principle (MB)
What livelihood benefits are available to poor/landless?	Farm labour	• Locally available labour opportunities	• Loss of access to grazing lands compensated	• Locally available wage labour opportunities created
Who carries the risk if projected yields are not realised?	Farmer Company – of not getting feedstock	• Indebtedness	• Loss of income & food source due to diversion of labour & other resources	• Increased vulnerability
Is there possibility for vertical integration?	Currently none (MB) Possibility of farmers having a share in processing (RL)	• Chances of higher returns (RL) • Reduced individual risk • Increased access to credit	• Food crop lands diverted to bioenergy plantations	• Local food insecurity • Agri-business promoted
What ecosystem services are gained or lost?	Lost: grazing / fuelwood collection / usufruct collection Gained: soil condition improved Unknown: impact on water resources / biodiversity	• Pressure on common / forest lands would increase • Potential for improved agriculture yield		

In the case of IOC-CREDA, local communities are directly divested of informal rights that they have on the lands which have been brought under biofuel plantations, but the intervention also provides potential employment opportunities. Furthermore, in this case there are no direct risks to farmers in financial terms and local communities will not be affected if the expected yields are not realised. However, since they will be denied access to lands that were earlier used for open grazing and usufructs these practices are likely to be transferred to other areas surrounding the villages, e.g. forestlands or common lands of neighbouring villages, which could increase the chances of conflicts between villages as well as with the forest department. This would have indirect and cumulative impacts in terms of indirect land use change (iLUC) which could be adverse for these communities as well as the environment. Infrastructure such as tube-wells that this initiative expects to develop in order to irrigate the biofuels plantations could directly benefit local agriculture and enhance productivity. Despite this, local communities have no active role in decision-making as regards the production of biofuel feedstock, even though they are being directly affected by the intervention.

Similarly, in the case of private ventures, farmers are provided with buy-back guarantees. In the case of MBIPL they are locked into a thirty year contract which removes their right to change the land use within that time. Furthermore, there is a breaking down of free market principles by a monopolisation of produce at a set price. Biofuel plantations provide an alternative and potentially long term income source for individual farmers, but there is also the risk of diverting under-utilised indigenous food crops which, though largely ignored during good years, are important buffers in terms of food and livelihood security, particularly during drought conditions. In view of predicted higher intensity dry seasons under global climatic change scenarios, this could possibly have considerable adverse and long term impacts on local food security. These initiatives can also further increase the vulnerability of local farmers through indebtedness created by the company providing loans towards establishment and management of the plantations. If the farmers are unable to repay these loans it could result in a loss of assets as well as an unproductive crop (Borman *et al*., in press). This would be particularly true if the expected yields are not realised - a risk that does not exist in the IOC-CREDA example. However, conversely, if the farmers are able to repay these loans it would enhance their future credit-worthiness.

There is a clear mix of positive and negative social impacts – direct, indirect and cumulative – across the three production models that have been investigated here. If the Biofuels Programme in India is to be effectively used as a vehicle for generating rural employment opportunities and promoting environmental security, then the negative social impacts that could result from it need to be appropriately addressed. Despite the lack of basic knowledge around the agronomics and economics of Jatropha production, the approach adopted by the implementing agency and the choices that they make will also have social impacts that can be identified with a relatively good degree of certainty, and some of these would be negative regardless of crop performance as the selected production models show. As more reliable information on the crop becomes available, a greater understanding of potential social impacts can be developed. Because SIA is a heuristic process, this would be incorporated in later iterations whereas other sustainability mechanisms could miss improved understanding or not be detailed enough to appreciate any changes.

3.5 A higher level process for understanding the social impacts of bioenergy feedstock production

Following the experience of the Indian case study, a new higher level methodology has been designed. This is deliberately broad to ensure its cross-country applicability and allow it to be applied at different scales and situations, despite it having been developed and trialled specifically in India. Further, it is intended to be simple yet rigorous so that it can be moulded to some extent by different actors under various contexts. It is accepted that any assessment of social effects is shaped in some way by the specific issue or project/programme context. Therefore, by making the approach flexible it is intended to be possible to adapt it to other feedstocks and processing technologies in different social and policy settings. The two steps, sub-steps and corresponding tools which are proposed to be used in the process of assessing the social impacts of bioenergy plantations are presented below. Whilst the sequence of the steps is intended to be followed in order, it is expected that there could be overlaps between them and it is possible that certain steps may need to be revisited again. Therefore this iterative process is intended to be adaptive and flexible to incorporate learning as it progresses.

3.5.1 *Step One: Situation Analysis*

The first step is to analyse the programme / project context from the macro to the micro scale. This is very similar to the scoping (Barrow, 2000) or baseline analysis (Becker, 2001) from a traditional SIA, and it allows the practitioner to gain a preliminary understanding of the environment within which the intervention is proposed, including the internal (e.g. major drivers and strategies) and external (e.g. global economy and other forces) factors that do or could influence its outcomes. This is important in terms of gaining an understanding of how the baseline situation could be affected by the project. Most importantly, perhaps, this is the first stage in identifying the stakeholders involved. This step helps to identify expected impacts on each of these stakeholders, who should be extensively drawn from all groups and societal levels (including, for example, women, farmers, indigenous groups, landless and labourers). In order to achieve the Situation Analysis, two sub-steps have been designed collaboratively by the *Re-Impact* team. These are now outlined.

Sub-step 1: A desk-based review of all relevant documents (policies, programme/project documents) pertaining to the proposed bioenergy intervention, which broadly covers the following points and questions:

a) An analysis of the broader context (e.g. national / regional) within which the proposed project is planned – what led to its development and how it developed? Rationale, justification and goal - what are the major issues it proposes to address?
b) What are the major drivers? (e.g. less dependence on fossil fuels; economic security)
c) What are the proposed strategies? (i.e. how it proposes to achieve its goals)
d) What are the planned targets? (i.e. measurable points on the way to meeting its goals)
e) Focused analysis of the context – existing policies / projects; resources available / data.
f) Preliminary identification of all relevant stakeholders – from policy makers to communities
g) Other issues, concerns and suggestions (e.g. raised by civil society organisations / research institutions with regards to the proposed bioenergy intervention)
h) Any lessons from previous interventions of similar nature (e.g. community plantations)
i) What are the data needs and gaps?

Sub-step 2: Identify stakeholders from the national to community level through completion of a stakeholder analysis using the matrix presented in Table 3.1. This follows on from the preliminary identification of stakeholders but categorises them according to the level at which they operate i.e. national; state/province; community. The categories presented under the stakeholder column in the table are only indicative and should be customised according to the specific context within which the SIA is being undertaken (for example, regions may be more appropriate than States in certain cases). In order to complete the stakeholder analysis information, the desk-based review exercise should be substantiated with semi-structured interviews with each of the identified stakeholders using the matrix provided in Box 3.2 and Table 3.1 as the basis for the interview. This is crucial as, no matter how thorough, a desk-based study is unlikely to provide sufficient detail to provide a genuine level of understanding of the stakeholders and relationships between them.

3.5.2 *Step Two: System Analysis*

This final step provides further insights into the functioning, interactions, and varying social effects on stakeholders within the particular biofuels intervention. This exercise comprises of two sub-steps:

Sub-step 1: In the first sub-step, the degree of influence of the proposed bioenergy feedstock production model across specific components of each of the five social variables (Box 3.1) should be assessed, using the matrix provided in Table 3.2. The completed matrix indicates areas where actual or potential social impacts would be higher for a particular intervention.

Sub-step 2: having broadly categorised the potential social impacts, both positive and negative, in the previous sub-step, this exercise focuses on clearly identifying them; (again both positive and negative). The matrix presented in Tables 3.3 and 3.4 facilitates this process. A set of questions which need to be answered for biofuel plantations planned on different land ownership types (i.e. government lands; communal lands; private lands) are listed, though they would need to be carefully assessed to ensure their appropriateness for a different context. Populating the tables should be done through using the relevant questions in the stakeholder interactions, and assessing the social impacts in terms of expected ‘direct’, ‘indirect’ and also anticipated ‘cumulative’ impacts.

3.6 Key messages and implications from Chapter 3

That biofuel projects can have both negative and positive social impacts has been established based on the substantive findings from the Indian case study presented here, as well the examples provided earlier in Chapters 1 and 2. The major stakeholders in Indian biofuel feedstock production and their respective expectations have been recorded; social impacts (positive and negative) across five social variables for three different approaches have been ranked and mapped; and their potential direct, indirect and cumulative impacts have been identified. Through the assessment and analysis of specific social variables it has been found that change of land use to biofuel feedstock production has potential social risks, particularly in terms of the ‘community resources’ variable, independent of approach, scale, and choice of land type. For the other four variables there is significant scope for improvement for each of the investigated models. The farmer-centred production model has recorded the highest ‘social score' as it adopts an inclusive approach and, to an extent, attempts to align the mandate of the facilitating agency with the needs of local farmers. The government-centred model excludes local communities from any decision-making processes and so registers the lowest score, whilst the corporate-centred model has an intermediate score as it does engage with local farmers, but retains a higher degree of control over the production chain. Essentially, the level of participation and inclusion of local communities in the planning, decision-making and implementation of bioenergy projects in India has a direct bearing on the type of social impacts that can be predicted. These outcomes contribute towards answering thesis objective [B]: analysing the contribution of specific production models to meeting social criteria (page 18).

The approach to assessing social impacts of bioenergy feedstock production models presented in this Chapter, following the learning from the Indian case study, helps in understanding the wider context within which specific bioenergy projects have been formulated. This procedure was developed using existing models of feedstock production, though it is intended to be an *a priori* approach to identify social impacts in the planning phases, and thus contributes to thesis objective [A]. The approach set out in this Chapter provides policy makers and implementing agencies with a relatively easy-to-use and low resource-intensive tool that could be effectively used for identifying potential social risks and provide an opportunity to (re-) strategise accordingly. The identified positive social impacts are indicators against which the intervention can be monitored from a social impact perspective during both its implementation and post-implementation phases. On the other hand, the negative social impacts need to be discussed and addressed so that they are either eliminated if at all possible, or minimised by formulating and adopting alternative strategies. As with the positive impacts, the outcomes of these alternative approaches could also be indicators for future monitoring. For this approach to be effective in the Indian context it would need to be incorporated into planning procedures at either national or state level. This is because the market for biofuel feedstock is likely to be internal (i.e., not produced for export) due to high, politically driven demand, and therefore international market-based mechanisms such as certification (see section 2.1.1(a), page 22) would not be able to ensure sustainability.

To ameliorate the identified negative social consequences and design improved scenarios it is vital to engage more extensively with stakeholders to define alternative approaches, assess the anticipated impacts of implementing them, determine the additional costs that would be incurred, and finally define realistic potential strategies for each. This is a complex exercise and would need to be undertaken in a fully consultative manner that includes all relevant stakeholders. For this, multi-stakeholder consultations (MSC) would need to be organised. All stakeholders – from policy makers to the targeted populations – should be adequately represented at this consultation for it to be effective. Facilitating MSC requires a specific skill set and experience in order to balance out differential power dynamics between the stakeholders and to ensure that each stakeholder group has an equal voice in the entire process. This is an extremely challenging but nonetheless necessary task. The approach to understanding stakeholder dynamics in bioenergy projects as presented in Chapter 4 is intended to assist this process.

In conclusion, it is important to acknowledge that there is not one ideal solution to this complex set of interactions between social, economic and environmental concerns that cut across interests at the local level to those at the national and global levels. There are tools such as the one presented here that facilitate the design of socially beneficial initiatives; nevertheless, getting the balance between these three key parameters of sustainability absolutely right is a major challenge. There are almost certainly going to be trade-offs involved. The crucial question is whether, for a particular area and a particular set of stakeholders, these trade-offs are mutually acceptable. Managing trade-offs requires the participation of stakeholders in the planning process. Getting stakeholder roles, requirements and risks (their dynamics) taken into consideration before project design and implementation takes places is the intention of the approach in Chapters 4 and 5, and a major driver of the research behind this thesis as a whole. The structured approach proposed in Chapter 4 contributes to the development of the SIA methodology and results from India presented above. During the SIA fieldwork and analysis it became apparent from the results that enabling stakeholders to get their dynamics understood before planning takes place, and ensuring they are adequately represented in the process, would be a major contribution to a successful outcome. However, how to achieve this in practise was found to be a daunting and poorly defined task. Using the excellent stakeholder relationships provided by *Re-Impact* and the opportunity to spend additional time in the case study locations, I worked towards designing an approach to follow SIA which would improve this aspect of sustainability planning.

Chapter 4.

Stakeholder Dynamics in Bioenergy Feedstock Production; the case of *Jatropha curcas L.* for Biodiesel in Chhattisgarh State, India

Building on the methodology for assessing the social effects of bioenergy projects presented in Chapter 3, here an additional approach to understanding stakeholder dynamics in bioenergy projects is proposed, contributing towards objective [A] "methodological development" (page 18). The approach is designed to facilitate the multi-stakeholder consultation (MSC) required for SIA and therefore, indirectly, contribute to successful sustainability planning as discussed in Chapter 2. The case of *Jatropha curcas L*. based biofuels production in India is taken as a case study. Using the methodology in this case addresses thesis objective [B] as the understanding of socio-economic aspects and stakeholder dynamics in feedstock production models in this case study is improved. The research behind this Chapter was personally designed and driven, with practical support from *Re-Impact* colleagues at Winrock International India. Their contribution was to facilitate initial stakeholder meetings. The approach and analysis was entirely my own, but verified by co-authors once completed. This has been submitted to, and revised according to constructive referee comments from, the journal *Biomass and Bioenergy*.

Firstly some background on socio-economic issues and sustainability in bioenergy production is given, followed by a discussion contextualising the need for and compatibility of my approach with SIA. The approach is then introduced and its application in the Indian State of Chhattisgarh reported. The planning and undertaking of stakeholder interactions in Chhattisgarh, including the initial contact with stakeholders, is documented and techniques presented for analysing the results. Consideration is given to the social impacts that the different models of Jatropha seed production analysed are having or are likely to have locally through a typology of different production models. 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. Following the analysis of the results in this case, the usefulness of the approach towards planning for sustainability is reviewed.

4.1 Socio-economic issues and sustainability in bioenergy production

The focus of Chapter 3 was predominantly social impacts. In many situations financial implications are inherently linked with social issues in livelihood decisions, and in this and the remaining Chapters consideration will be given to both social and economic (termed socio-economic) issues in order to reflect this. It is thought that economic factors can have a more immediate effect on project design, approval and ultimate success or failure than social and environmental ones, which often have longer term implications. There are a number of socio-economic challenges regarding the implementation of modern bioenergy production systems (Domac *et al*., 2005). These can include (i) limited motivation due to a lack of training and skill development; (ii) mistrust of new technologies and outside influence by some cultural groups; and (iii) relatively high capital costs for acquiring feedstock and low purchasing power of potential users (Lwin, 2004). It has been suggested (Elghali *et al*., 2007) 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; indeed gaining agreement from different departments with a range of vested interests can be one of the main challenges to successful programmes (Goldemberg and Lucon, 2010).

Full stakeholder participation, where representatives from all relevant stakeholder groups are involved, is considered vital to the successful incorporation of sustainability into planning (Gibson, 2006). However, gaining stakeholders' agreement on sustainability goals and criteria remains a major methodological constraint in Sustainability Assessment (SA) (Bell and Morse, 2008). Getting equal engagement of various multiple groups in MSC is reportedly difficult (Dalal-Clayton *et al*., 2003; Reed *et al*., 2009) and stakeholder participation is often thought to provide confusing levels of detail which cannot be effectively analysed or used in policy making (Dalal-Clayton *et al*., 2003). Improving these processes, and in turn the success of sustainability planning in bioenergy, will be the focus of this Chapter through the trialling of a structured approach to understanding and analysing stakeholder dynamics. This is intended to support the objectives of SA, increasing its likelihood of inclusion in policy making or project planning, and therefore its ultimate success in achieving more sustainable bioenergy feedstock production.

4.2 Learning from Social Impact Assessment

One of the main advantages of developing this approach to understanding and analysing stakeholder dynamics alongside SIA is that it offers assistance in the evaluation, management and understanding of the process of social change. Furthermore, an important component of contemporary SIA is that the process necessitates the participation of the local community (that could be) affected by change (Vanclay 2005b). Therefore, using the SIA approach in Chapter 3 ensures that development interventions: (i) are informed and take into account the key relevant social issues; and (ii) incorporate a participation strategy for involving a wide range of stakeholders. This helps in identifying the expected positive and negative impacts of proposed policy actions, likely trade-offs and synergies, and therefore facilitate informed decision-making (CGG, 2006).

The first step in the SIA methodology detailed in Chapter 3 is to gain a thorough understanding of the baseline conditions and context of the area in question (section 3.5, page 72). This Situation Analysis involves a desk-based study to build up a background understanding of the political, ecological, societal and historical context in the location. Identification of the stakeholders who are involved in some way in the production process follows, as having completed this initial analysis of the project context, it is necessary to gain a more detailed understanding of the stakeholders involved in the feedstock production process and what their opportunities, risks, and input costs are (Gibson, 2006). Initial identification of the relevant stakeholders, as well as their roles and expectations, is taken from the Situation Analysis and is then validated through semi-structured interviews with each of the identified groups or individuals. The assessment of social impacts in the previous Chapter has therefore provided a strong platform of information and understanding which is vital for informed policy making. In order to move forwards with increased participation of stakeholders in the planning process, I feel that a supplementary approach which builds directly on that procedure and outcomes is required.

4.2.1 *Representativeness of stakeholder analysis*

For objective analysis of both the approaches presented in this thesis, 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 (Reed, 2008; Reed *et al*., 2009). 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 (Bell and Morse, 2008; Rogers *et al*., 2008). Rogers *et al*. (2008) recognise four categories of stakeholders in development, with varying roles at different phases 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 agencies

Categories [1] and [4] map directly onto two of the participant stakeholder groups proposed by Bell and Morse (2008): '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 of these could come from either [2] or [3]. Nonetheless, the important aspect stressed in both cases is the need for inclusion of actors from all 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. More detail on the stakeholders included in this process is included in Table 4.1.

It was also found to be important, during stakeholder interactions, to work with female as well as male participants. The nature of rural resource management in developing countries, particularly with regards agricultural activities, water and energy provision, is such that women regularly have the greater share of practical responsibility and knowledge, despite often having fewer legal land rights or recognition (Johnson *et al*., 2004; Moraes and Perkins, 2007; Agarwal, 2009). Advocating or designing stakeholder participation without the equal involvement of women, and other often marginal groups, from the start would be counter-productive to successful and sustainable outcomes (Cornwall, 2003).

4.2.2 *Assessing bioenergy projects – focusing on production*

There are a number of phases involved in the production of usable liquid or gaseous fuels from biomass (bioenergy), termed the full fuel chain, which were represented in Figure 3.1 (page 60). At each phase 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 (Cherubini *et al*., 2009). 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 (*ibid.*). A core challenge with LCA, in terms of assessing carbon dioxide emissions, is the amalgamation of impacts at all phases of the chain into a final representative GHG balance value (*ibid.*). 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 phases of the chain are often handled by entirely different groups, and impacts or benefits are not often passed between phases where this is the case (FAO, 2008). It is therefore suggested that phases in the chain could be 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 straight oil feedstock, see Figure 3.1 (page 60) will be the focus. This is because during this phase any biophysical (e.g. land use) and/or institutional (e.g. land tenure) changes are most likely to occur and cause significant 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.

4.3 A structured approach to understand and analyse stakeholder dynamics

The approach to evaluating stakeholder dynamics of biodiesel feedstock production in the Indian State of Chhattisgarh is summed up in Box 4.1. Experience gained from the SIA and SA methodologies, as discussed in previous sections, as well as from other fields such as corporate management and local government guidance, has been centrally employed in the subsequent development of this approach. 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 provides a MSC facilitator with additional material to aid consensus building; through an improved appreciation of stakeholders' roles, requirements, risks, responsibilities and relationships. In order to trial it, analysis of the production of Jatropha seeds for biodiesel in the 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 4.2.1) could be interviewed and, if possible, involved in workshop sessions; using a range of techniques such as those in the field of participatory learning and action (Dalal-Clayton *et al*., 2003). Firstly a recap of the Indian context, as well as more specific information about biofuel production in Chhattisgarh, is required to provide the context analysis.

1) **Context analysis**: identification of stakeholders, their role in feedstock production, their expectations from it, and any assumptions therein;
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.

Box 4.1: the structured approach to understanding socio-economic impacts and stakeholder dynamics in bioenergy projects, designed around the Indian case study. This will be referred to in later Chapters.

4.4 Results and discussion of the approach in the Indian case

4.4.1 *High level context analysis: biofuels development in Chhattisgarh State*

India was selected as a *Re-Impact* case study because of its proactive attitude towards biofuel implementation (Mandal, 2005). There has been a national Biofuels Programme for over 60 years, though the most significant action has only happened in the past decade, most noticeably since the mid 2000s. A discussion of the delayed policy formulation was given in section 3.3.1 (page 51) and also in Reddy and Tiwari (in press); however a major complicating factor was the fact that there are numerous, cross-cutting drivers behind the policy. These were outlined in Box 3.2 (page 52) and it is important to note that rural employment and development has had a strong influence. With Government support, a number of States took the initiative to begin their own Biofuels Programmes before the final national policy was published in December 2009. Chhattisgarh (Figure 4.1) is among the leaders, with a well established Biofuels Development Agency and Board (CBDA and CBDB) and extensive plantation both planned and implemented. 2.14 million hectares (15.84% of the State) have been classified as wastelands that could be planted with Jatropha (Kumar Biswas *et al*., 2010). In 2008 around 90,000 ha were reportedly covered and the State has plans to reach 1 million ha of plantation by 2014 (Tiwari *et al*., 2008).

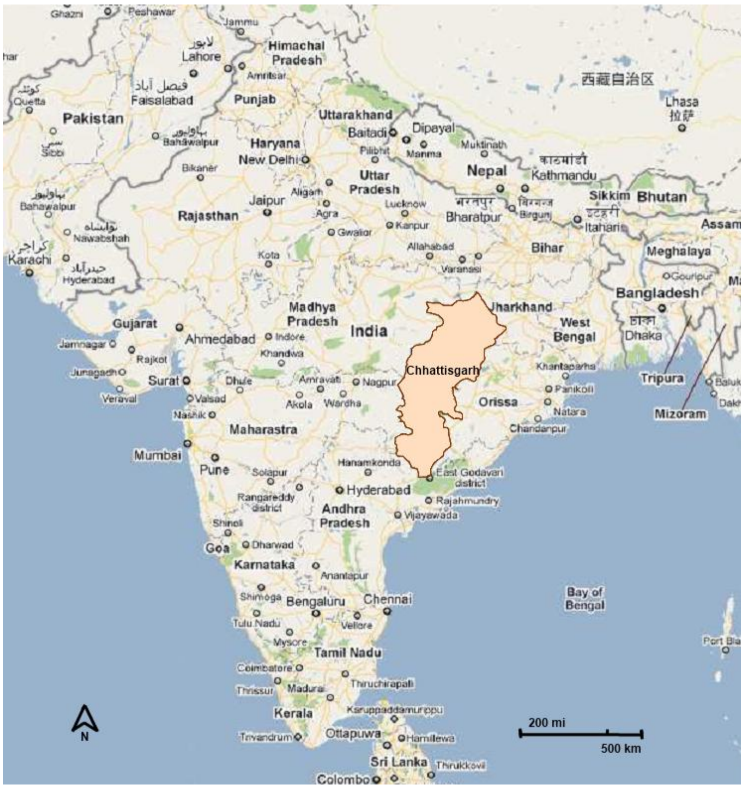


Figure 4.1: Location of the State of Chhattisgarh, India.

Chhattisgarh is a newly formed State; until 2000 it was part of neighbouring Madhya Pradesh. As a predominantly agricultural State, with 80% of the population living in rural areas, there is a strong commitment to further development by attracting funding from both government and external agencies such as the European Commission (Shukla, 2008). This proactive attitude and the link to stakeholders at all levels afforded through *Re-Impact* mean that Chhattisgarh State provides an ideal context for application of the structured approach. In addition, there is real potential to secure an institutional home for the methodologies because of the involvement of the State government in *Re-Impact* workshops and their interest in the project outcomes. The CBDB initially promoted Jatropha plantation through the provision of free seedlings for farmers, produced through cooperation between the Forest Department, the Agriculture Department, Forest Corporation, Minor Forest Produce Federation, CREDA and the Agriculture University (Shukla, 2008; CBDA, no date, a). To stimulate the cultivation and harvesting of Jatropha the State has also set up a pilot transesterification plant and has a guaranteed minimum support price (MSP) for seeds. Whilst the MSP still exists, CREDA has now set up Joint Ventures with public companies and is looking to this model to boost production in the State.

Besides the CBDB there are a number of other actors involved in the biofuels production chain in Chhattisgarh; including the Department of Rural Development, the Forest Department, private companies, public companies, individual farmers and NGOs. From the high levels of State and private investment into the biofuels industry, Chhattisgarh projects significant economic returns amounting to approximately INR 90.5 billion (see Box 4.2).

- 2 million tons of biodiesel; value INR 60 billion (around US$ 1.3 billion[9])
- 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 4.2: Projected socio-economic benefits from Jatropha plantations in Chhattisgarh, adapted from CBDA, 2006 (CBDA, no date (b)).

[9] According to http://www.xe.com, exchange rate: 1 INR = US$ 0.0218771 on 25/01/2011

Previous efforts, including the use of funds from the National Rural Employment Guarantee Scheme (NREGS) to establish plantations which were then left for local communities to harvest, have been unsuccessful in terms of productivity due to the lack of institutional structures around plantation management and seed collection. This has led to plantations which are partially abandoned and unmanaged, except in certain cases where they have been taken over by the Joint Venture companies which the State Government has set up.

The State facilitates rural employment generation through biofuel feedstock production in different ways. The Department for Rural Development provides funds labour for plantation, management and processing of Jatropha seeds for government plantations through NREGS (whereby 100 days work per year, paid at a standard minimum wage, is assured to all those registered) (Jha *et al*., 2009). For private operations, labour is generally only seasonal for smaller projects, or very often feedstock cultivation is contracted out to individual or collective farmers. For the purpose of encouraging seed production, many millions of seedlings have been distributed free of charge by the State. In addition a guaranteed minimum support price (MSP) of INR 6.5 per kg is available, though producers are free to sell on the open market if they are able to procure a better price (Lele, 2010). Only when contracted are farmers bound by a set price and buyer.

4.4.2 *Identification of stakeholders and production models in Chhattisgarh*

To begin the contextual analysis of biofuels production in Chhattisgarh State a community, State and national level stakeholder identification for biodiesel production was completed. Table 3.1 (page 54) in Chapter 3 showed a (non-exhaustive) list of stakeholders who are involved in some way in the biodiesel production industry in the country, and outlined for each group their existing (or potential) role, the impacts that they might be expected to encounter and any assumptions made about the production scenario. In addition to those listed, there are several other ministries, departments, and autonomous (or not) institutions that are expected to play a supportive role in the Biofuels Programme. The information in Table 3.1 was based on extensive consultation with involved stakeholder groups. These interactions often took the form of semi-structured and informal interviews, as described in section 3.3.1 (page 51), as well as different participatory exercises including community resource mapping with men and women as outlined in Kalibo and Medley (2007). These interactions are detailed in Table 4.1, which I produced as a summary.

Table 4.1: Summary of the stakeholders and interaction methods used in Chhattisgarh State, India.

Stakeholder	Type of communication
National Level	
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)	Semi-structured interviews with one representative of the biofuels division from each Ministry
The Heads of Unit from the Public Oil Marketing Companies (OMCs) Indian Oil Corporation and Hindustan Petroleum Corporation Limited	Participated and presented in two separate stakeholder workshops organised under the *Re-Impact* project
Winrock International India development and field officers	Collaborated continuously with development officers during *Re-Impact*; semi-structured and informal interviews with field officers on 3 separate occasions, participation in two stakeholder events organised under *Re-Impact*
National and local representatives from the NGO Ekta Parishad, working on indigenous land rights	Semi-structured interviews during two visits (saw different representatives both times)
State Level	
Head of the Chhattisgarh Biofuels Development Board (CBDB) and the Chhattisgarh Renewable Energy Development Agency (CREDA)	Interviewed on three consecutive field visits as well as participating in two stakeholder events organised under the *Re-Impact* project
Managers, lab technicians and workers at the government supported pilot transesterification plant in Raipur, State capital of Chhattisgarh	The plant was visited on four separate occasions and staff were informally interviewed
Professors from Raipur Agricultural University	Semi-structured interview
The manager of several government block plantations in Chhattisgarh	Plantations visited and informal field interviews conducted
Private Sector	
Agricultural entrepreneurs Agricon Agropreneurs Ltd (AA)	Semi-structured interview and site visit
Director of the private biodiesel plant Tekno Biotech India	Semi-structured interview and site visit
Staff in charge of the Biofuels Programmes at the Head Offices of Mission Biofuels and Reliance Life Sciences	Semi-structured interviews
Local level	
Village Energy Committee (VEC) from Ranidehra village in Kawardha District	The village was visited four times so that the VEC could be observed, interviewed, and participate in an interactive resource mapping exercise
Farmers in Bastar producing for Reliance Life Sciences Biofuel Programme	Focus group question answer session and discussion and site visit
Farmers in Kawardha District	Focus group question answer session and discussion and site visit
Government funded on site worker, school teacher and villagers from Tiriya government ‘model renewable energy’ village	Informal and semi-structured interviews, site visit and tour

Five separate models for Jatropha seed production were identified for further analysis following the field research and interactions with stakeholders. These models, summarised in Table 4.2, 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.

Table 4.2: Five models of Jatropha biofuel production in Chhattisgarh State, India. Author's own

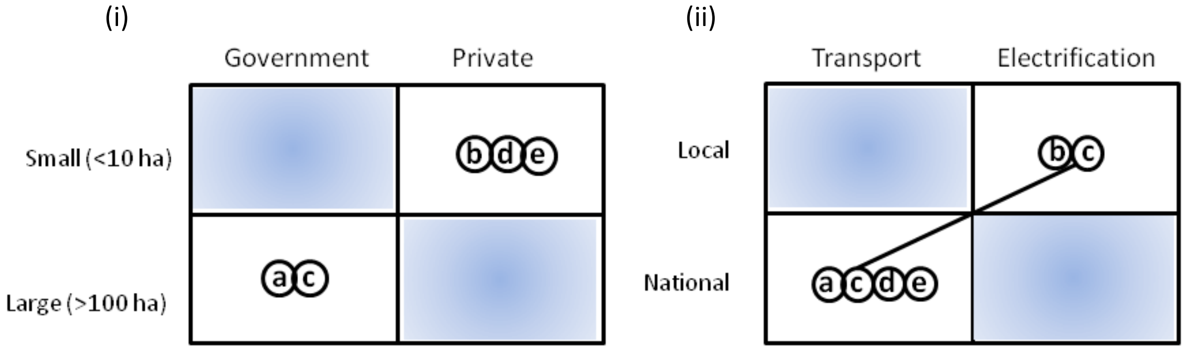
Models (a), (d) and (e) were also referred to in Chapter 3.

Name	Status	Type of proponent	Business model
(a) IOC/CREDA Joint Venture	Plantation	Public private partnership	Large scale 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)

4.4.3 *Distinctions between production models*

For initial comparison the five production models are mapped very simply, according to land size and ownership (Figure 4.2(i)), and market end use and scale (Figure 4.2(ii)). These distinctions were identified as key issues following interactions with the different stakeholder groups. At this stage it was not clear whether the same features would always be identified in any application of the approach. In other situations there might be other more fundamental distinctions to be made, and so the flexibility of these is considered to be important.

The shaded areas in Figure 4.2(i) 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.



Outputs from production model (c) Tiriya government 'model renewable energy' village are used for both transport and electrification as shown by the black line. Shaded area = no models

Figure 4.2: Classification of production models in Chhattisgarh according to (i) land size (vertical axis) and ownership (horizontal axis); and (ii) market end-use (horizontal axis) and scale (vertical axis).

The Government has access to 13.4 million hectares of land classified as wasteland by the Planning Commission in 2003 (Kumar Biswas *et al*., 2010) 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.

In Figure 4.2(ii) it can be seen that there is no local use of Jatropha-based biodiesel for transport. In this case economies of scale are influential. Biodiesel production for transport from Jatropha seeds has been found to be financially profitable at a seed purchase price of 4 to 5 INR (approximately US$ 0.09 to 0.11) per kg (Anonymous, 2010) based on a sale price of biodiesel at 37 INR (around US$ 0.81) per litre[10]. The Government current MSP for seed purchase is 6.5 INR per kg; in the open market the price paid is reported to be between 10 to 14 INR per kg (Thakur, 2009). These current sale prices are thought to be inflated by high demand for seeds for setting up plantations and nurseries; and the economic viability of the Jatropha-based biodiesel schemes of private companies rely on this effect diminishing and disappearing within the next five years (Anonymous, 2010).

It can also be seen from Figure 4.2(ii) that there is no national scale use of Jatropha-based biodiesel for electrification in the models considered. In terms of electrification, efficiency of supply becomes more significant than economies of scale. Village electrification through

[10] Conversion using exchange rate of 1 INR = US$ 0.0218771, according to http://www.xe.com, on 25/01/2011

renewable energy sources such as liquid biofuel is, for the most part, a rural development driven activity. The capacity of electricity to enhance development has long been recognised (Modi *et al*., 2006) and provision of a decentralised energy supply to remote villages without access to the national grid has been a well publicised agenda item of the Indian Government (Agoramoorthy *et al*., 2009; Tiwari *et al*., 2009). Electricity production from either straight Jatropha oil or refined biodiesel is currently achieved using fossil fuel generators, and significant volumes of seed are required depending on the efficiency of the oil expelling procedure. At the power plant in Ranidehra village, Jatropha seeds are crushed using a mechanical oil expeller (see Plate 4.1) and the oil is used directly in recycled generators which required only slight modification[11]; here the oil output is reported to be 1 litre per 8-10kg of seed which would be classed as low efficiency.

Plate 4.1: Mechanical oil expeller in Ranidehra village, Chhattisgarh (source: author, February 2008).

The oil content of seeds is also crucial; Jatropha seeds are often quoted to contain between 30 and 45% oil (Mandal, 2005; Pant *et al*., 2006) but actual figures are known to be extremely variable and the highest are understood to be achievable only from well established (over 5 years), high quality plants in non-stressed agronomic conditions (in terms of temperature, nutrients, water content etc.), when seeds are picked at an optimum time and used with little or no delay (Thakur, 2009). In reality, on private land, crop management and picking take place outside of the main agricultural season and seeds may be stored for up to five months. This greatly reduces the oil content of the seeds, as do agronomic management and site

[11] The pipe supplying the generator with Jatropha oil is wound around the steam inlet in order to reduce the viscosity.

characteristics such as altitude (Pant *et al*., 2006). The feedstock requirements for Jatropha oil-based electricity production on a large scale, even at high efficiency, are therefore extensive; and seed procurement is only financially viable within 15km (Gowda, 2008). This would explain the absence of large scale Jatropha-based electricity plants in Figure 4.2(ii).

4.4.4 *Typology of Production Models*

In 2008, a team of researchers led by Tilman Altenburg produced a detailed report entitled "*Biodiesel policies for rural development in India*" for the German Development Institute. This report was based on eleven weeks of field research and over 100 stakeholder interviews (Altenburg *et al*., 2008). In their analysis, Altenburg *et al*. suggest that there are three modes of value chain organisation that different production models should be classified into before further assessment. These classifications, namely government-centred, farmer-centred or corporate-centred, were introduced in section 3.3.5 (page 59). One problem identified in this study with using the value chain classification alone for the purpose of understanding stakeholder dynamics is that the issue of land ownership was 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 classified 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 what type of land use would be employed for plantation. Figure 4.3 shows how the production models identified in Chhattisgarh fit this classification.

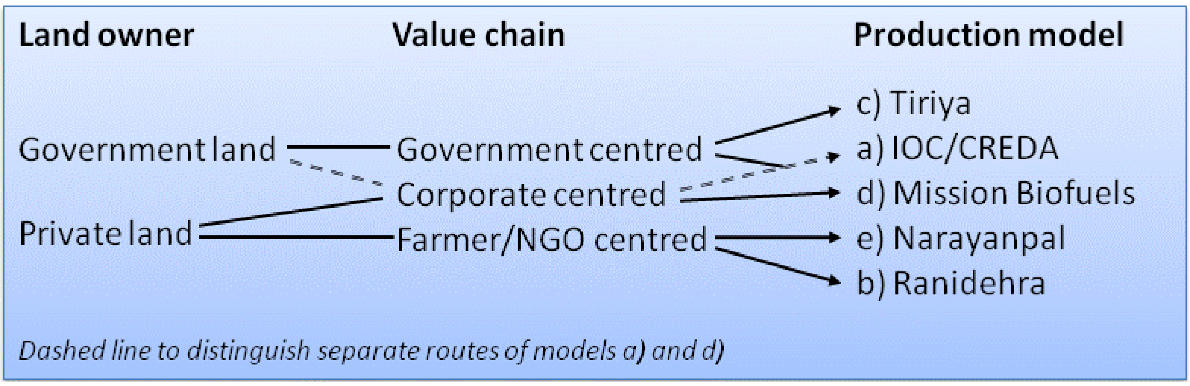


Figure 4.3: Models for Jatropha seed production in Chhattisgarh distinguished by land owner and value chain, author's own.

As seen in Figure 4.2 and Figure 4.3, the main distinction drawn in the Indian context between the identified models is based on whether the feedstock production takes place on government- or privately-owned land. Figure 4.2(ii) introduced another important factor additional to the value chain classification, namely the distinction between market end use and scale. Figure 4.4 goes further in terms of the route to market (public/private company) and includes the significant distinction between private models implemented through contract farming and those driven by Corporate Social Responsibility (CSR).

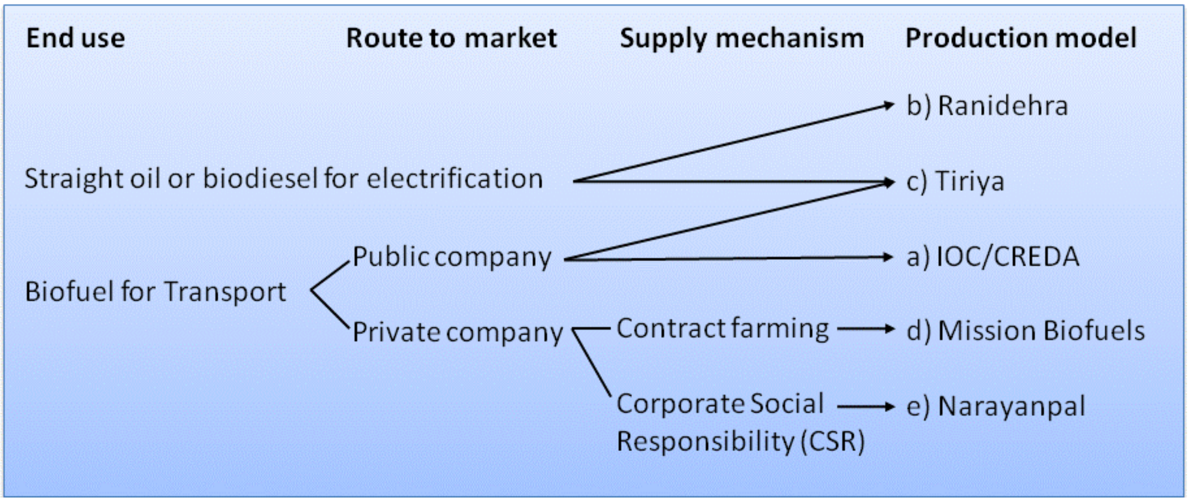


Figure 4.4: Market-based distinction of Jatropha seed production in Chhattisgarh, author's own.

An important consideration for the Indian case is that domestically produced feedstock is being used to satisfy internal demand. In other words the vast 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 (Kumar Biswas *et al*., 2010). In fact, India does actually import feedstock from countries such as Malaysia and Uganda, so the national demand is not even being met through domestic production (Patel, 2008; Basajjabelaga, 2008). This is 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 due to global debates over sustainability of production (Harrison *et al*., 2010), as discussed in section 2.1.1(a) (page 22).

The identification of the distinguishing features with which to classify the production models in Figures 4.3 and 4.4 is used to form the basis of the high level typology presented in Table 4.3.

Table 4.3: Typology of biodiesel feedstock production models in Chhattisgarh State, India, including potential benefits and key issues. Author's own.

Production model typology	Production models	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 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-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.

Production model typology	Production models	Potential socio-economic benefits	Key issues identified
(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); • Local ownership and management	• 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.
(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.

This exercise builds on the information gathered in the SIA in Chapter 3, in terms of the identification of potential direct, indirect and cumulative social impacts (Table 3.3 and Table 3.4, page 67). 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 more detail. When using this approach in a planning context, the social mapping exercise would be completed for all proposed production types. In this case a representative selection of three was chosen then each was discussed and refined with stakeholders.

4.4.5 *Social Mapping*

The first levels of analysis have demonstrated the significance of the distinctions that can be drawn between the production models in terms of land size and ownership, and between markets. The next stage of the analysis consists of a specially designed form of social mapping. This is a qualitative, transparent and participatory method which adds a new layer of understanding to the earlier, simpler assessment of production models. In this case two forms were used; (i) mapping of actors by decision-making power and level and nature of involvement in implementation, and (ii) mapping of risks by extent of impact of project failure and level of personal capital input required (see Figure 4.5).

(i) *after Winstanley et al. (1995)* (ii) *author's own*

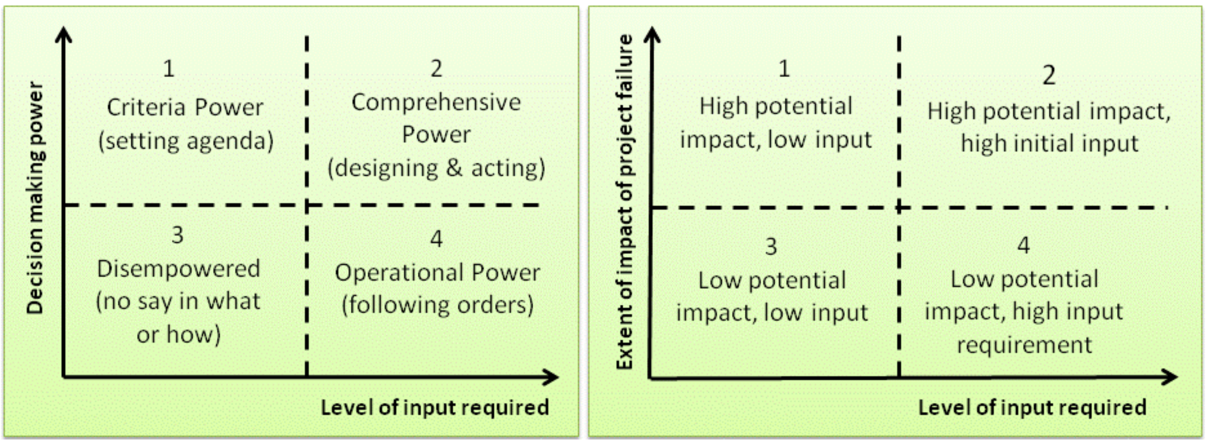
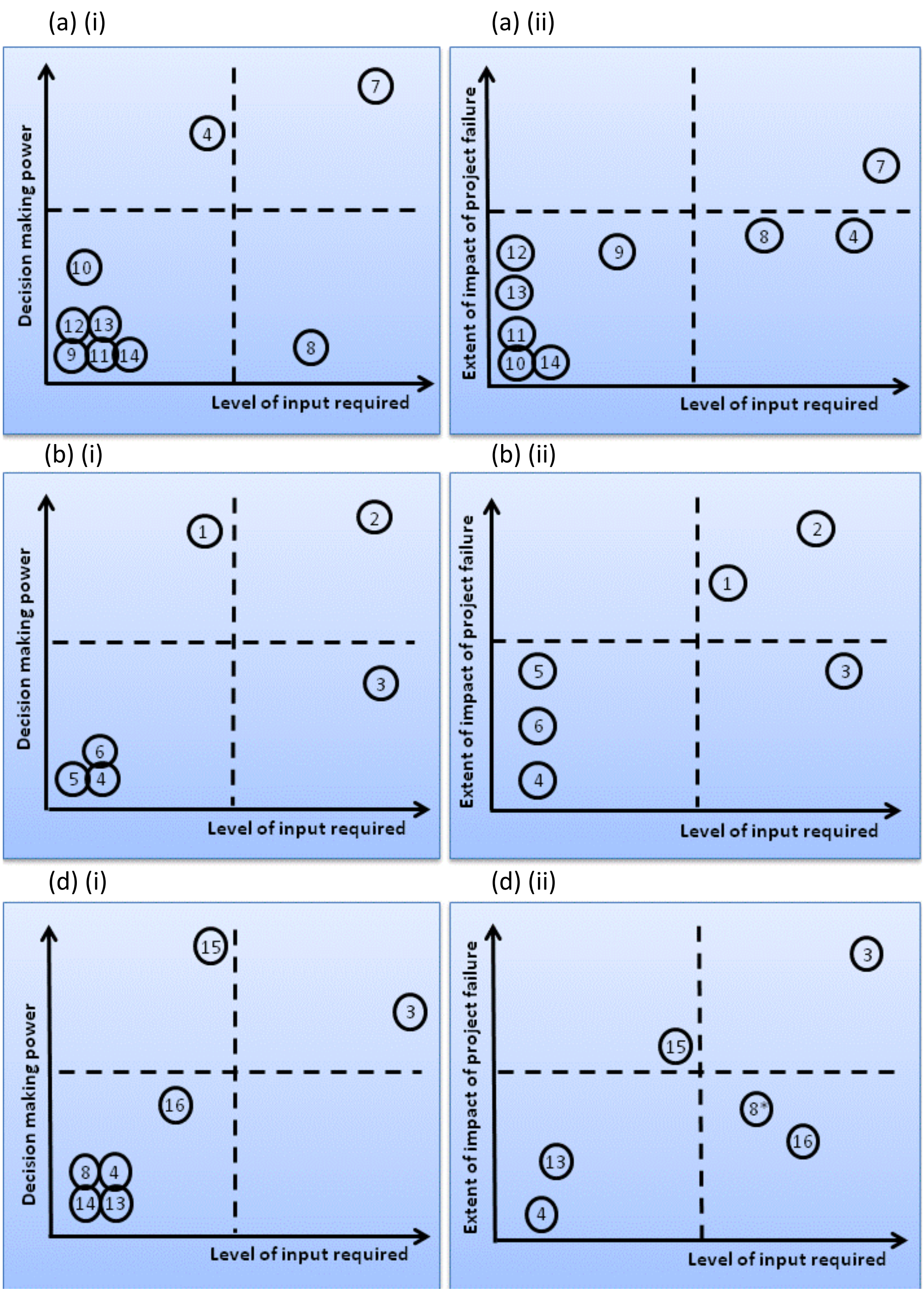


Figure 4.5: Social mapping matrices by (i) power and (ii) risks.

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 types which is the intended outcome of the approach as a whole. Lessons learnt from corporate management (Winstanley *et al*., 1995) and stakeholder participation (ODA, 2005; UNEP, 2005) approaches has been incorporated. Figure 4.6 shows completed maps for three of the production models to demonstrate a representative range of the results. I produced the initial versions following first interactions with the stakeholders involved and then refined them with project colleagues. Wherever possible, the first draft matrices were presented to the stakeholders during follow-up meetings where they were invited to comment and discuss their positioning (or that of others). In some cases this led to alteration of the results and the overall understanding of the stakeholders' power, relationships and risks in different production models. Yin (1994) suggested that this type of informant review can be particularly beneficial in gaining a better appreciation of case study dynamics.

The mapping of stakeholders by power, roles and risks has shown that, in all production models excluding the IOC-CREDA Joint Venture, the Marginal Farmers' stakeholder group (number (3) in Figure 4.6) features strongly; indicating that they stand to gain from the expansion of biofuel production in India, but also that they are potentially at high risk of project failure. Whilst this risk might be considered a negative aspect of the different ventures, its identification provides a mitigation opportunity for stakeholders with decision-making power. Advance understanding of vulnerabilities increases the likelihood that policies which take into account the best available research and development activities, and reduce risks, can be employed. It is important to understand the risks (here in reference to the level and nature of impact of project failure) at all levels, including those facing the production companies (without whom sector development is impossible), and how these then affect stakeholders functioning at a particular level. The nuances regarding changes arising from different policy interventions have been investigated (Bird *et al*., in press) but can still be further explored locally. Additionally, it must be noted that opportunities available to marginal farmers in the majority of production models have been identified as high. Promotion of a model with few or no opportunities for marginal farmers is unlikely to result in sustainable rural development; the goal identified as a major driver behind the Biofuel Policy. Also, the stakeholders' requirements are included in dynamics, gleaned from the stakeholder analysis for the Indian Biofuels Programme which was completed in Chapter 3 (Table 3.1, page 54). This shows that the farmers and landless poor have expectations relating to financial returns and diversification. Ignoring these requirements (even if there are no negative impacts on these people) means that the programme has not achieved its aim.



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

Discussions with the marginal farmer groups resulted in their level of risk, i.e. the impact on their livelihoods as a result of project failure, being shown lower on the Ranidehra (Figure 4.6(b)(ii)) risk map and higher on the Mission Biofuels (Figure 4.6(c)(ii)) map. The farmers in Ranidehra village had chosen where to plant the Jatropha, and could therefore decide for themselves how much of their livelihood would be invested in feedstock production. In addition, many were represented on the Village Energy Committee and so were involved in the strategic decisions around payment and management structure. The support of the team from Winrock India in terms of research and development input, as well as troubleshooting assistance where required, means that the farmers feel that the level and nature of risk to them is reduced. The farmers in contract with Mission Biofuels had a much greater livelihood stake in the Jatropha feedstock production, including in some cases substantial loans and opportunity costs from crop management. This group were certainly more concerned about the extent and nature of risk they faced if the production were to fail. However, they were aware of this and felt they were informed and had taken the decision to accept the risk because of the potential returns. Arguably, if the Jatropha feedstock production is a success then the Mission Biofuels contracted farmers could stand to gain more than the Ranidehra farmers. The latter do have the freedom of having the power to decide what they do with their produce, though, whereas the contracts require sale to the company at a set price, meaning that these farmers are limited to a particular market.

If the models which don't involve marginal farmers, such as the IOC-CREDA Joint Venture, are to be pursued for alternative benefits, there is a need to simultaneously support models in which they are collaborators. This overall positive outcome is 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).

4.5 Key messages and implications from Chapter 4

This Chapter has detailed the development and trialling of a structured approach to understanding and analysing stakeholder dynamics in the Indian State of Chhattisgarh. The main outcomes are a typology of feedstock production models, with associated benefits and issues (Table 4.3), and identification of the stakeholder dynamics in the different models through a specially designed form of stakeholder mapping (Figure 4.6). These outcomes have contributed towards overall thesis objectives [A] and [B] (page 18) because of the methodological contribution and the comprehensive analysis of socio-economic impacts from bioenergy projects in Chhattisgarh which builds on the approach in the previous Chapter.

In analysing social impacts locally, it was found that considering the roles, requirements and risks of different stakeholder groups is an effective way to better understand expected socio-economic impacts. In Chhattisgarh the marginal farmers stand to gain from the expansion of biofuel production, but are potentially also at high risk of project failure. This group can be seen from Figure 4.6 to have comparatively high expectations of feedstock production. It is therefore suggested that, in order to meet the rural development goal of both national and State level governments, the marginal farmers should be supported by research and development into the production models in which they are involved. In addition, the design of transparent policy in which they are consulted is likely 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 (see Table 4.3); providing of course that the interrelationships between the 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, and a further round of project planning and design completed to avoid negative impacts where possible. In such a situation, participation of stakeholders from all affected groups, including women and other often marginalised groups, would be required in order to ensure that the solutions agreed upon are optimally beneficial and equal. The role of the Oil Marketing Companies (OMCs), such as IOC, in Indian bioenergy production is strengthening, due to high profile initiatives such as the 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. In addition to strategic advance planning, monitoring of impacts following implementation is also vital as discussed in section 2.4 (page 38).

In order to plan for sustainable bioenergy 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, as introduced in Chapter 2, is not necessarily reduced as a result. *A priori*, informed stakeholder interrogation and social mapping, 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 as seen in Figure 2.2 (page 36). 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 understood 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.

Further testing of the method with policymakers and project developers is required to streamline and optimise it. Application to other situations is important to ensure replicability in multiple contexts. In order to achieve this, the following Chapter 5 will apply the approach to predominantly wood-based bioenergy projects in Uganda. This will enable an objective evaluation as to whether the approach developed in India can be robustly adapted to alternative bioenergy projects in a very different context. Through comprehensive analysis of socio-economic impacts of bioenergy production models in Uganda, this next Chapter will also focus on thesis objectives [A] and [B] (page 18).

Chapter 5.

Rural Bioenergy Production in Uganda – Understanding Stakeholder Dynamics and Socio-economic Impacts

In this Chapter the case of bioenergy feedstock production models in Uganda will be considered, using the structured approach proposed in Chapter 4. Despite the fact that both are developing countries, there are many significant differences between Uganda and India in terms of policy, history, level and drivers of development amongst others. Despite these differences, it is proposed that the assessment of social impacts and stakeholders as discussed in Chapters 3 and 4 remains relevant in this context because of its flexibility. By testing the portability of assessment methods in a different country setting their strength can be evaluated, contributing to objective [A]: designing a straightforward yet robust methodology (page 18). The research forming this Chapter has been peer-reviewed for the journal *Biomass and Bioenergy* and accepted for publication as part of the *Re-Impact* project outputs. Kai Windhorst of UNIQUE Forestry Consultants was my main *Re-Impact* contact in Uganda, and facilitated my initial contacts with stakeholders. His input to this work was in terms of background knowledge and contacts. Jaime Amezaga provided policy support and guidance. Thesis objective [B] is also supported in Chapter 5 by expanding the understanding of the socio-economic impacts of numerous proposed bioenergy production models in the Ugandan situation.

In the *Re-Impact* activities the opportunity to carry out a full Social Impact Assessment (SIA) for Uganda was not available. This is because the project was concerned primarily with the development of methodologies and the work completed in India (detailed in Chapter 3), based on extensive available literature and practical applications, was sufficient to provide a strong SIA for bioenergy projects. However, in development of the structured approach outlined in the previous Chapter, it became obvious that application in another context would be required in order to ensure that the methodology was robust. The opportunity arose to apply the approach in the very different context of Uganda because I was coordinating other activities in the country and was already collaborating with local stakeholders. Uganda proved to be an excellent case study because of the interest from other *Re-Impact* partners in additional aspects of the case study, which I was able to direct and in some cases input directly, forming the basis of Chapter 6. Certain key aspects of SIA (Situation Analysis, stakeholder identification) have been incorporated in this Chapter where necessary to provide essential context for the understanding of stakeholder dynamics. It is still recommended that, for informed policy making and implementation, both tools should be employed in full because of their direct complementarity.

5.1 The Ugandan context: energy, development and land use

5.1.1 *Energy and socio-economic development; the role of bioenergy*

In section 1.1 (page 1) it was shown that sustainable development relates to more than simply a country or region's economic performance. In fact the social features of the population at all levels and the divide between rich and poor need to be accounted for. In addition, the link between insufficient energy supply and low levels of development has meant that policies, programmes and projects which are intended to improve the availability and accessibility of secure energy supplies for the poorest and most remote people have been central to development efforts (Goldemberg and Lucon, 2010). The increasing drive towards decentralised, renewable provision of energy which relies on local resources (Buchholz and Volk, 2007) rather than trying to improve and extend existing, insufficient national grid infrastructure, is intended to be one such effort. Bioenergy schemes are regularly reported to be motivated by socio-economic drivers such as employment and livelihood opportunities in rural areas, localised multiplication of financial benefits due to proximity of processing, and improvements to local energy supplies (Domac *et al*., 2005; IEA, no date; FAO, 2008). These benefits are far from assured however, and in many cases do not have as profound an impact as might be anticipated (Gallagher, 2008; Grunwald, 2008). As is the case in other sectors, there is a need to ensure a thorough and structured understanding of stakeholders and social issues in order to maximise social gains (Esteves and Vanclay, 2009). Tools, such as the structured approach suggested in Chapter 4 and further developed in this Chapter, are considered essential in planning and assessment of bioenergy projects in order to better understand differing stakeholder dynamics (Dalal-Clayton *et al*., 2003; Elghali *et al*., 2007).

The environmental impacts of different bioenergy systems as investigated using the Life Cycle Assessment (LCA) method have been seen to be influenced by regional variation, particularly with respect to land use, biomass production patterns and the reference energy system (Cherubini *et al*., 2009). This context specification also applies very much to social impact variables which are also affected by aspects such as scale, political structures and resource availability (Barrow, 2000; Becker, 2001; Esteves and Vanclay, 2009). To adequately capture context diversity, two separate case studies are examined: the State of Chhattisgarh in India

(Chapter 4) and several examples from across Uganda (this Chapter). Here, the approach trialled in India in Chapter 4 will be used to look at the socio-economic impacts and stakeholder dynamics of several proposed bioenergy projects in Uganda, in order to assess whether the methodology is meaningful in this very different context. In the following section, the background information gathered through desk-based Situation Analysis is presented to provide the overall context for the case study and approach.

5.1.2 *Electricity and energy in Uganda*

From 1954 when public electricity supply in Uganda commenced, until 2005, more than 98% of the country's electricity was sourced from the Owen Falls dam (Keating, 2006). At that time it was reported that only 5% of Ugandan households had access to electricity - one of the lowest rates in Africa (Clark *et al*., 2005). In 2005, to meet growing demands and counter poor hydro performance due to drought and consequent low water levels in Lake Victoria, the Government contracted an independent power producer to supply 150 MW capacity to the grid, based on diesel (Kiza, 2006). This has had the effect of dramatically raising electricity price tariffs, resulting in the need for substantial government and donor subsidisation. The high energy import bill associated with increased use of (at the time of writing) entirely imported petroleum products has caused some shortages in Uganda, with an accompanying rise in diesel and fuel prices in the country (*ibid.*). Despite this, the most commonly used alternative energy source in rural areas still not connected to the grid comprises petrol and diesel powered generators (Buchholz and da Silva, 2010), see Plate 5.1.

In addition to extremely low overall access, the distribution of electricity supply in Uganda has historically been very inequitable. It has been recently reported that, despite 84% of Ugandans living rurally, electricity supply is mostly centred around the major urban areas, leaving less than 1% of available electricity to supply rural communities (Buchholz and Volk, in press). The government initiated the Rural Electrification Strategy and Plan (RESP) in 2001, with a target of 10% access by 2010, but reportedly less than half of this rate was achieved (NRECA, 2010). Even if rural areas had an electricity supply the vast majority would not be able to afford to use it for cooking. Most Ugandans rely on traditional fuelwood for energy, as seen in Plate 5.1, as it is the cheapest option. Fossil fuel generators supply electricity to those who have the capacity to pay, generally commercial enterprises, centrally funded hospitals and schools, or large scale charity centres. Bingh reported in 2004 that around 90% of the total energy needs of Ugandans were supplied by fuelwood. It is accepted that this fuelwood consumption is not only outstripping supply, resulting in forest degradation, but provides an inefficient energy source with knock-on social and environmental consequences due to its uncontrolled collection (MEMD, 2003). The negative social impacts from traditional biomass use include time to collect fuelwood, primarily by women and children, and indoor air pollution with detrimental health consequences (Bailis *et al*., 2005). Both are perceived as barriers to sustainable development (Modi *et al*., 2006).

Plate 5.1: Left: fuelwood collected on a farm in Konokoyi village. Right: Diesel generator at the Gumtindo cooperative coffee collection station. Both in Mt Elgon region (near Mbale, see Figure 5.2). Source: author's own, November 2009.

There is clearly a need for alternative, off-grid electricity and other energy supply solutions whilst grid extension projects are mainly in early phases of agreement, funding and implementation (REA, no date(a)). This is particularly the case for rural parts of northern Uganda which have been affected by more than two decades of conflict and are gradually being re-inhabited (Syngellakis and Arudo, 2006; Rugadya, 2008). It is suggested that investment in small scale electrification plants could help to secure domestic energy supplies, as well as provide economic and social benefits to rural areas (Woods *et al*., 2006b; Buchholz and Volk, in press). This is reflected in one of the main aims of Uganda's energy policies; which is to eradicate poverty through increasing access to modern, affordable and reliable energy services (MEMD, 2003; MEMD, 2007). The 2002 National Energy Policy for Uganda also outlined the need to achieve this "*in an environmentally sustainable manner*" (REA, 2006, page 8). The overall objectives are to both increase public access to electricity and modernise biomass conversion technologies, though with existing financial and technological capacity it is unlikely that these objectives will be achieved in the near future (Kiza, 2006). The Ugandan Rural Electrification Agency (REA) is looking to attract investment and has funding from the World Bank and African Development Bank (REA, no date(b)). Nonetheless, rather than trying to meet energy needs through large-scale hydro, fossil fuel and even nuclear power projects, which have reportedly faced difficulties and low success rates due to lack of investment capital and international opposition (Clark *et al*., 2005), it has been suggested that small-scale, decentralised, wood-based biopower systems could be more successful in meeting multiple development objectives (Buchholz and Volk, in press). This is despite the fact that since around 2006 it has been widely expected, in western Districts in particular, that the discovery of oil in the Albertine basin (see Figure 5.1) will result in cheaper petroleum products and improved electricity infrastructure across the country (Rice, 2009; Thompkins, 2010). The difficulties associated with locals actually benefitting from oil production in other African countries including Nigeria, Sudan and Gabon (Rice, 2009) mean that it remains debateable whether these discoveries negate the need for decentralised energy provision. Even if the oil exploration was to result in improved energy access in the poorest, most remote areas of the country, peak production is not expected to begin until 2015 (*ibid.*) and the time taken to construct the necessary infrastructure would likely lead to a time lag of over a decade before this is achieved. In the meantime the use of decentralised energy supply improvements remains an important option.

Figure 5.1: Location of oil discoveries in western Uganda (The Economist, 2010).

In 2007, after the discovery of oil in the Albertine region, the Government published its Renewable Energy Policy for Uganda, for which the overall policy goal is to "*increase the use of modern renewable energy, from the current 4% to 61% of the total energy consumption by 2017*" (MEMD, 2007, page 7). To achieve this, a combination of biomass, peat, hydropower, geothermal, solar and wind sources are being targeted. This Chapter evaluates the different models of biomass for energy production, and identifies the potential socio-economic impacts (positive and negative) of these approaches. Neither the impact of such models on the level of biomass use nor the most sustainable means of providing the wood feedstock are considered here, however as these are both critical aspects in such projects bearing in mind the current, rapidly degrading state of Uganda's biomass resource, they are considered later. The level of biomass use for wood gasification projects is discussed in Chapter 6. The most sustainable means of providing feedstock will always be situation-specific, but is considered briefly for the models in this Chapter and in more detail in the following Chapter, which focuses on the proposed woody biomass for gasification model of electricity production at Anaka trading centre. The Anaka model is introduced, along with others, later in this Chapter.

5.1.3 *Opportunities for bioenergy investment and development in Uganda*

The Government policy mentioned above, along with donor development objectives for Uganda (particularly in relation to the less developed northern region), focus on provision of decentralised, often renewable, energy sources through programmes, financial and other fiscal incentives (MEMD, 2007; GTZ, no date). In addition to local schemes, this opens up private investment opportunities, often from international companies. The ensuing risk is that this could result in feedstock being produced purely for export, which would be assumed to have limited local socio-economic benefits compared to decentralised production. At the other end of the scale, the recent history of conflict and internal displacement in the north of the country has resulted in the establishment of densely populated Internally Displaced Persons' (IDP) camps by the United Nations High Commissioner for Refugees (UNHCR) (Rugadya, 2008). Since the declaration of peace in 2006 there has been a movement for these camps to be systematically closed and for their inhabitants to return to their homelands, many of which have been abandoned for over two decades (Russo, 2007). In some cases the local council authorities can decide to pursue the establishment of a trading centre around the remaining community; meaning a centrally situated focal point where communities can come together for trading and exchange. This is particularly likely where there was an established settlement prior to camp formation. There are opportunities for entrepreneurship within these locations, and such prospects are deemed essential for enabling people to move themselves out of poverty (Alvord *et al*., 2004). Donor funding is also available for commercial forestry plantation and community or institutional woodlots, alongside other projects such as improved cook stoves (Jacovelli, 2009; Namaalwa *et al*., 2009). In this Chapter consideration is given as to what the implications of such opportunities are for rural planning, of bioenergy projects in particular, and key issues that need to be taken into account will be identified. Chapter 6 goes into more detail on this important aspect, evaluating benefits, impacts and barriers from a specific case study example.

There is a particular stakeholder group which is often overlooked in project development terms, but is often at the centre of both local and national concerns. These are the rural landless poor, colloquially described as 'idlers', who are usually unskilled youths and young adults unable to find employment and not having land of their own to provide themselves a living (Rugumayo, 2009). Locally, problems occur because these individuals can be driven to crime. Incidents such as crops and tools being stolen have necessitated the hiring of security services by some to protect their land, an increasing phenomenon particularly in the Mt Elgon region of Uganda (Wambedde, 2009). Other groups including NGOs, donors and even government are increasingly looking for ways to provide vocational, entrepreneurship and other opportunities for these landless poor. Developmental projects and policies need to consider their inclusion as well as mechanisms to provide assistance such as micro finance to enable them in livelihood generating activities (Harrington, 2009). This will be considered a specific goal of Uganda's energy policy. Achieving this goal may take more than just providing opportunities and encouraging entrepreneurship, as some previous attempts at cooperatives and community based initiatives have been unsuccessful at including the "*destitute*" (Hanisch, 2010, page 14). It has been suggested that, in certain cases, the idlers are passive individuals (predominately male) with a low level of initiative and predisposition to alcoholism and that engaging them in developmental activities is not always an easy task (YEAH, 2007; da Silva, 2011).

The following sections discuss how a range of bioenergy projects could contribute to meeting Uganda's policy goals and objectives as described in section 5.1 above, using the approach trialled in India (Chapter 4).

5.2 Using the structured approach to understanding stakeholder dynamics in the Ugandan situation

A structured approach to understanding stakeholder roles, requirements and risks (dynamics) in bioenergy projects was outlined in the previous Chapter. This method builds on SIA in particular (Burdge, 1995; CGG, 2006) but also takes account of developments in Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA) (Hacking and Guthrie, 2008). It is intended to be used within a planning for sustainability framework as described in Chapter 2 (Figure 2.2, page 36). Increased stakeholder participation in planning is being demanded more and more by donor organisations, international NGOs and many government departments due to extensive social science research into the concept (Healy, 2009; O'Faircheallaigh, 2010). Unfortunately, participation is regularly ineffective and all too often results in the views or goals of individual stakeholder groups not being taken into account (Dalal-Clayton *et al*., 2003). Gaining a more structured understanding of stakeholders' roles, requirements and risks (referred to here as their dynamics) is intended to help planners, project developers and policy makers to incorporate these views early in the planning process. This then paves the way for a more community-centred approach where participation is collaborative and empowering rather than simply one-way information sharing (Rogers *et al*., 2008). It is also anticipated that this approach will improve facilitation of the multi-stakeholder consultation (MSC) required for effective stakeholder participation in the *Re-Impact* planning for sustainability framework. This is because the facilitator could benefit from understanding the stakeholder dynamics and be subsequently prepared for the discussion. In addition the stakeholders themselves will be introduced early to the concept of sustainability planning and be ready to contribute.

Extensive interaction with stakeholders was carried out during six weeks of field research in Uganda over three separate trips. Table 5.1, which I personally produced as a summary, shows the different stakeholders who were approached and the way in which their interactions were conducted. This ranged from involvement in a two week teaching module with international technical experts and students from Makerere University, which included daily interactive sessions; to semi-structured interviews; a focused stakeholder workshop and many informal discussions, using participatory techniques such as iterative stakeholder mapping as discussed in section 4.4.5 (page 93). The mode of interaction was mostly governed by opportunity, but a representative range of stakeholders for this exercise was identified, again using purposive sampling. This ensured that members from as many different stakeholder groups as possible (see section 4.2.1, page 79) were included and given the opportunity to be involved. In the same way as in India (section 3.3, page 51), where feasible these interactions were conducted in English. Translation was provided whenever this was not possible, and the stakeholders were offered the opportunity to ask questions of myself and whichever of my colleagues were present. I took very detailed shorthand notes throughout the interactions which were written up as transcripts and then verified with project colleagues who had been present, and in some cases the stakeholders themselves. The questions forming the semi-structured interview schedule listed in Box 3.2 (page 52) were altered slightly to better reflect the nature of the stakeholders and the Ugandan context, following discussion with project partners and local experts. Again, the questions were also refined as the interactions proceeded, as new issues were raised. The new set of questions and issues is given in Table 5.2.

Table 5.1: Summary of the Ugandan stakeholders interacted with, and methods of communication.

Stakeholder	Type of communication
National Level	
Students from Makerere University and international technical experts (teaching the course)	Daily interactive sessions over a two week module
Energy for Rural Transformation Department Coordination Manager, Ministry of Energy and Minerals Development (MEMD), Renewable Energy Policy author	Semi-structured interviews on two occasions
Environmental Impact Assessment (EIA) Officer for the National Environmental Management Agency (NEMA)	Informally interviewed
The professor heading the Centre for Renewable Energy and Energy Conservation (CREEC), Makerere University	Met on three occasions, involved in a workshop along with other experts
Academics from the Water Resources Department and the Institute for Adult and Continuing Education at Makerere University	Semi-structured interview
Representatives from an EU Delegation to Uganda	Discussions were held on three occasions; they were also involved in the workshop
Researchers who have many years of experience living and working in Uganda in fields including forestry, rural development and climate change	Multiple discussions were held both during the field visits, and remotely via email/skype
Field officers for the United Nations High Commissioner for Refugees (UNHCR)	Written communications via email
Private Sector	
The Managing Director of the firm Human Energy, Kampala	Semi-structured interview
The chairman of the Uganda Carbon Bureau	Semi-structured interview
Multiple forestry consultants and an energy consultant	Multiple interactions ranging from semi-structured to informal interviews/remote group and individual discussions via skype
Head of the Uganda Timber Growers Association (UTGA)	Informally interviewed
Commercial timber plantation manager	Provided a plantation tour, answered questions
The Chief Technical Advisor to the Sawlog Production Grant Scheme (SPGS) project	Interviewed and involved in the workshop
A number of SPGS clients	Informal interviews, conference discussions
Local level	
Farmers, villagers, a land manager and cooperative workers	Informally interviewed
Representatives from the NGO Twin, the Welsh Assembly representative in the region and Gumtindo Coffee Cooperative Enterprises (GCCE)	Two day site investigation in the Mount Elgon region, question and answer, informal interviews and discussions
A field supervisor, an environmental officer, a certification officer (also a local Youth Group leader), a coffee quality promoter, the secretary and the chairperson of GCCE	Interviewed in an interactive group session
Head teacher (and founder), volunteers and pupils of the Bududa Vocational Institute, Konokoyi Village, Mt Elgon	Informally interviewed

The structured approach to assessing stakeholder and production model dynamics in bioenergy projects proposed in Chapter 4, Box 4.1 (page 81) has been applied in the Ugandan case. The results are presented in the following sections.

5.3 Results

5.3.1 *Context analysis: Identification of stakeholders*

The stakeholder identification table for bioenergy projects, as piloted in India, has been completed for Uganda, see Table 5.2. This was populated following the stakeholder interactions outlined in Table 5.1, as well as the desk-based study described in section 5.1. Ideally a full SIA would have been completed in this situation prior to the employment of the structured approach. However, in this case it was not feasible to carry out this exercise due to constraints on time and repeated access to the relevant stakeholders. Instead, aspects of the SIA methodology (Situation Analysis and identification of potential direct, indirect and cumulative impacts) were used informally and the results discussed at length with *Re-Impact* experts living locally in order to gain a basic level of understanding of the potential socio-economic impacts expected from bioenergy projects.

5.3.2 *Identification of production models*

Following the interaction with stakeholders and six weeks of field research, seven biomass-for-bioenergy and one biofuel from oil seed production models were identified, mostly potential but two existing. These are:

(a) large scale biomass powerplant planned by an International Energy Company (Aldwych);

(b) waste biomass to energy in sawmills;

(c) communal (Gumtindo),

(d) private land (farm scale)

(e) institutional (Bududa) woodlot cultivation for personal or cooperative consumption;

(f) a private company exporting biofuel feedstock (Human Energy);

(g) gasification of waste biomass for energy on a large, internationally owned tea estate (Muzizi); and

(h) gasification for electricity for a former IDP camp (Anaka) as shown in Table 5.3.

Figure 5.2 shows the locations of the different models, where existing plantation sites are defined. Figure 5.3 gives some more information on them.

Table 5.2: Bioenergy stakeholder identification for Uganda. Author's own.

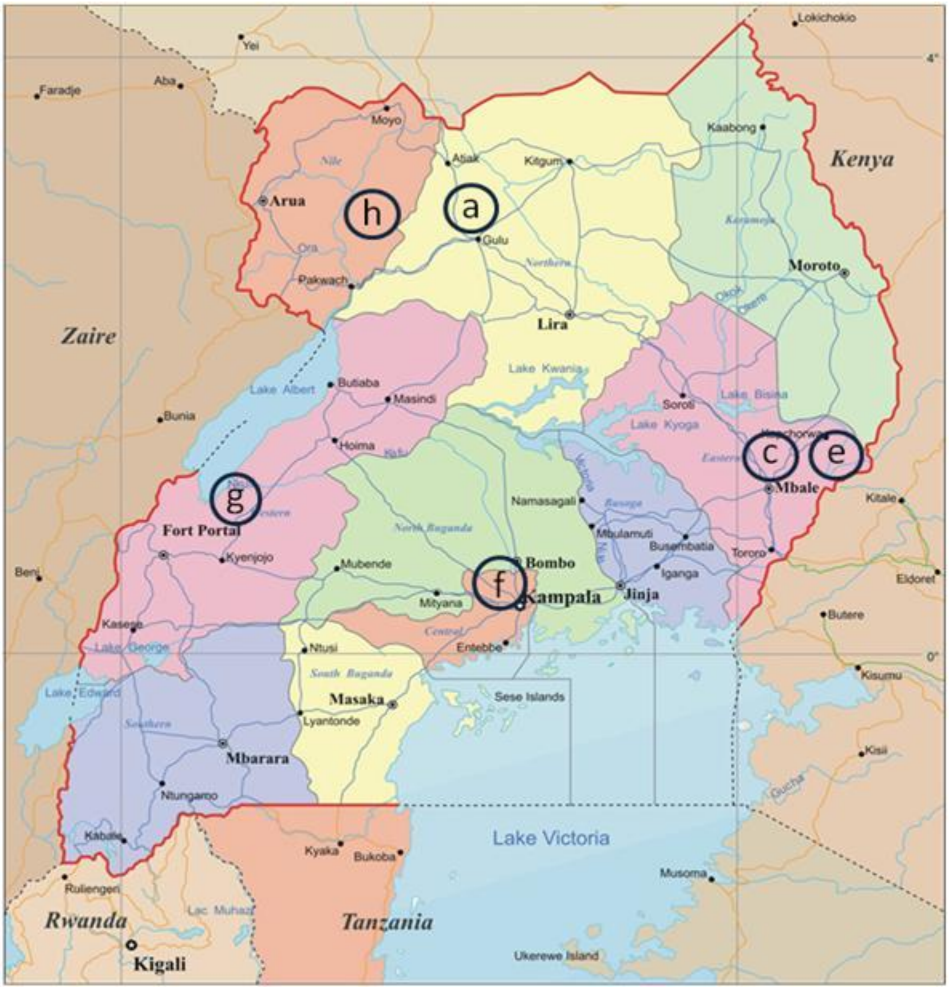
Stakeholder	(Potential) Role in the project	Motives for participation in bioenergy projects	Assumptions on which expected outcomes are based
National Level			
MEMD – Ministry of Energy and Minerals Development	National renewable energy / bioenergy policy development	Promoting renewable energy sources; sustainable (esp. rural) development; low-carbon energy; energy security; targets	Bioenergy is a viable renewable energy option
European Union Delegation to Uganda	Donor funding, research and development, market	Strengthen EU/Uganda ties; sustainable (esp. social & economic) development; applied research; poverty eradication	Bioenergy will contribute towards social and economic development
GTZ / DfID / Developed country donors	Donor funding, research and development, market	Strengthen national ties; poverty alleviation; sustainable development; energy supply	Bioenergy will lead to sustainable development
Uganda Timber Growers Assoc. (UTGA)	Coordination of land holders & the private timber forestry sector, dissemination of ideas	Added value	Markets for biomass waste are available
Uganda Carbon Bureau	Providing assistance for CDM projects	Low-carbon energy; suitable projects for CDM	Bioenergy cultivation qualifies for CDM
National Environmental Management Authority (NEMA)	Approval of bioenergy projects, ensuring environmental/social sustainability of projects	Sustainable (esp. environmental) development	Bioenergy will contribute towards environmental development
District Level			
Civil society organisations / NGOs	Social watchdogs – protect local communities' & marginalised rights, establish innovative methods of involving local communities in developing bioenergy plantations, R&D, outreach	Sustainable (esp. social and environmental) development; poverty eradication; energy supply; potential negatives – biodiversity loss; water resource depletion	Bioenergy is a viable renewable energy option; monocultures would affect local biodiversity and use water extensively; bioenergy will contribute towards social and environmental development

Stakeholder	(Potential) Role in the project	Motives	Assumptions
Cooperative leaders and coordinators	Coordination of producers, market for feedstock	Profit; energy security; sustainable (esp. social) development	Bioenergy is a viable energy option and will contribute towards social development
Sawmill operators	Market for feedstock	Profit; energy security; feedstock supply	Bioenergy is a viable energy option
Private corporations	Production of or market for bioenergy feedstock, refining and sale to Oil Marketing Companies or for export	Feedstock supply; profits; rural development (if CSR activities)	Bioenergy plantation is a 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	Cultivation of feedstock	Profit; livelihood diversity; assured markets	Food crops not displaced; minimal financial risks; access to relevant information & technical inputs
Poor / landless / 'idlers'	Participate in plantation establishment & management	Employment	Bioenergy intervention strategy specifically involves landless
Local education and research institutions	Training farmers / landless in improved agronomy, perhaps have model production	Skills/livelihood opportunities to pass on to pupils; sustainable development	Bioenergy is a viable energy option and provides employment / livelihood opportunities
Land managers and owners	Cultivation of feedstock	Profit; livelihood diversity; assured market	Bioenergy is a viable energy option; food crops not displaced

Table 5.3: Eight potential models of biomass to bioenergy production in Uganda. Author's own.

Name	Status	Type of proponent	Business model
(a) Aldwych	Proposed	Private company	50MW biomass plant
(b) Sawmills	Proposed	Private company	Purchase waste biomass for gasification
(c) Gumtindo	Proposed	Private company (Cooperative)	Private woodlot for gasification
(d) Farm scale woodlots	Proposed	Farmer/NGO	Individual farm scale bioenergy woodlots
(e) Bududa, Konokoyi	Proposed	NGO (vocational institute)	Individual farm scale bioenergy woodlot
(f) Human Energy biofuels	Existing	Private company	Exporting Jatropha feedstock for biodiesel
(g) Muzizi Tea Estate	Existing, on hold	Private company	Private woodlot for gasification
(h) Anaka trading centre	Proposed	Locals/NGO	Multiple farm scale woodlots for gasification

Of the eight models, only Human Energy is currently fully operational. This private company, an Indian owned biofuel production company with subsidiaries in Uganda, interacts with stakeholders in Kampala and exports processed biofuel to India from *Jatropha curcas L.* plantations in northern Buganda. The Aldwych venture was a 50 MW biomass powered plant proposed in 2006/7 for which 35,000 ha of *Eucalyptus grandis* would have been required in the Amuru and Gulu Districts. The results from localised field trials and problems with land tenure resulted in the company pulling out and no further plans being put forward at this stage. The biomass for energy in sawmills is a business proposal being considered by entrepreneurs associated with the SPGS and UTGA, which have organised commercial timber growing clients into 'clusters' within which sawmills will be required once the plantations reach maturity (Jacovelli, 2009). The intention is that the sawmills contain small gasifiers which can be used to run electricity generators. The sawmills would purchase trimmings and prunings from farmers within their clusters, as well as using chippings from their own activities to cheaply produce their own electricity (Harrison and Windhorst, 2010). Gumtindo Cooperative and Bududa Vocational Institute, both small and medium enterprises with NGO involvement, are considering the use of small scale woodlots for gasification to serve their electricity and heating requirements. Similarly, the farm scale woodlots have been suggested as a means for individual farmers to provide themselves with a more sustainable fuelwood source or even to provide funds for micro gasifiers (Buchholz and Volk, in press).



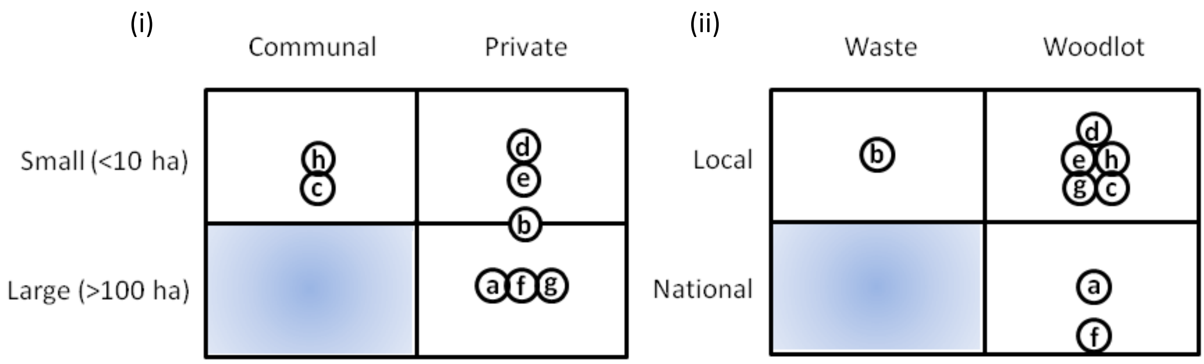
Models (b) sawmills and (d) farm scale woodlots are not represented as they could be in multiple locations

Figure 5.2: Location of six of the eight Ugandan bioenergy production models.

The Muzizi Tea Estate, owned by James Finlay (Uganda) Ltd., has a woodlot and gasification unit on site to provide internal electricity supplies (Buchholz and Volk, 2007). Whilst the gasifier is still in place, there have been technical difficulties with its operation which are currently being addressed (Hemsted, 2010). The Anaka trading centre was formerly an IDP camp (closed officially as a camp in January 2010 and designated as a trading centre) where the existing schools, hospital, shops and market rely on fossil fuel generators to provide electricity; a gasification unit is suggested as an alternative, cheaper electricity generation source. A theoretical feasibility and multi criteria analysis study has been done for a similar example of a trading centre, Kasonga, in western Uganda (Buchholz and Volk, 2007), and the Anaka case forms the basis for a culmination of donor activities, private sector involvement and academic research directed towards reliable, renewable energy provision for sustainable rural development in northern Uganda (CLUWRR, 2010). This example will be explored further in Chapter 6.

5.3.3 *Distinctions between production models*

The simple matrices for comparison of the production models used in section 4.4.3 (page 86) are not directly applicable in this case for two reasons. Firstly, there are no government-led feedstock production models in Uganda. This relates to one of the key differences between the two case study countries: in India the Government takes a much more active role in implementation (Nagar, 2009) whereas in Uganda, donor organisations and NGOs tend to play a greater role on the ground (Owomugasho, 2005). Secondly, biomass for bioenergy is being almost exclusively considered for gasification for electricity, there is little or no local market for conversion into liquid biofuels which is a costly and often inefficient process. Therefore modifications to the matrices have been completed to make them relevant to this context, see Figure 5.3.



Shaded area = no models fit this classification

Figure 5.3: Classification of production models in Uganda according to (i) Land size (vertical axis) and ownership (horizontal axis); (ii) Feedstock type (horizontal axis) and market scale (vertical axis).

The straddling of the small/large distinction by the sawmills' model (b) in Figure 5.3(i) is due to the fact that each sawmill would in total be collecting fuelwood from a large area (within a cluster of forest plantations); however the scale of production from each plot directly for energy purposes would be small. The shaded area in Figure 5.3(i) shows that, from the production models identified, there is no large scale communal biomass for bioenergy production. In fact the majority of the models would be implemented on private land, with only the cooperative group Gumtindo and the Anaka trading centre proposing to use communal land for production. Land tenure in Uganda is a highly contentious issue (Himmelfarb, 2006). Private land ownership can take different forms of tenure, either customary or statutory. Whether customary land is formally certified and a freehold title has been allocated will often influence people's inclination to invest in forestry plantations. Land rights and occupation in Uganda have been strongly disputed, largely due to the country's history of conflict, poor land records and political instability (Rugadya, 2008). A rapidly expanding population and increased demand for fuelwood, as discussed earlier, is resulting in growing pressure on protected or forested lands. Communal land holdings are not frequent, and private land can be leased from the Government (although this is by no means a straightforward or all-inclusive arrangement) (Hunt, 2004). Large scale private land holding or acquisition is more likely than in India because of the opportunity for all rights to the use of customarily held land in Uganda to be accorded to the land holder (Government of Uganda, 1998).

The interesting distinguishing factor for Figure 5.3(ii), as (unlike in Chhattisgarh biodiesel models) virtually all biomass for modern forms of bioenergy in Uganda is planned to be used for electrification, is whether feedstock is purposely cultivated or comes as a by-product or 'waste' biomass from an existing operation. There is no national market for energy produced from biomass waste from the selected production models (shown by the shaded area in Figure 5.3(ii)), and only one local bioenergy from waste model proposed. This is largely because of constraints in terms of volumes produced per unit area and viability of the exercise where transport distances are high (Woods *et al*., 2006b). Bioenergy from waste is generally only economically viable where conversion is done on site or in the locality, so is unlikely to be a major national source of feedstock; however it can be an excellent value-adding activity for existing operations such as commercial timber production which produce significant quantities of waste (Woods *et al*., 2006b; Harrison and Windhorst, 2010).

5.3.4 *Typology of production models*

The differences observed between the distinguishing features identified in Figure 5.3 (communal versus private land ownership; by-product versus dedicated plantation feedstock type) and those used in the Indian case (Government versus private land ownership; electrification versus transport market end uses) suggest that the typology of production models produced in India (Table 4.3, page 91) will not be identical to that for Uganda (shown in Table 5.4). The great majority of land ownership type in this context is private, and so the distinction here simply between communal and private land was not seen to be sufficient to classify the full range of possible bioenergy production models. The size distinction used in Figure 5.3 maps directly onto the value chain classification, i.e. all farmer/NGO led models would be small scale, whereas all corporate models would be large scale, so therefore using this distinction would not necessarily add anything to the typology either.

Table 5.4: Typology of Ugandan bioenergy feedstock production models, potential benefits and key issues. Author's own.

Production model typology	Production models	Potential socio-economic benefits	Key issues identified
(U-1) Corporately-led, feedstock is produced for their own use	Muzizi	• Saving expenditure on electricity if feedstock can be produced easily alongside commercial activities; • More control over energy expenditure and reliability.	• Little inclusion of farmers or landless poor; • Power generation for internal requirements is unlikely to have any benefit in terms of energy access for the rural poor; • Questionable external regulation of company activities could lead to resource depletion and negative environmental impacts with knock on implications for locals.
(U-2) Corporately-led, land is owned by the company processing feedstock and selling the final product	Aldwych; Human Energy	• Employment opportunities on the plantations and in associated commercial activities; • Foreign exchange generation, tax revenues for government; • Possibility of CSR activities, e.g., improved energy infrastructure.	• Large scale power production or export of energy feedstock is unlikely to result in improved energy access for the rural poor; • Questionable external regulation of company activities could lead to resource depletion and negative environmental impacts; • Possibility of plantation establishment on land without clear tenure arrangement, potentially impacting on informal residents/users.
(U-3) Corporately-led, farmers produce the feedstock but are contracted to sell to particular company	Human Energy; Sawmills	• Value-addition for farmers diversifying their incomes; • Assured markets for agricultural produce.	• The breaking down of free market principles allowing company price fixing to be a possibility; • Potential penalties if yields are low depending on contract arrangements • The locking in of current land use (although it has been verbally suggested this is unlikely to be a real problem in Uganda where contracts are not always honoured).

Production model typology	Production models	Potential socio-economic benefits	Key issues identified
(U-4) **Government/donor-led, feedstock produced on private land for own use**	Anaka	• Affordable local electricity; • Local ownership of the process; • Employment and entrepreneurship opportunities for landless poor; • Income diversity for local farmers producing feedstock.	• Technology may not be perceived as modern or advanced enough; • Mechanisms to specifically address the needs of landless poor are still required; • Availability of land for small scale farmers.
(U-5) **Farmers/NGO-led, feedstock is produced for their own use on either private or communal land**	Farm woodlots Bududa Gumtindo	• Affordable local electricity; • Local ownership of the process; • Possibly employment and entrepreneurship opportunities for landless poor.	• Technology may not be perceived as modern or advanced enough; • Involvement of landless poor may be sporadic at best, mechanisms to specifically address their needs are required; • Availability of land for small scale farmers.
(U-6) **Farmers/ NGO/ Government/ Donor-led, feedstock production, on private/ communal land, and processing for sale**	Alternatives	• Foreign exchange generation, tax revenues for government; • Employment opportunities on the plantations and in associated commercial activities; • Local ownership of the process.	• Involvement of landless poor may be sporadic at best, mechanisms to specifically address their needs are required; • Availability of land, concerns over equitable sharing of assets where communal land is used.

From observations made during field research, the key distinguishing feature between the models on privately owned land was seen to be whether the land was: owned by the production company; owned by farmers and provided by contract to a production company; or owned and used on site by the producer, the distinction between which has been termed the 'production arrangement'. The classification of the eight Ugandan production models according to land ownership, value chain and production arrangement is shown in Figure 5.4. This formed the basis of the typology in Table 5.4.

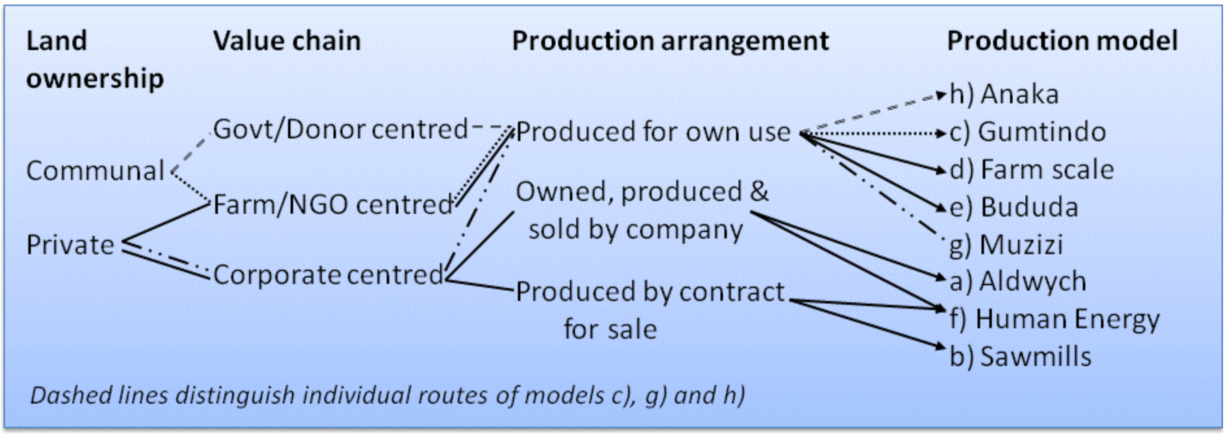


Figure 5.4: Models for biomass for energy production in Uganda distinguished by land owner, value chain and production arrangement.

Having been reviewed by an expert in Ugandan land use arrangements (Schoneveld, 2011), it was decided that another option exists: government/donor centred models which aim at exporting feedstock. This was proposed as an additional possibility which is already being explored in the country, but did not emerge from the field research undertaken for this study. The higher level typology of models which has been produced (Table 5.4) accommodates this example and is comparable to that produced in the Chhattisgarh case study in Chapter 4 (Table 4.3, page 91), though for very different production models. The potential socio-economic benefits and key issues for the different model types were identified from the field research, stakeholder interviews, workshops, understanding gained from the earlier stages of the approach and the additional work completed to produce the necessary outputs of SIA (for example, Table 5.2). This typology forms the basis of the social mapping exercise in the next stage, where three representative examples have been selected for further examination.

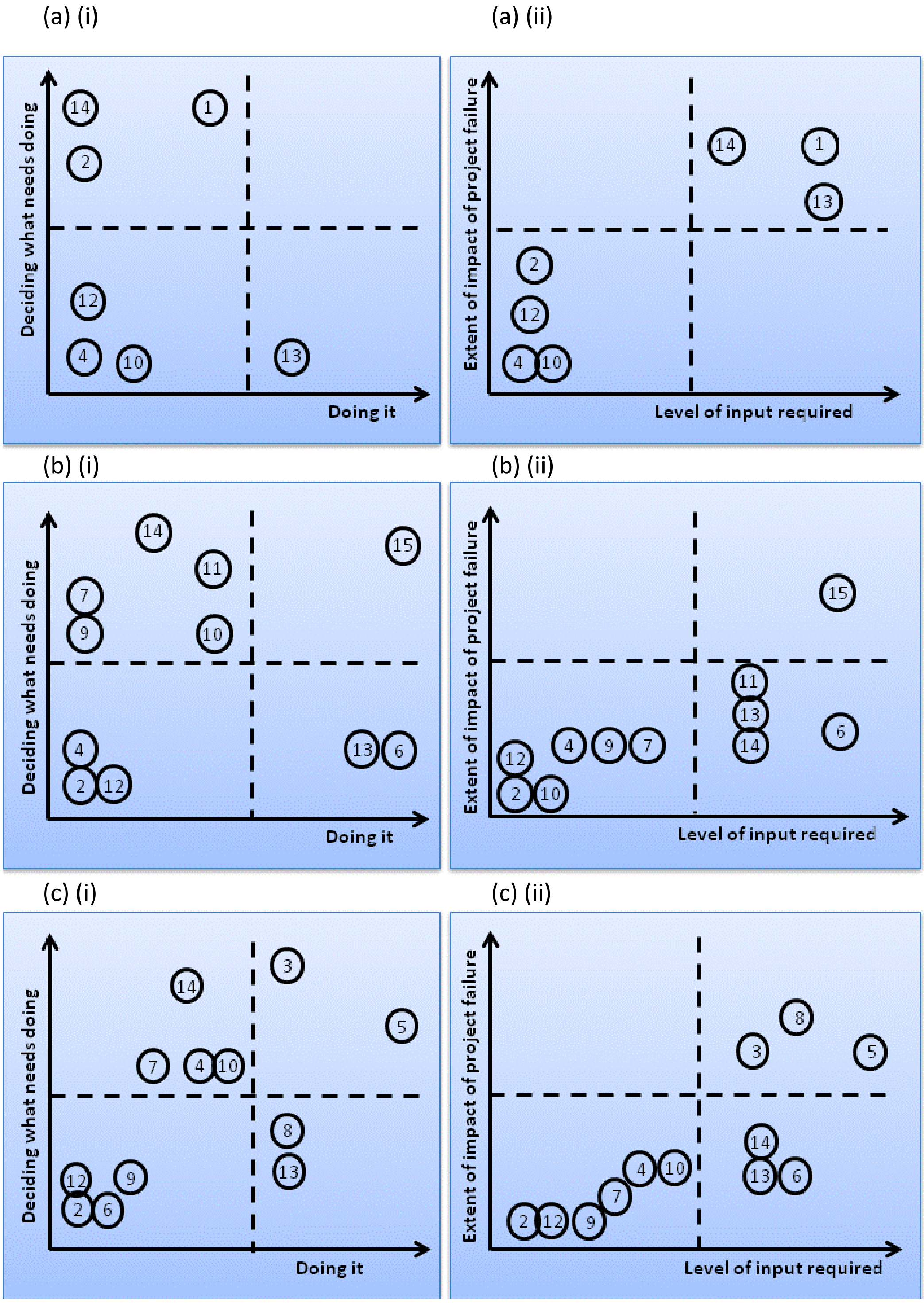
5.3.5 *Social Mapping*

For this stage, stakeholders have been qualitatively and interactively mapped onto matrices according to their power in terms of decision-making involvement in implementation; and risks in terms of extent of impact of project failure and level of personal capital input required as introduced in Chapter 4. These distinctions are important in gaining a better understanding of the dynamics of and between the various stakeholders in the different models. The mapping is a participatory, qualitative and iterative tool for comparing the stakeholder dynamics of different production models. It is intended that it would be revisited throughout the lifecycle of a particular model to see how these dynamics change over time or how new actors fit in to, and potentially affect, the existing situation.

Figure 5.5 shows the results of the social mapping for three of the models; (a) Aldwych, (b) sawmills and (c) Gumtindo. These three have been chosen as being representative in terms of their socio-economic opportunities and potential impacts (as shown in Table 5.4). This mapping exercise shows that the range of stakeholders and their levels of involvement in the different production models vary widely. This is consistent with Figure 5.4, from which the range of diversity in the classification of models is clear. Because the 'alternative' final type was not identified through the stakeholder interactions, the participatory stakeholder mapping has not been completed for this type of model. From discussions with experts around the topic it was determined that the results from carrying out this exercise would not have any significant influence on the discussion and conclusions that can be drawn in this case. The discussion of the maps in this case with the stakeholders did not result in positioning being changed, as had happened in India (section 4.4.5, page 93). It seemed that the theoretical nature of the models being discussed in certain cases meant that the stakeholders were not as easily engaged with the practicality of how much decision making power they might have, or the risks involved and how they might be affected if the project were to fail. They were inclined to agree with my presentation of the situation without as strong views. This leads me to suggest that the previous recommendation to revisit these maps with stakeholders throughout the project design, implementation and monitoring phases is important. The positioning of individual groups within the maps is likely to change as a project matures, and so they should not be considered as static. An iterative process of stakeholder mapping could help to identify increasing inputs or vulnerabilities and take appropriate mitigative action if required.

5.4 Understanding stakeholder dynamics in the Uganda case study

In this section the Ugandan results are evaluated, with a particular focus on the typology of bioenergy feedstock production models for Uganda and the social mapping exercise. The findings of this exercise are then related back to thesis objectives [A] and [B] (page 18).



Stakeholder Key

1. Production companies; Aldwych International
2. National Government; "MEMD"
3. Cooperative leaders
4. NGO's
5. Cooperative members
6. Marginal farmers
7. Uganda Carbon Bureau
8. Landless poor; "idlers"
9. Aid funding bodies; EU, GTZ
10. Local education & research institutions
11. Uganda Timber Growers Association (UTGA)
12. National Environmental Management Authority (NEMA)
13. Land managers; Bruno Nyeko
14. Land owners
15. Sawmill operators

Figure 5.5: The completed stakeholder mapping matrices for (a) Aldwych (type U-2); (b) the Sawmills (type U-3) and (c) Gumtindo (type U-5) production models by (i) power and (ii) risks.

5.4.1 *Providing energy security and modern forms of bioenergy*

Section 5.1.1 highlighted the need for increased energy supply security in Uganda, particularly the northern region, to provide a platform for sustainable development. The country's energy policies aim to increase public access to electricity, particularly in rural areas, and modernise biomass conversion technologies. Whether or not the energy produced from the different bioenergy feedstock production types is used in the country or exported (Figure 5.3) is therefore going to have a bearing on whether or not a particular model contributes to meeting this goal of improved rural electricity access. Production types where the feedstock is produced to provide energy for the producers (types (U-1), (U-4) and (U-5)) are going to be most likely to achieve increased local energy security and therefore realise the benefits expected to arise from that activity (Table 5.4).

It is not necessarily the case that the alternative will be true – even if feedstock is being produced for sale there may still be local energy security benefits. Income generated through the trade of feedstock (or any product manufactured from it) is likely to be multiplied within the community and increase the potential of individuals or communities to pay for improved energy provision. Collective action and the ability to pay could even improve the leverage on government and energy firms to provide grid energy to areas previously unconnected. However, this possibility is thought to be a 'best case scenario' and not a guaranteed outcome. This is because in one area visited during the field work, there was a community with the ability to pay which had been campaigning for grid connection but been unsuccessful. This was despite reported years of lobbying, promises of connection and a community pledge to pay towards the infrastructure and maintenance costs (Wambedde, 2009).

Another mechanism whereby local energy security might be achieved through production models producing feedstock for sale would be where the companies purchasing the feedstock were doing so with a view to providing energy services within the area. This could be either as part of their business plan, due to an agreement with the government, or even as a corporate social responsibility (CSR) exercise. With the creation of a large scale powerplant such as that proposed in the Aldwych model, the construction of infrastructure required to transport the electricity generated away from the plant could increase the likelihood of local grid connections (particularly if this was stipulated in a planning agreement). In this situation there would need to be controls in place to ensure that the services being provided were of sufficient quality, quantity (of connections) and affordability. Alternatively, in cases such as the Human Energy or Aldwych models, where feedstock is being produced entirely for export, if local energy needs are to be sustainably met there needs to be some mechanisms in place whereby local benefits are assured either from government or donor mandate. This is because of the government's driver to reduce poverty through increasing access to modern, affordable and reliable energy services outlined in section 5.1.2. Figure 5.5 shows that marginal farmers and landless poor do not feature in these model types in terms of risks or responsibilities, and so are unlikely to directly benefit and achieve the policy goal. If the government were to solely support this type of bioenergy model then they would need to ensure that there was some local contribution to the availability and affordability of modern energy services.

In terms of the use of more modern forms of bioenergy generation, proposed small scale gasification units are perhaps not seen as the advanced technologies which many people would prefer (Buchholz and Volk, 2007). The size and potential output of a project such as the Aldwych powerplant would seem to be more favourable in meeting this particular policy objective. However, it is important to note that the concerns over negative impacts (see Table 5.4) would need to be adequately addressed prior to anything being implemented on that scale. The decision on whether or not to promote a particular model should be based on more than one objective (see the comprehensive analysis of the Anaka case in Chapter 6). By contrast, a severe negative impact on any one aspect could be enough to result in a block or complete redesign of a project even if there are multiple other benefits expected, for example increased water resource availability.

5.4.2 *Social mapping: assessing power and risk dynamics*

The social mapping exercise was used to visualise and easily compare some aspects of the stakeholder dynamics (roles and risks) in three feedstock production models. The requirements of the stakeholders would usually be identified through SIA, which was not possible in this case. The Situation Analysis and stakeholder identification exercises were used to gather the necessary information on different stakeholder requirements, presented in Table 5.2. In the Aldwych case, representing type (U-2), the company itself takes decisions, and ultimately bears a substantial risk of failure (Figure 5.5(a)). There are landowners involved, from whom the land for plantation would be leased or purchased, however their role is ultimately limited as the company manages the whole product chain from feedstock to market. There is a degree of risk for those who would retain ownership of the land if the company pulled out and the land use proved unprofitable. The land managers and labourers would not be participants in decision-making and so be powerless in that respect but with a substantial role to play in ensuring the success of the venture through management activities. Their level of risk would be lower than the company and the landowners, but still relatively high because of their entire livelihood being potentially centred around employment at the plantation. The government and NEMA have a limited role to play in the stakeholder dynamics in this model except that they ought to be involved in the monitoring and assessment of the venture. The high level of corporate risk in this case could have been a contributing factor to the proposal not being implemented.

In the case of the sawmills, which is a type (U-3) model, it is the operators of the mills who would have the highest input, role and ultimately risk (Figure 5.5(b)). The likelihood of failure could be minimised by pilot projects supported by donors, NGOs or government to demonstrate best practise and a viable business model. However, compared to the previous model the level of risk is minimal because this is not the central income generating activity for either the feedstock producer or the end user. The plantation owners and managers incur minimal risk because they already need to thin and prune their stands in order to maximise timber yield, and so any revenue from this activity adds value. The additional stakeholders included in the mapping (Figure 5.5(b)) would perform supportive roles, and it is unlikely that this model would provide any substantial socio-economic benefits outside of those already engaged in the timber plantations or sawmill operation.

The cooperative members in the type (U-5) example of Gumtindo would have the greatest power and risk (Figure 5.5(c)). The cooperative workers and local community members could benefit from the electricity produced if there was surplus after the needs of the coffee processing were met. This would offset the price of the diesel purchased for power generation, and potentially provide additional revenue if further connections could be established and paid for. Because, again, the production of bioenergy feedstock is not the main income generating activity in this model, there is overall an inherently lower risk of failure. There were reported to be specific targeted opportunities for the 'idlers' in this particular model driven by international NGO involvement (unlike in other cases where excluding them was seen to be a priority). The intention was to support groups of these landless poor in setting up and running parts of the product chain through entrepreneurial training. If taught the basics of business skills and supported by the cooperative (as both a market and potential financing source), it was expected that this group would be able to work their way out of poverty and help to improve the security and cohesiveness of the whole community though energy provision and poverty reduction. The importance of local education and research in the success of such a scheme was seen to be paramount. Although using communal land does make it more feasible, this is not the only model or type of model which could involve idlers in part of a bioenergy product chain. In models where private land is used for feedstock plantation (e.g., type (U-2), (U-3), (U-6)) it is more likely that the idlers would be employed as labourers, if at all. If an entrepreneurial method of involving the landless poor were to be adopted, then NGO or donor groups would need to play an active role, at least in the short term. The difficulties anticipated with achieving the involvement of idlers, as discussed in section 5.1.3, mean that additional efforts may be required to get their input and feedback. Safe technology and sound economics are insufficient to ensure the success of a rural bioenergy project; involvement of the stakeholders in planning, implementation and monitoring is vital. The Anaka model, type (U-4), is an example of how the government and/or donors could be involved in setting up a model which potentially contributes towards realising energy policy goals (see section 5.1) and development objectives as well as providing opportunities for the landless poor. This model seems to have high socio-economic potential, there was an opportunity to visit the trading centre through a *Re-Impact* field trip, and experts in multiple fields expressed an interest. Therefore it was selected to be the subject of a more extensive investigation of potential impacts and its contribution towards sustainable development, which is reported in Chapter 6.

5.4.3 *Scale remains important*

Despite the fact that, in understanding stakeholder dynamics, scale was not found to be distinctive in the typology of production models, the issue remains significant in all of the different types. This holds true whether in reference to the size of the plantation area or the destination of the end product. Generally the small scale woodlots on privately owned land for internal use are unlikely to inflict negative social impacts on the community because they will be managed in a relatively closed system where effects (for instance on food supply through changed land use) would be immediately felt. Whilst potentially providing indirect socio-economic benefits to rural areas, they are unlikely to provide opportunities for idlers as no employment or other direct cash benefits would be provided as a result. If the goals of the energy policies (in terms of poverty alleviation through electrification) are to be met then those initiatives which serve to provide opportunities for individuals at multiple levels of rural society, particularly the lowest, should also be pursued. If there are financial constraints to the successful outcome of such projects then donor or entrepreneur schemes could be employed to assist in their early piloting and development of local capacity. The cases of the trading centres, such as Anaka and Kasonga, as well as the Gumtindo example, are thought to be of strategic importance in this regard due to the possible entrepreneurship opportunities for the landless poor. There are also likely contributions towards agenda including energy security, livelihood diversity, renewable energy and rural development. Further consideration of this type of model, and in fact any other small scale options that could potentially be implemented in multiple locations, would need to be completed for a true assessment of cumulative social and environmental consequences. This has been completed for the Anaka model in Chapter 6.

On the whole, the larger scale projects provide more opportunities to local labourers and therefore socio-economic benefits, but may have other negative social and biophysical consequences which should be considered (see Table 5.4). These could include impacts on the resource base of the area, which would be felt more unevenly by the local population, and perhaps not immediately but over the longer term. Initiatives which provide livelihood opportunities for the rural poor, for example by allowing them to participate in feedstock production and value-adding activities through having a stake in the process, are the most likely to provide the desired rural development outcomes. In order to minimise the negative impacts of larger scale projects, careful planning which takes into account potential social and environmental impacts should be employed and, where possible, interventions designed to be socially beneficial and improve livelihood options for local stakeholders through an iterative sustainability planning process, such as that proposed on page 36. There is a need to learn from international examples such as sugarcane production in Brazil, where recent attempts to improve the sustainability of their product have included land use zoning to reduce environmental impact and giving workers a personal piece of land for food cultivation with time set aside to work on it (Schaffel and La Rovere, 2010). Once large scale or multiple projects are in place there is a need for ongoing regulation, including monitoring of biophysical and socio-economic impacts, by an independent party to ensure that the identified goals of the intervention are being met. The participation of stakeholders should continue through to the monitoring stage to ensure that their criteria are used in the evaluation of projects.

5.5 Key messages and implications from Chapter 5

Understanding the social benefits and opportunities through use of the structured approach has enabled the typology of bioenergy feedstock production models in the Ugandan case to be generated, contributing towards the comprehensive case study analysis (thesis objective [B], page 18). As outlined in section 5.1.2, drivers behind increasing bioenergy feedstock production in the country are predominantly socio-economic, so this approach is very useful to aid decision and policy makers in identifying the most suitable types to meet their goals. In order to more accurately define the criteria against which proposed projects or plans might be assessed, this approach needs to be incorporated within a sustainability planning framework - and ideally follow on from a full SIA. It is likely that additional criteria would include national energy security, foreign exchange and investment, and these will also have a bearing on the range of preferred types. If the benefits of small scale gasification do match up to the expectations of their proponents (including the *Re-Impact* team; Buchholz and da Silva, 2010) then it is proposed that education and activities to change the perceptions of individuals who are against the ‘simplicity’ of the technology are more important than just promoting larger scale, more technologically advanced models. More detail on negative perceptions held by Ugandan communities and how these might be allayed is provided in the following Chapter.

Of the models discussed in section 5.4.2, the Gumtindo type (U-5) example appears to have the potential to contribute most strongly towards meeting the country’s energy policy and development objectives. Providing energy security to individual areas using technology capable of competing with current alternatives such as fossil fuel generators, whilst simultaneously providing opportunities for the landless poor to generate livelihoods for themselves, presents a potentially favourable socio-economic situation. There are, of course, additional reasons (socio-economic and otherwise) why other models are likely to be pursued. For example, larger scale, privately owned ventures would be expected to contribute towards foreign exchange, whilst smaller scale value-adding models could provide localised benefits and support other industries such as commercial timber production. In each individual case the positive outcomes expected from implementing a project or policy should be assessed in context, weighed up against potential negative impacts and a suitable monitoring strategy be put in place if and when they do actually become operational.

The structured approach to understanding stakeholder dynamics in bioenergy projects has been applied successfully to the Ugandan case study. The development of the methodology has met thesis objective [A] as it can be seen from the discussion section 5.4 that this approach provides sufficient detail to support MSC. The method has been effective in terms of giving a thorough understanding of both the existing production models in the Indian State of Chhattisgarh and the proposed models in Uganda, with some flexibility in the approach which allows it to be used comparatively in the two very different contexts and on various types of bioenergy production models. This demonstrates that it is adaptable enough to be applied in multiple scenarios, but nonetheless provides the sort of robust analysis which should be used in policy and decision-making. In addition it presents a clear idea of the relevant scales for planning and monitoring. A key priority in both cases is for stakeholders from all representative groups to be involved in the process. These should include donors and the landless poor, and consideration needs to be given to their roles, risks and requirements (dynamics) from the proposed intervention. Local, context-specific planning and assessment are essential and the participation of stakeholders should last throughout the project lifecycle. There needs to be a focus on collaboration rather than simply data or information sharing.

The approach is found to be highly applicable within a sustainability planning framework (Figure 2.2, page 36), and this would be important in practise. This is because of the need to include stakeholders in planning through MSC, but the inherent difficulty in doing so discussed in Chapters 2 and 3. This approach has been designed specifically to provide sufficient level of detail of stakeholder dynamics to both enable the facilitator to achieve successful MSC and provide the stakeholders with a fair and collaborative way to get their views incorporated into the planning process, without overburdening the practitioner or planner.

There are a number of useful outcomes from this case study to consider in relation to future planning in Uganda. The availability of secure and renewable wood supplies for bioenergy production are not discussed at any length in this Chapter, however this aspect must be a critical consideration for any form of land use planning in the country where current wood consumption is dramatically outstripping re-growth. The following Chapter 6 examines the actual fuelwood requirements of the proposed Anaka gasification project and attempt to balance this with current levels of deforestation in the area. In addition the focus will be broadened, to consider socio-economic issues of this particular case study example alongside environmental aspects. Physical issues such as resource availability, biodiversity and the carbon balance have emerged as crucial and are strongly linked to socio-economics as shown in Chapters 1 and 2. Chapter 6 will explore this link in more detail because all such aspects must be considered for a Sustainability Assessment.

Chapter 6.

Energy Provision, Poverty Alleviation and Avoided Deforestation in Anaka Trading Centre; investigating whether biomass gasification can provide a locally sustainable option

Building on the detailed assessment of socio-economic issues and stakeholder dynamics of different types of bioenergy feedstock production models gained in the previous Chapter, a broader consideration of one production model is undertaken here. An evaluation of the possible impacts that could arise from the proposal to use a woody biomass gasifier to produce electricity for Anaka trading centre in Nwoya District, northern Uganda, is completed. This model has been selected because it comes under type (U-4) in the production model typology for Uganda (Table 5.4, page 115) which was seen to be one of the types with high potential to provide socio-economic benefits and meet locally-set sustainability criteria. In addition, through interactions with donor groups and local research institutions through the *Re-Impact* project, the capacity to actually implement such a project was identified. I coordinated the activities of other *Re-Impact* specialists from various partner organisations to use Anaka as a case study looking into multiple sustainability aspects of this model. I then amalgamated this research and presented back to the stakeholder group at the project workshop. The outcome of this workshop is discussed in section 6.4.5.

In this Chapter the potential hydrological, greenhouse gas (GHG) emission mitigation and economic impacts from the use of a small biomass gasifier for electricity in Anaka trading centre are investigated, and an evaluation of the potential barriers to the scheme is undertaken. The intention is to identify whether such a project, already identified from the previous Chapter to have potentially positive socio-economic impacts, could sustainably meet the development needs of the local population. The meeting of thesis objective [A]: methodological development (page 18) is finalised in this example because it presents a culmination of approaches developed in this thesis and considers how they work alongside others to achieve mutually beneficial outcomes. The consideration of the Anaka example itself supports thesis objective [B] by comprehensively analysing the contribution of the proposed model to national and local objectives. Consideration will also be given as to how this project could be implemented successfully. Firstly, to contribute towards thesis objective [C], the wider relevance and significance of the Anaka case study within a global context of energy provision, poverty alleviation and avoided environmental degradation will be explored.

6.1 Energy, Poverty and Environmental Degradation – Cause and Effect?

In sections 1.1 (page 1) and 5.1 (page 100) the link between low levels of development and energy supplies was introduced and discussed. Here, the broadening of that relationship to include environmental protection or degradation is considered. Poverty alleviation, energy supply and environmental degradation through deforestation are three global issues whose mitigation is understood to be of utmost priority (Modi *et al.*, 2006; Goldemberg and Lucon, 2010). For whatever reason an individual, household or community might be in poverty (see the definition in Box 1.1), and their development opportunities (those which would enable them to become more sufficient in whatever they are lacking and ultimately improve their quality of life) diminished, it is likely that they would have a minimal impact on the surrounding environment compared to wealthier individuals (Rogers *et al.*, 2008). It is once an individual, household or community begins along a path of development that their environmental impact would be expected to increase (Mills and Waite, 2009), a relationship described by the Environmental Kuznet's Curve (EKC) suggested by Grossman and Krueger (1995), see Figure 6.1. Goldemberg and Lucon (2010) suggest that this is because people trying to obtain the resources required to meet their basic and immediate needs are less likely to account for future provision or be concerned by phenomena which might occur more frequently in future due to, for example, climate change.

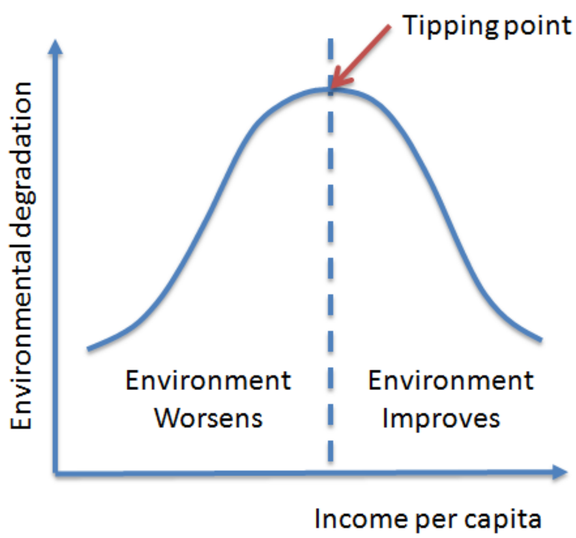


Figure 6.1: The Environmental Kuznet's Curve. The standardised relationship between environmental degradation and income per capita (after Grossman and Krueger, 1995).

Environmental degradation, such as uncontrolled deforestation, is likely to be a knock-on effect of having to supply larger populations with more resources (Rady, 1992). This relates to the complex interconnections displayed in Chapter 1, Figure 1.1 (page 2) through the cycle of poverty, biomass and ecological crisis. People may be forced to over exploit resources at a non renewable rate in order to meet their basic needs and those of growing families or communities before they are able to take decisions and action regarding protection of the environment for a longer term benefit (Nunan *et al*., 2002). In addition, the immediate biophysical environmental concerns are likely to be those which directly and closely affect their sphere of influence, such as safe water provision, rather than protection of biodiversity or other global issues.

The EKC relationship shown in simple form by Figure 6.1 is based on the assumption that there is a tipping point of development up to which the environment has been negatively affected and beyond which the condition of the environment improves as people become wealthier. This suggests that the early stages of development are always going to be achieved at the expense of environmental protection, and that communities or populations should have a "*provisional right to degradation*" (Goldemberg and Lucon, 2010, page 83) in order to improve their well-being. However, the simplistic nature of this suggested relationship has been strongly disputed (Stern *et al*., 1996; Torras and Boyce, 1998; Sunderlin *et al*., 2005; Rogers *et al*., 2008), and even in the original paper it was concluded that efforts in political and social economy would be more effective than market economics in achieving environmental protection. In other words, simply pursuing economic gains and assuming that environmental protection will be the outcome is insufficient. There are other factors contributing to environmental protection which have a greater influence on the state of the natural environment, and oftentimes these are related to increased income per capita or national economic performance, which is why the EKC exists in many cases (Stern *et al*., 1996). The goal for policy makers and planners in developing countries should therefore be to identify mechanisms whereby socio-economic development and an improvement in well-being can be achieved either through natural resource protection or at least without detrimental environmental impact. In this Chapter the understanding from the case study types in India and Uganda will be combined with broader knowledge from the literature and the *Re-Impact* project in order to see whether one of the proposed bioenergy feedstock production models considered in the previous Chapter could provide a locally sustainable option in terms of both socio-economic and environmental aspects.

6.1.1 *Is win-win possible? Selecting a test case*

In their overview of livelihoods, forests and conservation in developing countries, Sunderlin *et al*. (2005) provide a simple yet useful classification for understanding the outcomes on human well-being and forest cover arising from site-level programmes and projects, see Figure 6.2. These are both relevant issues in the context of bioenergy, environmental degradation (characterised simply in this case through impact on forest cover) and the project types already discussed in this thesis, and so this approach provides a good basis for selecting one of the scenarios for further evaluation.

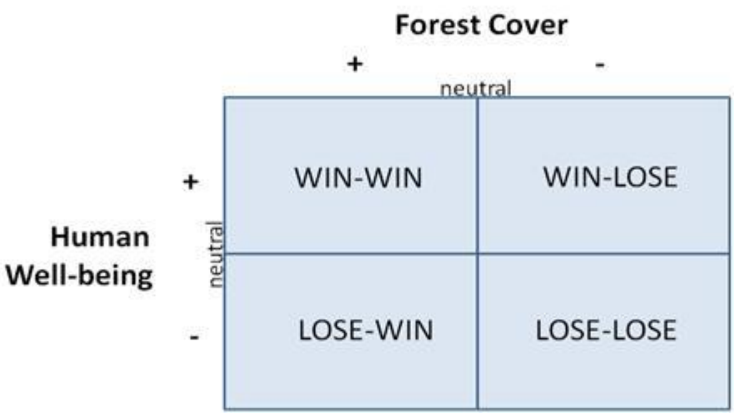


Figure 6.2: Fourfold classification model of human well-being and forest cover (after Sunderlin *et al*., 2005).

Table 6.1 shows the production types from India and Uganda presented in the previous Chapters and how they fit Sunderlin's classification. Sunderlin and colleagues explain that it is never completely "*black and white*" (page 1396) as might be implied by the model, and recommend that application to particular cases is done carefully and appropriately with a good understanding of the context, as is necessary with the approaches documented throughout this thesis. Some additional comments have been included in Table 6.1 to explain the classifications given. In some cases a distinct classification is not possible because of unknowns in project outcomes and so the range of possibilities is identified.

Table 6.1 shows that the Ugandan farm scale woodlots and the Anaka trading centre scenarios would be the most likely to have win-win outcomes in terms of improvements to human well-being (socio-economic development) and forest resources. Of these two, Anaka is a more clearly defined example with a physical location and has greater potential to be used as a pilot for other projects using central development funds. I was also given the opportunity to visit the centre during a *Re-Impact* field trip and discuss it with project colleagues. This example was therefore selected to be explored in more detail in this Chapter.

Table 6.1: Production models from India and Uganda (Chapters 4 and 5) classified according to Sunderlin *et al.* (2005).

Model	Sunderlin classification	Comments
India		
(a) (I-1) IOC/CREDA Joint Venture Jatropha plantations	Lose - neutral	People moved from communal land; plantations on degraded land so no forest reduction expected
(b) (I-3) Ranidehra village Jatropha oil electricity	Win - neutral	People benefit from electricity, jobs etc; plantations on degraded land so no forest reduction expected
(c) (I-1 & I-2) Tiriya model village Jatropha & renewable energy	Win/neutral - neutral	People benefit from energy and water supply but not self-funded; plantations on degraded land so no forest reduction
(d) (I-4) Mission Biofuels Jatropha contract farming	Win/lose - neutral	Well-being gains depend on uncertain yields; plantations on farm or degraded land so no forest reduction
(e) (I-5) Narayanpal (RLS) CSR Jatropha farming	Win - neutral	People benefit from market for products; plantations on degraded or farm land so no forest reduction
Uganda		
(a) (U-2) Aldwych plantation & 50 MW power plant	Lose – win/lose	People displaced for plantation; may have impact on old forest if people relocate there
(b) (U-3) Sawmills – use of commercial forestry thinnings	Win - neutral	Jobs created, money available for thinnings; no impact on forest as using waste product from existing industry
(c) (U-5) Gumtindo cooperative plantation & gasifier	Win - neutral	Provide jobs and capacity building; may reduce pressure on forests but mainly replacing fossil fuel use
(d) (U-5) Farm scale woodlots agroforestry and gasification	Win - win	Risk on individuals but potentially win-win; self-funding difficult, need pilot to support micro-financing of projects
(e) (U-5) Bududa vocational institute plantation & gasifier	Win - neutral/win	Energy supply and capacity building; may reduce pressure on forests but mainly replacing fossil fuel use
(f) (U-2 & U-3) Human Energy Jatropha feedstock export	Lose - neutral/lose	Little benefit locally as feedstock exported; plantations may replace forest
(g) (U-1) Muzizi tea estate plantation & gasifier	Neutral - win	Not benefitting locals, only the business
(h) (U-4) Anaka trading centre plantation & gasifier	Win - win	Provides jobs, energy, capacity building; plantation to reduce pressure on surrounding forest land

Anaka is situated within the catchment of the Aswa River, a tributary of the River Nile in the north of Uganda adjacent to the town of Gulu, see Figure 6.3. This northern region is the target for much of the development aid in the country as it is lacking in infrastructure, services and stability. This Chapter considers the proposed alternative energy source for the case study of a biomass gasification unit to provide electricity, as recommended in other published literature, and provide information on the economics, greenhouse gas (GHG) mitigation potential, and water resource implications of the proposal. Social barriers to the project will then be considered and ameliorating strategies put forwards, before a final summary of the discussion surrounding this suggestion at a stakeholder workshop will be given and conclusions made.

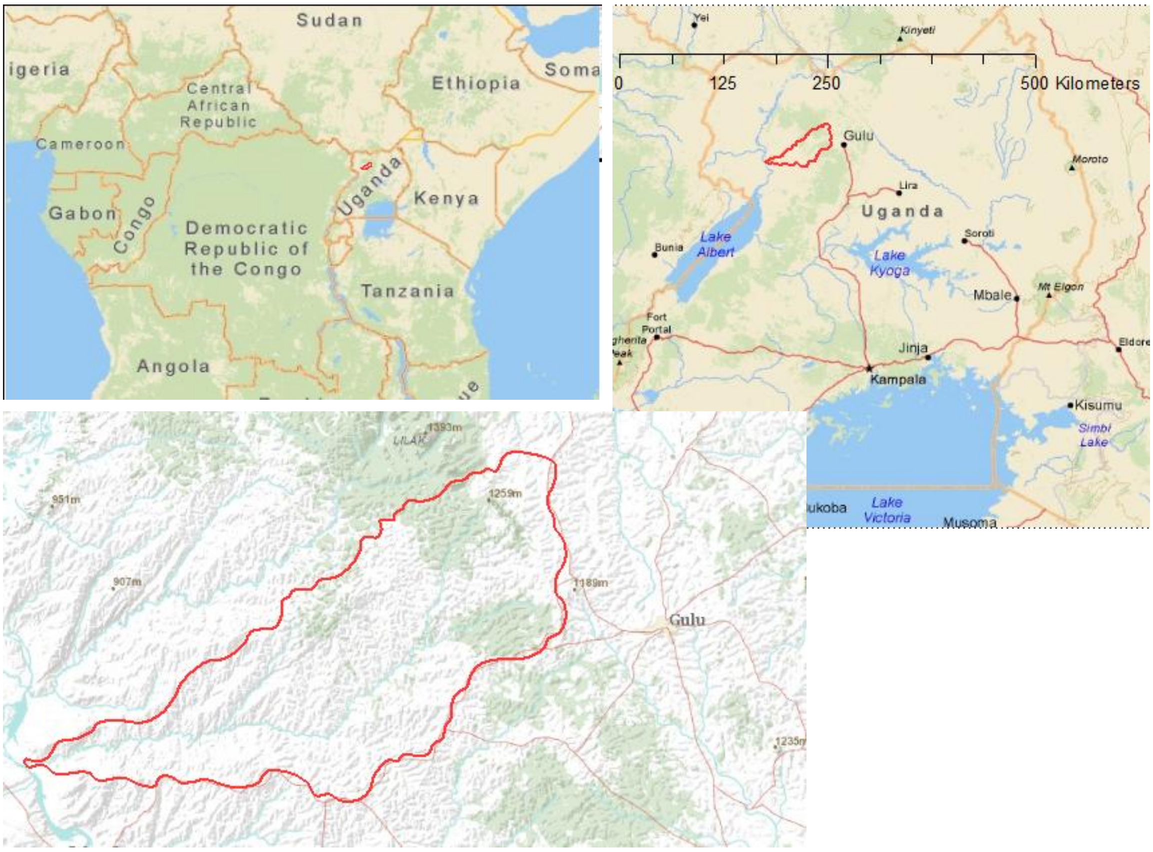


Figure 6.3: Location of the Aswa catchment in northern Uganda[12].

Firstly, more information on the background to the Anaka trading centre, which was formally an Internally Displaced Persons' (IDP) camp, and the regional context, will be provided.

[12] Maps from ESRI, freely available at http://resources.esri.com/arcgisdesktop/index.cfm?fa=content

6.2 Energy and development in northern Uganda – context to Anaka

The Ugandan civil war affected the security and livelihood stability of northern Ugandan citizens from the early 1980s, and only in the last decade has the conflict eased and the area become relatively safe (Global Security, 2010). The people who lived in IDP camps during the war for security reasons have been encouraged in recent years to return to their homelands, which for the most part have been untended for decades. To re-establish farms and homesteads, land is being cleared and crops planted. The camps themselves were often sited where villages or trading centres used to be, but in many cases once the former IDPs have left, the remaining populations are larger than before the war (Russo, 2007). This is due to high fertility rates and because there are some residents there who do not wish to return to their homelands (Rugadya, 2008). Many of the former camps have become trading centres where communities, facilities and merchants have established themselves. For the commercial properties the most commonly used electricity source is fossil fuel generators despite high fuelling costs as discussed in section 5.1.2 (page 101) (Buchholz and da Silva, 2010). However, traditional biomass burning remains the main energy source in these locations for household cooking and heating (Bingh, 2004). It is well accepted that the demand for fuelwood and charcoal is not only outstripping supply in most cases, but is generally an inefficient source of energy which has knock-on social and environmental consequences through its uncontrolled collection and indoor combustion (MEMD, 2003; Bird *et al*., in press).

As discussed in section 5.1 (page 100) there is no centralised electricity grid infrastructure across the majority of northern Uganda, and current plans to increase the coverage are going to leave many areas still without grid connection (see Figure 6.4), hence the use of fossil fuel electricity generators. There is work currently underway to dam the River Nile at Murchison, near Gulu, to provide power to the existing national network which is unable to meet current demand. New power lines are planned in order to transfer this electricity to the main grid, but it seems that very little will be done to improve the transmission to the surrounding areas in the north of the country (Kiza, 2006; EIA, 2008). Even if the grid coverage is improved in this region through this project or by oil-powered grid electricity from the discoveries in the Albertine basin (see section 5.1.2, page 101), the local population will be unlikely to benefit from the supply within the short term as the projects and related infrastructure are expected to take at least 15 years to complete. This would have severe knock-on effects regarding potential economic development in the region as it has been reported that the quality and adequacy of power supply is thought to be the most binding constraint to private investment (Sanghvi, 2001).

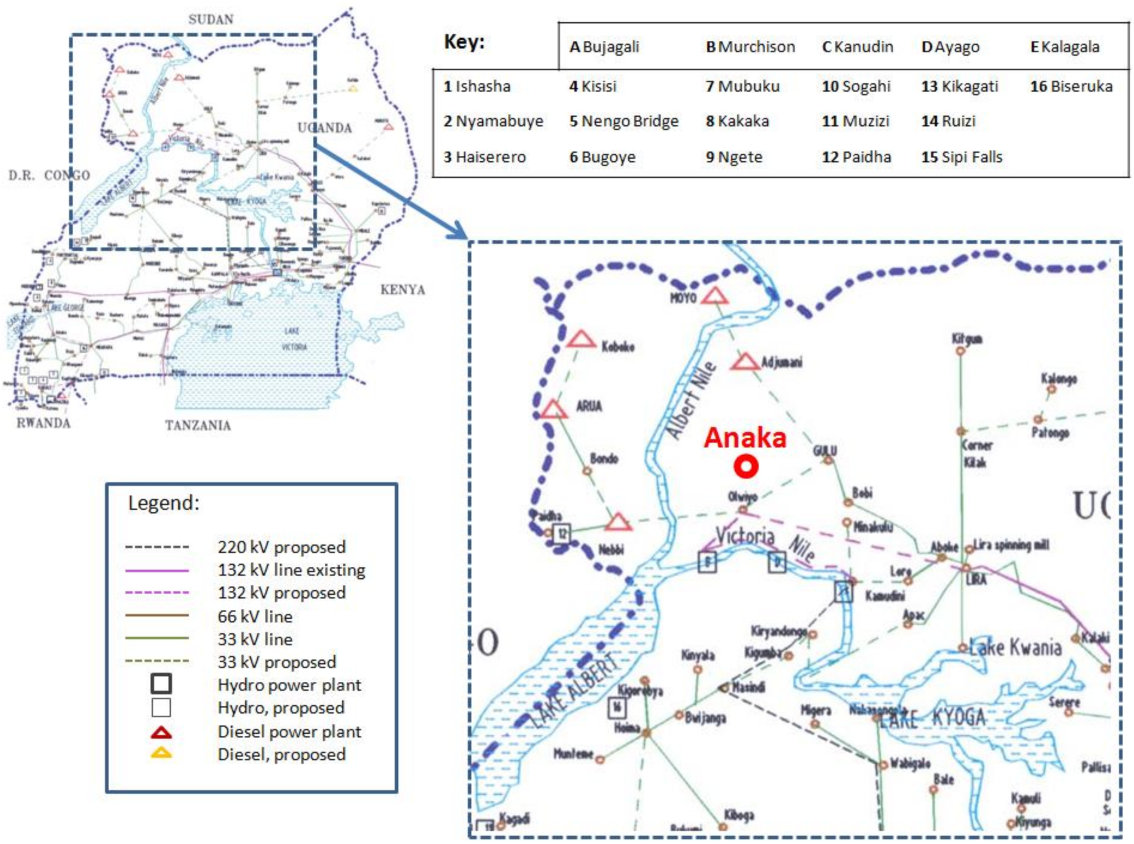


Figure 6.4: Uganda's energy grid map, planned and existing, showing the location of the Anaka trading centre (Uganda Electricity Board).

It has therefore been suggested that small scale decentralised electrification plants could help to bridge the gap in terms of domestic energy supplies to these locations, as well as provide economic and social benefits to the whole area (Woods *et al*., 2006b; Buchholz and Volk, in press). Wood-based biopower systems are one of the favoured solutions, as discussed in Chapter 5, to meet the multiple development objectives desired in this case (Buchholz and Volk, in press).

6.3 The Anaka Trading Centre

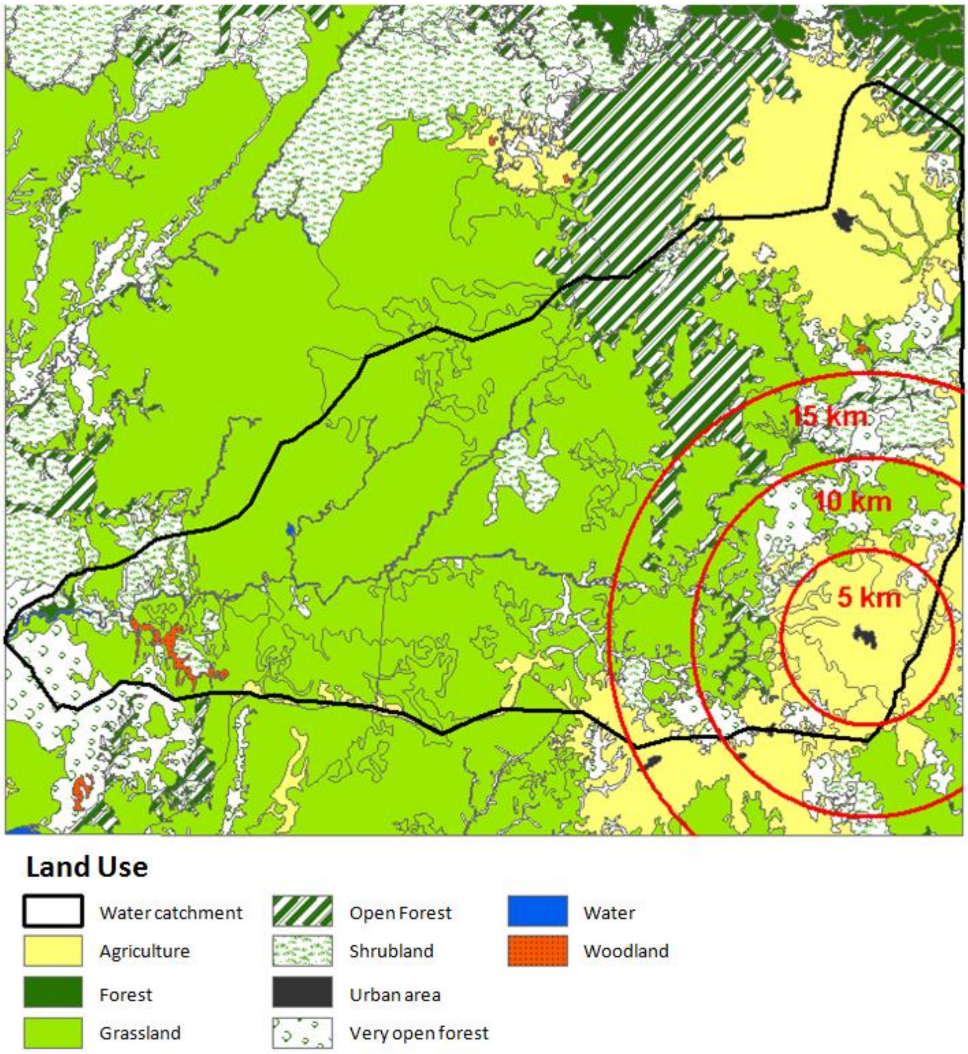
As an IDP camp during the conflict, Anaka was run by the United Nations High Commissioner for Refugees (UNHCR). It is located within the catchment of the Aswa River, a tributary of the Albert Nile, which is situated within the newly (early 2010) formed Nwoya District, previously part of Amuru and Gulu Districts in northern Uganda. A site visit to this location, described as a 'satellite peri-urban area' by the UNHCR, was undertaken in August 2009, where information was gathered from inhabitants. Further data was later provided by the UNHCR and donor organisations (UNHCR, 2009; Lukwiya, 2010). On the site visit, the group had a walking tour around the centre and the hospital (see Plate 6.1), guided by a resident and a Ugandan academic colleague. The hospital staff were away for the day on an immunisation programme, however we were shown the treatment rooms, labs and fossil fuel generator on site. From talking to our guides and the residents, it became evident that Anaka has a moderate level of electricity requirement, and that the community have the ability to pay for energy because of their consumption of petrol or diesel for generators at a higher rate than in the urban areas.

Plate 6.1: Photographs taken in Anaka trading centre. Left: hospital building, right: view of the centre accommodation. Source: author's own, August 2009.

Following the site visit, donor agencies and NGOs were contacted to learn more about the centre. I engaged in an email dialogue with regional UNHCR personnel and gained some additional information from donors including the European Union. The results from these interactions are presented here. Anaka has been in transition ('phase out') since 2008 as the UNHCR gradually worked towards reducing aid and enabling the populations to either return to their homelands or provide their own livelihoods in and around the site. In January 2010 the camp was formally closed, meaning that the UNHCR would provide no more aid, except for 381 Extremely Vulnerable Individuals (EVIs) including orphans, patients and elderly. The population of the camp was more than 46,500 at its peak; but has now stabilised at around 22,500 since the phase out operation. There is still some limited in-migration as traders and civil servants are coming in to do business and to work in the government hospital and schools. The governance of Anaka was relinquished to the local sub county council at the end of 2009. They have determined that it is now a trading centre and will be transformed into a viable community through: livelihood generation opportunities, tree planting, levelling of the ground and rehabilitation, continued assistance to EVIs and the demolition of obsolete camp infrastructure according to agreement with host communities and the local authority (UNHCR, 2009). Other than this there is very little documented about the site and there was no further opportunity within the project to visit or collect primary data. From this point on I, and the project team, relied mainly on secondary data including land use maps, the National Biomass Survey and published literature on the area and similar sites in the country.

6.3.1 *Current local energy supply and demand*

Many of the centre's population farm small plots around the site, and increasingly the availability of fuelwood in the surrounding area is diminishing, at an unsustainable extraction rate of 91%, replaced by subsistence agricultural crops such as sorghum, ground nuts and simsim (see the catchment land use map in Figure 6.5).



The red circles around the camp represent suggested fuelwood supply distances (Zanchi et al., in press).

Figure 6.5: Land use map of the Aswa River catchment in which the Anaka camp is located (provided by the National Forestry Authority, Uganda).

The current demand from Anaka for fuelwood has been calculated from the National Biomass Survey and per capita consumption, proposed in previous studies (Naughton-Treves and Chapman, 2002; Teera and Buyinza, 2008) as being up to 15.5 Mt per year, which is available at the present time within 15 km of the centre if managed responsibly, collected homogeneously, and based on current levels of use (Zanchi *et al*., in press). The inhabitants rely mainly on the purchase of wood and charcoal for cooking and heating from traders who come in with pickup truck loads from increasingly long distances. Some of the poorer households rely on fuelwood collection by women and children, however the opportunity costs of this are becoming insurmountable as the distances travelled to find wood increase. Both of these scenarios are socially and environmentally unsustainable and are not contributing to significantly improved levels of development or well-being. This is because the forest resource is diminishing with very little replanting taking place, the burning of biomass on traditional three-stone fires contributes to indoor air pollution and resultant poor health, and time taken to collect fuelwood restricts the opportunities for other income generating activities (Kanagawa and Nakata, 2008). Without moving to a more sustainable cycle of energy production and use it is difficult to see how the situation will be improved, so this is a key research need for the area.

Anaka trading centre includes a Government hospital, 3 primary schools, 1 nursery school, 1 senior school, 1 technical school, a market and a number of shops including barber shops and mobile phone charging stations. The centre is on one of the highways to tourist attractions in the north, predominantly the Murchison Falls National Park, and so the market benefits from passing tourist trade. The commercial properties have a combined electricity demand, although as there is no grid supply to the camp the demand is met by a number of gasoline generators (the exact number is unknown). Kerosene lanterns are widely used for both domestic and commercial lighting. Based on a study completed for a similar sized trading centre in western Uganda named Kasonga (Buchholz and Volk, 2007) and other related research (White, 2002; Modi *et al*., 2006), the electricity demand of Anaka is assumed to be around 30 MWh/year. This accounts for the lighting and cooking requirements of the hospital, schools, market and shops as well as a number of households who have the ability to pay towards a domestic supply.

6.4 The alternative solution: Biomass gasification and sustainable woodlots

Small scale wood gasifiers could be an economically and socially feasible energy system to produce electricity in rural areas. It has been proposed that their use in such cases would stimulate social and economic development (Buchholz and da Silva, 2010) and replace the need for imported oil for generators (Zanchi *et al*., in press). In Anaka, the scenario would be a gasification unit in the centre, possibly attached to the hospital. This would be controlled and run by a community group, supplied by wood fuel purchased from local farmers and paid for on a set tariff according to level of use by traders, government and a proportion of households. A more precise identification of demand in collaboration with representatives from the area would be required if a decision was made to pursue a full sustainability plan and implement the model. This would also help to judge the likelihood of increasing energy supply which is not considered formally in this Chapter.

The technical requirements of a suitable gasifier were presented in a recent article by *Re-Impact* colleagues (Zanchi *et al*., in press); who calculated that, in order to produce an annual output of 30 MW, a yearly supply of 40 oven dried tons (odt) of timber would be required. Based on the use of *Eucalyptus grandis* with a stand productivity varying between 5 and 15 odt/ha per year, this would require conversion of between 2.7 and 8 ha (depending on the actual productivity), with a sixth being cut each year for use in the gasifier. In the study for the Kasonga case, Buchholz and Volk (2007) arrived at a similar figure of 8 ha required to supply the gasifier (assuming a stand productivity of 10 odt/ha per year). In order for the current fuelwood requirements to be sustainably satisfied, and to reduce the pressure on the natural forest resource, managed plantations of 1,783 ha or 865 ha respectively would need to be set up within 5 or 10 km of Anaka (Zanchi *et al*., in press). These could be run by local entrepreneurs to sell the fuelwood, or set up as environmental protection woodlots to protect the surrounding forest (Rady, 1992) which is currently being harvested at a highly non renewable rate. The introduction of additional efficiency-improving options for heating and cooking, such as clay ovens or stoves, could help to reduce fuelwood use further. There is research to suggest, however, that this is not always the case as people have set aside a certain opportunity or economic cost to themselves of energy use and increased supply often results in increased consumption. This phenomenon is known as Jevon’s paradox (Alcott, 2005). In this Chapter I am focusing on the current level of demand that exists in Anaka in terms of fuelwood and electricity so as to reduce pressures on the remaining forest resources. I am not explicitly accounting for increased future demand because this is not an objective of my thesis, although I do appreciate that this is an important consideration for further research. Here, consideration will be given to the economic, carbon balance, water resource and social aspects of the case study. Biodiversity was suggested, but not identified as a pressing issue currently by the local stakeholders. This could change, but ultimately it was agreed that the existing biodiversity would at least be protected by any such measure to halt deforestation.

6.4.1 *Economics of supply*

For the long-term viability of rural electrification projects, the financial sustainability and the focus on demand-side needs are thought to be the most relevant parameters (Monroy and Hernández, 2005). Buchholz and Volk (2007) found that the total amount spent in the Kasonga trading centre on gasoline for generators and kerosene for lanterns was between US$ 220 and US$ 310 per week. The average cost of lighting for businesses by kerosene or candles was calculated to be US$ 0.17 per evening. In Kasonga, the cost to the customer of mobile phone charging was around US$ 0.28, which is assumed to be a standard level of charge for a remote peri-urban context. Considering the cost of running the generator is roughly US$ 0.3 per kWh and the phone charging requires only around 0.1 kWh, it is clear that the customers can afford to pay for services requiring electricity and the trader in turn has significant capacity to pay for their electricity consumption. Indeed, conversely, many rural poor already pay more per unit energy than the urban wealthy due to inefficient technology and corruption in the supply chain (Nunan *et al.*, 2002). In addition to the cost of electricity and the ability of the traders and customers to pay, many of the commercial premises are only using a fraction of the electricity that their generators are producing, despite the fact that 80 % of their income is spent on the fuel (Buchholz and Volk, 2007). It was suggested that the profit to the service providers would be much improved if they only had to pay for the electricity that they actually consume, which would be possible through the biomass gasification system.

There are two scenarios of energy supply being considered in this context (as in the Kasonga case), the fossil fuel generators being used currently (business as usual, BAU) and the proposed gasifier. In the BAU scenario there are 2 people employed for maintenance of the generators, and the average electricity cost is around US$ 0.5 per kWh (*ibid.*). It has been assumed that a total of 9 jobs would be created under the gasification scenario, covering the technical services to operate the gasifier and grid (2 km to connect commercial premises and households), supply the fuelwood and overall management. This business case involves the farmers who are providing the fuelwood for cash to be trained in sustainable forest management practices to efficiently produce a renewable short rotation coppice (SRC) tree crop. Around US$ 700 would be spent locally on fuelwood each year, which results in an equivalent price to that currently paid for timber construction poles, the main competitor to the gasifier’s supply (*ibid.*). In addition the cost of producing the electricity in the gasification scenario, excluding the interest payments on the capital costs which would be assumed to be supported by project financing schemes such as grants, is US$ 0.23 per kWh. This offers the opportunity for profit even where electricity is sold cheaper than the BAU cost. This figure takes into account the cost of connecting the grid supply, as well as labour and fuel outgoings, and is based on a lifespan of 10 years (*ibid.*).

Whilst this proposal is theoretically financially viable, the high start-up costs (around US$ 2,700 per kWh, roughly 50% of the whole system cost), the exclusion of the interest payment on the capital cost in the calculation and the 6 year payback period are significant obstacles considering the low level of capital available to the community and the lack of existing project management experience. However, assuming that external funding or micro-finance could be made available to the community, however, the operational costs are extremely low and make the scenario economically viable. It has been reportedly difficult to engage the commercial finance sector with rural, off-grid project investments such as this (Monroy and Hernández, 2005), so therefore a successful working example would most likely need to be set up by government or donors in order to demonstrate the workability of the technology and iron out any issues. Learning from successful projects using gasification technology in remote parts of rural India could be extremely beneficial in designing business cases and identifying potential issues which would need attention (Ravindranath *et al*., 2004; Nouni *et al*., 2007).

There is currently no business plan for the establishment of community woodlots for fuelwood consumption within 5 or 10 km of Anaka. It is possible that these sites could be run by local entrepreneurs and the fuelwood sold to residents on a more sustainable basis than using the existing forest. With less revenue available for this facility the inputs to, and management of, the plantations would likely be minimal, resulting in low productivity stands and therefore possibly greater areas required than suggested in section 6.4. The alternative would be government- or donor-funded woodlot establishment as a direct measure to reduce the pressure on the existing forest resource and provide the community with a more stable and sustainable source of fuelwood. With the improvements in lifestyle and alternative energy supply that the gasifier would be expected to bring, it is anticipated that the reliance on fuelwood would diminish. In this case the plantations would remain a valuable commodity for the community in terms of timber production.

6.4.2 *A Life Cycle Assessment of the proposed project*

Zanchi *et al*. (in press), under *Re-Impact*, performed a full Life Cycle Assessment (LCA) of the proposed Anaka case in terms of both the gasifier and the fuelwood plantations as compared to the current use of fossil fuel generators and the non-renewable fuelwood extraction from rapidly depleting natural forests. They calculated that the land use change required to provide fuel for the gasifier, namely the conversion of 8 ha of savanna grassland to *Eucalyptus grandis*, would produce a net carbon sequestration of 2.6 tC (tons of carbon dioxide) per year on the total area, or 1 tC per year over a 20 year period. Taking into account the full LCA of both systems, the gasification scenario has a positive carbon balance compared to the reference BAU scenario. At low productivity of the plantations (5 odt/ha per year) there are some emissions overall, however only a fraction of those produced by the generators over their life cycle. If the productivity of the plantation is higher, so 15 odt/ha per year, the gasifier produces a net annual carbon sink of 8 tC per year in the 20 year period. In the gasification scenario the emissions are produced by management of the coppiced plantations, including: fertilising and harvesting, the transport of the biomass to the gasifier, the construction and operation of the gasifier itself and also the provision of the electricity transmission grid. However, these emissions are partially or totally (depending on plantation productivity) offset by the conversion from grassland to Eucalyptus (*ibid.*).

In relation to the household fuelwood supply plantations, it was reported that the non-renewable biomass removal from around Anaka produces annual carbon emissions of up to 158.4 tC per year, as the land use is being changed for a grassland or agricultural type with a low carbon stock (*ibid.*). If replaced with dedicated fuelwood plantations, however, the authors conservatively assume that the balance between carbon sequestration and the emissions produced during planting and management would be 0. Therefore, there is predicted to be a significant improvement from the baseline using this fuelwood supply scenario.

6.4.3 *The likely water resource impacts*

The Aswa River catchment, in which the Anaka case study is situated, has been the basis of a hydrological study for *Re-Impact* looking at the impacts from proposed large scale Eucalyptus plantations on the water resources in the catchment (Garratt *et al*., 2010). Using the HYdrological and Land Use Change (HYLUC) model (Calder, 2003) the catchment was parameterised for existing vegetation and peri-urban land use, and then for *Eucalyptus grandis* using a Short Rotation Forestry system for a proposed 35,000 ha required for a 50MW power plant; significantly more than the 10 ha required to supply the Anaka gasifier, and the 865 to 1,783 ha required for sustainable woodfuel provision. The hydrological results from this study were used to populate the EXploratory Climate Land Assessment and Impacts Management (EXCLAIM) visualisation tool which has been parameterised for a number of sites across the world and is freely available on the web. This tool provides outputs of changing daily runoff as a result of different land uses being diverted to Eucalyptus[13]. It has been used to provide the expected water resource impacts of the proposed levels of plantation (roughly 10 to 50 ha, 865 to 100 ha and 1,783 to 2,500 ha) under current and drier rainfall scenarios. The gaps in data availability for the area and difficulties experienced when parameterising the model resulted in uncertainties of the precise values, however the accuracy of the outcomes in terms of the overall direction and magnitude of change were thought to be realistic, according to a number of local and international experts who were consulted[14].

As can be seen in Figure 6.5, the land surrounding the camp within 15 km is predominantly agricultural, with some open forest, grassland and shrubland. The model was parameterised with agricultural land, forest and rangeland (which covers both grassland and shrubland), using a 57 year daily rainfall record from the nearby town of Gulu. The results of varying changes in the size of plantation, and on different previous land uses, are shown in Figure 6.6.

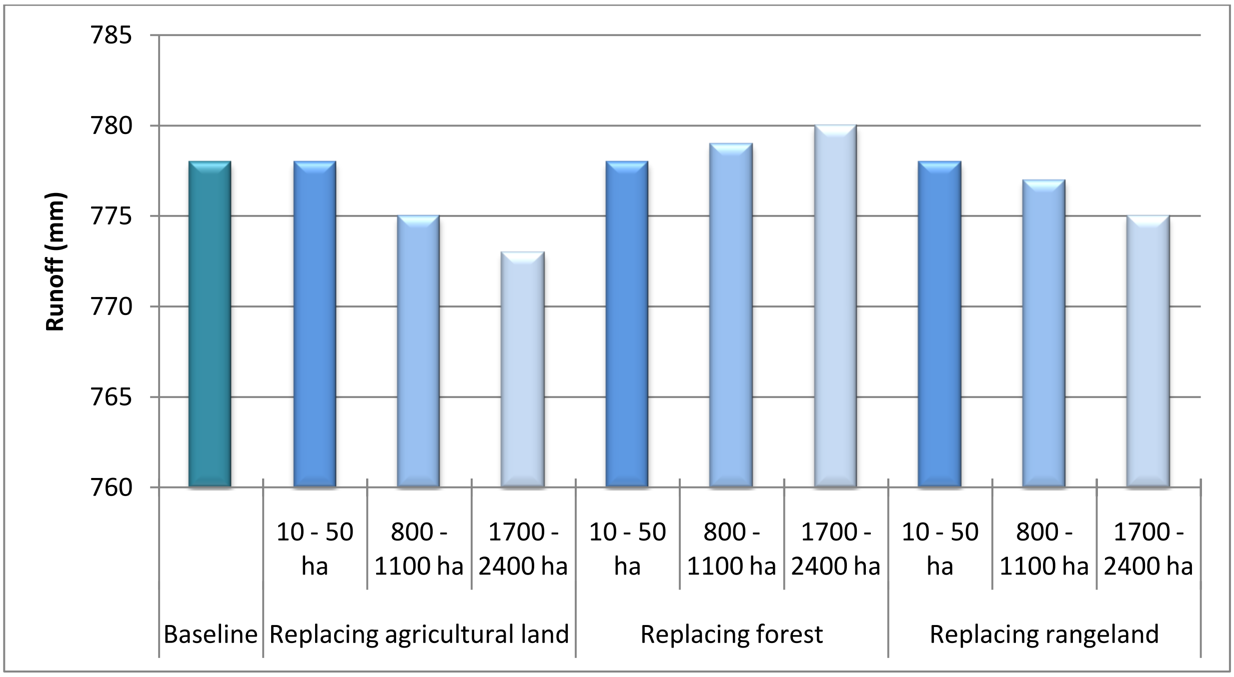


Figure 6.6: The effect on runoff of changing from current land use in the Aswa River catchment to *Eucalyptus grandis* at different scales in an average rainfall year (1522 mm), predicted using HYLUC. Author's own.

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[13] EXCLAIM Visualisation Tool freely available online at URL: http://www.ceg.ncl.ac.uk/reimpact/EXCLAIM.htm

[14] Ian Calder formerly of CLUWRR, Don White of the CSIRO Australia and Tom Nisbet of the Forestry Commission UK, pers. comms., between May 2006 and September 2010.

Based on the parameterisation values used, the model predicts that planting Eucalyptus would result in a decrease in runoff from the baseline of 778 mm per year to a minimum 773 mm (5 mm annual difference) in an average rainfall year (1,522 mm) when up to 2,400 ha of agricultural land is changed. According to section 6.4 this would more than cover the amount required to provide a sustainable woodfuel supply within 5 km of Anaka. In section 6.4.1 it was suggested that the required area of woodfuel supply may need to be a conservative estimate as the productivity of these stands could be affected if the opportunity cost of good management is too high compared to the potential return. The sensitivity of the land area and hydrological requirement to changes in stand productivity at this scale were found to be relatively low, however, and so would not be expected to significantly affect the results.

The outcomes from the HYLUC model suggest that replacing forest with Eucalyptus would marginally increase streamflow. This is because natural forests have a dense canopy and are comprised of predominantly mature trees. These are characterised by well established root systems, capable of transpiring groundwater at a relatively high rate compared to shorter vegetation (Calder, 2005). The Eucalyptus plantation, on the other hand, would consist of mainly young trees produced on a short rotation forestry system, meaning that they would be felled once they reached maturity. The plantations would also intercept less water due to tree spacing and less understorey. Therefore, overall it is predicted that the water use of the short rotation Eucalyptus would be slightly lower than the natural forest, by around 2 mm over the year. This potential water saving is in no way significant enough to justify afforestation of previously forested areas with Eucalyptus as the other disadvantages, for example impacts on biodiversity and carbon emissions would greatly outweigh the limited water resource benefit. In a dryer year (at the lower end of the rainfall record used) where rainfall was 1282 mm, the results are slightly modified, see Figure 6.7.

The runoff from the current land use configuration, with this lower rainfall, is reduced to 561 mm annually. In this dryer situation the runoff from Eucalyptus as compared to natural forest is unchanged because the trees, under water stressed situations, are expected to respond in a similar way. When rangeland and agricultural land are changed to Eucalyptus in this lower rainfall scenario, the reduction compared to the baseline runoff level reaches a minimum of 555 mm, still only 6 mm difference.

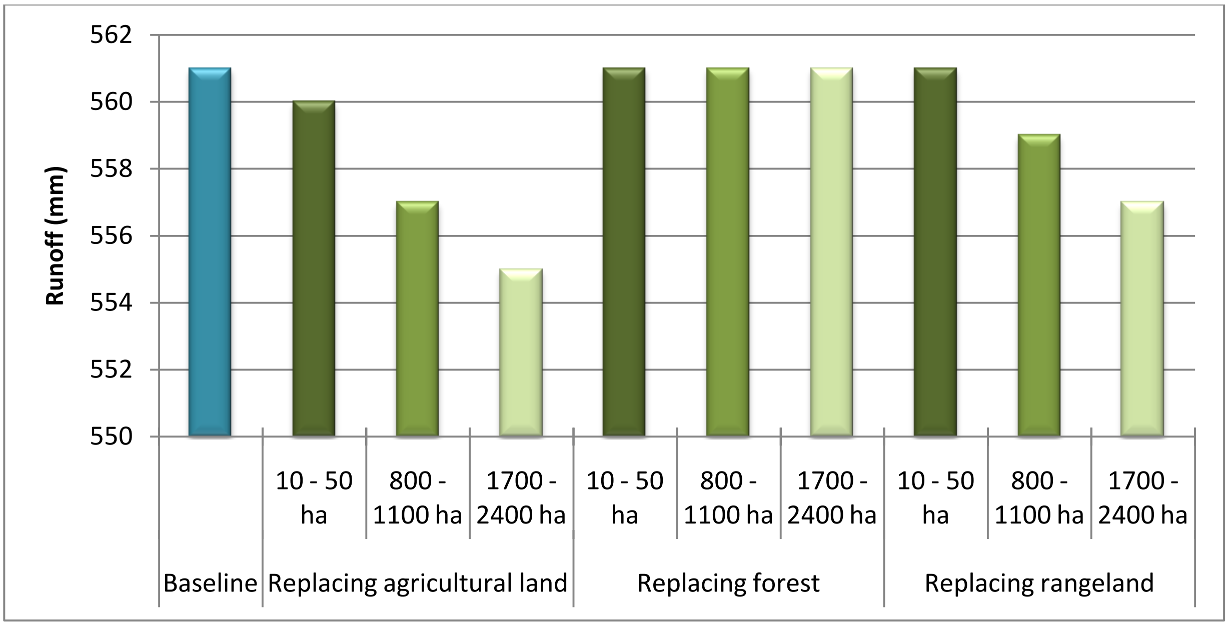


Figure 6.7: The effect on runoff of changing from current land use in the Aswa River catchment to *Eucalyptus grandis* at different scales, in a dryer year (1282 mm), modelled using HYLUC. Author's own.

Based on the results from the modelling, it seems that the levels of plantation required to fulfil the woodfuel and electricity needs of the Anaka community through Eucalyptus plantation would not have a significant detrimental impact on the water resource availability in the Aswa river catchment. Considering the different possible land use changes presented, it would be most sensible to convert rangeland (grassland or shrubland) to plantation rather than agricultural or existing forest land. This is because the agricultural land is vitally important for food production in the area as well as being a lower water user than the Eucalyptus. Conversely, the forest land has an intrinsic value in a preserved state, conservation of which provides part of the incentive to supply the plantation biomass alternative.

6.4.4 *The social side: benefits and barriers*

The social benefits to the population of Anaka of the gasification scenario would include access to a reliable and affordable source of electricity which is likely to allow economic development and in turn benefit the wider community through the multiplication effect. The availability of a secure, sustainable fuelwood supply would also be likely to reduce the difficulties of collection and purchase from traders coming in from increasingly far afield. Furthermore, improvements in the quality of timber and efficiency of use could reduce the overall amount required. However, the Jevon's paradox is still a possibility, i.e. efficiency increases may not necessarily lead to reduced consumption, and so this should not be relied upon in projections or calculations without further investigation.

Buchholz and Volk (2007) completed a Multi Criteria Analysis (MCA) for the Kasonga case study. Stakeholders identified and ranked sustainability criteria by their perceived importance using a 1-9 Analytic Hierarchy Process (AHP) rating tool. Table 6.2 shows the criteria that were selected and how they were ranked by perceived importance. Despite the fact that the gasifier scored higher on 5 out of 9 criteria, and could provide cheaper power to the community than the generators are able to, the total aggregated score based on the AHP methodology indicates that the stakeholders overall prefer the BAU scenario. This is because the gasifier scored lower in criteria which were assigned a high weight (known as the critical criteria) by the group, such as 'planning and monitoring', 'ownership', 'land availability' and 'training needs'. The decision to rank the BAU scenario higher than the gasifier scenario in the Kasonga case was not a statistically significant one. In addition, Buchholz found that the highest weighted critical criteria, apart from 'land availability' (which is an unavoidable disadvantage of the gasification system), could be reversed by "*providing business models, knowledge transfer, resolving user rights and identifying suitable management structures*" (Buchholz and Volk, 2007, page 19). Whilst the impact of the gasification and woodlot scenarios do have an impact on land availability, the increased efficiency of land use and reversal of degradation is more significant, and the lack of land availability is not perceived locally as a severe problem as there is still underutilised land available.

Table 6.2: Sustainability criteria for bioenergy power production as identified by stakeholders at Kasonga. Ranked according to perceived importance and rated alternatives (after Buchholz, 2008).

	Sustainability criteria	Weights	BAU (fossil fuel)	Gasifier
C1	Reduced competition for fertile land	12.1%	**0.88**	*0.12*
C2	Reduced pollution	3.7%	*0.12*	**0.88**
C3	Low training needs	13.4%	**0.62**	*0.38*
C4	High employment rate	7.6%	*2*	**9**
C5	Diversity and certainty in ownership and business schemes	12.6%	**0.89**	*0.11*
C6	Low planning and monitoring needs	17.9%	**0.63**	*0.37*
C7	Increased local commerce	10.6%	*0.18*	**0.82**
C8	High cost efficiency	11.4%	*0.34 - (0.5)**	**0.23**
C9	High supply security	10.7%	*0.41*	**0.59**

Bold and green: superior and preferred; *red and in italics*: inferior.

* *indicates minimum, maximum and average fossil fuel generated electricity costs in US$/kWh*

It is clear that, if it were to be successful, there would need to be an improvement in the local perception of the gasifier through training and capacity building, because currently the lack of expertise and understanding around the technology is a major barrier to such a project. Trying to implement without this level of understanding would undoubtedly result in failure because, without public acceptance, the business model would be unlikely to work as it relies on the participation and buy in from the community. It is assumed that the stakeholder perceptions in the Anaka case would be similar to those displayed at Kasonga, however if a pilot were to go ahead in this location then a similar participatory survey of a representative group would be highly recommended in order to understand their specific points of view. Whatever the outcome, it is strongly believed that public perception could be a barrier to such a project and should be mitigated at the earliest opportunity by working with the community themselves from the outset and including them in designing the interventions.

6.4.5 *The stakeholder response*

The results from modelling and social interactions were presented at a small stakeholder workshop hosted by *Re-Impact* in Kampala and attended by local representatives from the project, strategic donors, local energy researchers and the technical scientist associated with a commercial forestry production project in the country (the Sawlog Production Grant Scheme, SPGS[15]); nine in total. The discussion centred around the opportunities for decentralised electricity provision using woody biomass plantations in northern Uganda, where sustainable development is a high priority. The Anaka example, and the information provided on the impacts, was accepted by the group and seemed to correlate well with the stakeholders' experience and understanding of the area, the species being considered and the technology. One concern that was raised was around the lifespan of the gasifier, which was predicted in the LCA study to be 10 years, but according to an expert from Makerere University the production of electricity requires a generator which usually needs to be replaced after 2-3 years. This would need to be accounted for in the calculation. Another issue, raised by an experienced forester working in the country, was that the productivity suggested for the Eucalyptus stands was too conservative. This was met by consensus from the other stakeholders considering plantations existing in the country which far exceed the 15 odt per year maximum proposed for the Anaka case. This suggests that, with adequate management, the productivity of the plantations could

[15] SPGS is a donor-government partnership in Uganda which funds the establishment of timber plantations, website: http://www.sawlog.ug.

be considerably improved compared to estimates and result in even smaller areas being required for land use change. However, as discussed in section 6.4.3, change in productivity actually has a relatively insignificant effect on the required plantation size at small scales.

Finally, the stakeholders were unanimous in suggesting that the most important requirement for uptake of the scheme would be a well planned, funded and monitored pilot to strengthen the business case, and the importance of using pilots has been previously reported (Ravindranath *et al*., 2004; Turner, 2005). The European Union is collaborating with the Ugandan Government and the Norwegian Embassy on the SPGS project which provides grants for establishing a commercial timber production industry in Uganda. Under SPGS, funding is available for planting and managing community woodlots in the north of the country. In collaboration with Makerere University who have expertise on the gasification technology and could supply the gasifier, and the Ugandan Donor Working Group who could support the community and monitoring aspects of the pilot, there is real potential for a practical application of the theory presented in this Chapter using the planning procedure put forward in Chapter 2 (Figure 2.2, page 36). The stakeholders present in the workshop were all keen to continue working on this action.

6.5 Key messages and implications from Chapter 6

Contrary to simple observed relationships such as the EKC, environmental improvement is actually a possible outcome of projects to diversify incomes and improve well-being in remote rural areas of developing countries. What it does mean is that environmental protection, or more usefully development which results in environmental improvement, should be considered as a strategy by actors higher up the needs hierarchy or those whose jobs require them to do so. Namely either local government, national government or an international agency, or perhaps donors, NGOs and researchers.

In the Anaka case the gasification scenario looks to be economically viable considering the best available data. Questions were raised by high level stakeholders in Kampala over the lifespan of the machinery, which could impact the economics, and also that the economic calculations relied on there being no interest payments on the loan/grant required for setting up the power plant. Therefore if a pilot were to be designed, a more in depth and situation specific economic analysis would be required to ascertain the true costs and lifespan of the machinery. For such a venture to be possible, the unit cost of electricity needs to remain cheaper and the profit to the operator higher than that of the fossil fuel generators. If this is able to be realised then it would be a major factor in changing attitudes and perceptions over the gasification technology.

The LCA of the proposed Anaka project showed that it would produce significantly less carbon over its life cycle than the BAU fossil fuel generator scenario. Whether or not the gasifier scenario would actually sequester carbon overall as opposed to emitting was found to be dependent on the productivity of the plantations, and so increased productivity through good management practise would be a key factor. Even on the lower productivity calculation, however, the performance of the gasifier was significantly better than that of the BAU scenario in terms of its carbon sequestration potential.

Based on the results from the hydrological modelling within the Aswa River catchment, it seems that the levels of plantation required to fulfil the woodfuel and electricity needs of the Anaka community through Eucalyptus plantation would not have a significant impact on the water resource availability in the area. Considering the different possible land use changes, it would make the most sense from a sustainability point of view to convert rangeland (grassland or shrubland) to plantation rather than agricultural or existing forest land, although the water use of the plantation would be marginally higher. This is because the agricultural land is vitally important for food production in the area, as well as being a lower water user than the Eucalyptus, and the forest land has an intrinsic value in a preserved state, which is the intention from supplying the plantation biomass alternative.

The MCA and stakeholder interactions brought to light the difficulties that could be faced in terms of local perceptions and the ultimate acceptance of the gasification technology. Often seen as a secondary or inferior concern, social acceptance can present a major barrier to successful implementation. The indications in this case are that capacity building and stakeholder participation would be required from the outset if the adoption of the gasifier was to be achieved. This is because the community might feel, as in other cases, that they lack ownership and the ability to troubleshoot technical difficulties with the unknown technology.

The useful and productive stakeholder workshop demonstrated the importance of strategic planning and coordination between different departments and projects. The Anaka case could provide a pilot for sustainable development through decentralised rural electricity supply which balances both the immediate and longer term needs of the community with the importance of environmental protection through avoided deforestation and more efficient use of resources. In practise there would likely be lessons learned for future projects, but without a viable, well planned and monitored pilot case it would be challenging to roll out the technology at any reasonable scale. It would be expected that a successful pilot would provide encouragement for entrepreneurs in other locations to be able to set up their own similar enterprises and for financing organisations to provide the necessary capital. If this example, or a similar one, were to be taken forward to provide a pilot then I would strongly recommend the use of tools including context-specific Social Impact Assessment as outlined in Chapter 3, and the structured approach to understanding stakeholder dynamics as covered in Chapters 4 and 5. These would facilitate the use of a planning for sustainability approach and ensure that the local stakeholders are involved in the planning, design and monitoring of the final project; crucial for a successful scheme.

Chapter 7.

Discussion – Lessons Learnt and Key Themes

In this Chapter the most significant and important findings, and key themes, of this thesis are reviewed in relation to the aim and objectives introduced in Chapter 1 (page 16). In this research, mechanisms for ensuring the global sustainability of bioenergy, in particular liquid biofuel, feedstock production projects were considered. It has been shown that sound national policy and legislation are vital (although they can be ably supported by others such as certification). This provides a wider context for the approaches presented here, as this thesis is not focused on deciding whether bioenergy as a whole is a globally sustainable option. Instead, working primarily at the project level, it has been possible to see how sustainability could be achieved through improvements to the planning process which involve stakeholders as collaborators.

This discussion Chapter initially reviews the case studies on which my approaches have been developed and tested, looking at the cross-country lessons that can be learnt. This relates to thesis objective [B] (page 18), as does the following consideration of a number of themes which have recurred throughout my research, including: trade-offs, the importance of monitoring, and scale (both temporal and spatial). Finally, the meeting of thesis objective [A], through methodological assessment and development, is explored in a review of the approaches developed. This will lead on to concluding on thesis objective [C], an evaluation of the wider applicability of the approaches and analysis, which is presented in the final Chapter.

7.1 Lessons learned in India and Uganda

7.1.1 *Liquid biofuels production in Chhattisgarh State, India*

In India the role of the oil marketing companies (OMC) is becoming increasingly important. These publicly owned companies hold the majority market share of the petroleum industry in the country, and are increasingly becoming involved in bioenergy developments, in particular liquid biofuels for blending in transport applications. Considering that saving foreign exchange, providing both energy and environmental security, promoting renewable energy sources and meeting climate change commitments represent five out of the six drivers identified behind the Indian Biofuels Policy (see Box 3.3, page 52), the involvement of such large and influential companies in this political arena is crucial. The national policy was drafted and consulted upon for three years before being mandated in 2009 with no changes. This requirement for consultation is an important step, but seems to have been entirely ineffectual in this case. The policy is being implemented through State level government, each with their own agenda and individual approach to planning and application. In the case of Chhattisgarh State, as reported in section 4.4. (page 82), there is a strong commitment to rural development through export of agricultural produce and increased employment opportunities. The State has strongly promoted the production of *Jatropha curcas L.* (Jatropha) in multiple ways, most recently through its Joint Ventures with the national OMCs Indian Oil Corporation (IOC) and Hindustan Petroleum Corporation Limited (HPCL).

Through the assessment of social impacts or effects in the Indian case carried out in Chapter 3, it has been found that bioenergy projects can have significant consequences for local populations. In particular the 'community resources' variable (see the five social variables in Box 3.1, page 44) seems to be affected, independent of model, scale and land tenure arrangement. This is because of the changing patterns of natural resource and land use, particularly for indigenous people, observed as common in all of the production models. For the other four variables there is scope for improvement in all cases studied. The model which performs most strongly socially from the evaluation is the farmer-centred one, where the needs of marginal and landless groups are taken as the project goal. This is in contrast to the lowest scoring government-centred model which excludes local communities from any decision-making. Essentially, the level of participation and inclusion of local communities in the planning, implementation and monitoring of liquid biofuel feedstock production models in India is thought to have a direct bearing on the type of social impacts that can be expected. This level of analysis and understanding does not require significant resources, and would have been beneficial in the planning and consultation phases of the policy development in order to identify the most appropriate strategy for implementation. Alternatively, because implementation is ultimately carried out by individual States, the requirement for *a priori* assessment such as that in Chapters 3 and 4 could be mandated at that level. This would help to ensure that socio-economic expectations of bioenergy feedstock production could be clearly defined and met, whilst avoiding adverse social impacts.

The subsequent trialling in Chapter 4 of the approach to understanding socio-economic impacts and stakeholder dynamics in biofuel feedstock production models in Chhattisgarh showed that the marginal farmers, who are targeted in the Biofuel Policy, stand to gain in some of the production types but are also at high risk of failure. The landless poor, another targeted group, benefit from employment opportunities in many cases and tend to have a lower risk of failure because they do not have high personal investment in any of the models. The nature and level of employment available differs between models, but would rarely be full time, long term or secure and is dependent on the viability of the enterprise. In fact, the greatest uncertainty in understanding risks in these models is around the yield and productivity of the Jatropha crop itself (as discussed in Chapter 3). By identifying this risk, policymakers at State and national level have the opportunity to minimise it, which currently is not happening in any coordinated manner. In this case the most effective strategy would be to ensure that reliable and robust agronomic research into the productivity of the crop under different levels of input and management (and subsequent viability of different production models) is carried out and results made available. Without this, the likelihood of severe socio-economic impacts or substantial economic returns is unclear, which reflects poorly on the policy making process. In addition, monitoring of existing models would inform ongoing planning and design through validated field experience. If marginal farmers and the landless poor are to benefit from Jatropha production models in Chhattisgarh, then they need to have (i) some decision-making power (the opportunity to interact in decision-making), (ii) a role in the production model (requiring their input) and (iii) a certain, resultant, level of risk (balanced by robust, transparent research and field experience) in order to meet their requirements.

Model types which are being pursued for benefits other than local sustainable development and poverty alleviation should not necessarily be summarily discounted, particularly because of the potential for biofuel projects to contribute towards alternative national agenda and the need to support production companies (without whom sector development is ultimately limited). It should be the government's role to ensure that these projects do not impact negatively on locally generated benefits of others. Trade-off decisions may be required, and these should equally involve stakeholders from all relevant levels, including women and other often marginalised groups. In addition, more than just the socio-economic aspects need to be considered, and therefore employment of the full planning for sustainability framework is required. The current policy seems to be far removed from its implementation, and there is no strategic plan to align projects with specific requirements or an overall sustainability goal. If the Indian Biofuel Policy is going to successfully achieve the objectives which were set for it, then more effective and participatory planning, which uses straightforward, context-specific approaches such as those proposed in Chapters 3 and 4 to include socio-economic considerations, is needed. This is an example of a country which will most likely remain outside the influence of market-based mechanisms to ensuring sustainability because of the substantial internal demand (which exists because of national blending mandates). Therefore, the need for informed decision-making at the level of project design and implementation is particularly acute (as discussed in section 2.1.1(a), page 22). The inadequacy of the Indian policy making process to effectively incorporate socio-economic considerations was discussed in section 3.3.2 (page 53), but the relatively simple steps and stages followed in Chapters 3 and 4 demonstrate how this understanding could be greatly improved with little allocation of resources.

7.1.2 *Bioenergy and environmental protection in Uganda*

As shown in Chapter 5, the drivers behind bioenergy feedstock production in Uganda are predominately socio-economic, although reducing the pressure on existing natural resources including forests is an expected indirect impact. The role of donor organisations is strong in Uganda, and is likely to remain so for the foreseeable future. There is a multitude of contributing agencies; between them they are influential in policy making as well as project design, funding and implementation. Sustainable development is clearly the underlying goal; objectives to be met here include poverty alleviation, improved energy provision and environmental protection. Bioenergy has the potential to contribute towards all three of these and so is an important prospect for the country, at the very least in the short term until new hydropower or petroleum based projects become operational (as discussed in Chapter 5). There is no specific policy aimed at increasing bioenergy production in Uganda, though biomass is included in the 2007 Renewable Energy Policy and considered as an option to eradicate poverty through increasing access to modern, affordable and reliable energy services. The implementation strategy is rather vague, however, and makes no distinction between production types except for the use of "*modern*" methods (MEMD, 2007, page 7). In remote rural locations in particular, the setting up of plantations can provide communities with alternatives to either fuel for generating electricity, or even just woodlots for traditional biomass use to reduce pressure on the rapidly-degrading natural forests. In such areas grid electricity is not available, or is insufficient, and so fossil fuel generators are widely used.

If the outcomes of small scale, decentralised projects do match up to the expectations of their proponents and the expected benefits are realised, then education and capacity building to change the perceptions of those against the technology will be needed. This is more appropriate than simply promoting the largest and most technologically advanced models available. Through application of the structured approach to understanding socio-economic impacts and stakeholder dynamics in bioenergy production to the Ugandan situation, detailed in Chapter 5, it was found that the Gumtindo (type U-5) and Anaka (type U-4) models appear to have the potential to contribute most effectively towards meeting the country's energy policy and development objectives. This is due to the planned provision of electricity in remote areas using technology capable of competing with fossil fuel generators and the opportunities for the landless poor to generate livelihoods for themselves. There are additional reasons why other models which do not have these benefits are likely to be implemented. In each case the positive outcomes expected from implementing a project or policy should be assessed in context, weighed up against potential negative impacts, particularly on the success of other projects, and a suitable monitoring strategy be put in place.

Unless stakeholders are aware of potential problems with particular technology or crop selection, then the approaches detailed in this thesis will not be sufficient to decide whether or not a project would be sustainable in a given context. The selection of appropriate technology is part of the planning for sustainability process. It should be carried out in collaboration with stakeholders, and based on the best available information and multiple assessment tools (see Figure 2.2, page 36). In Chapter 6 the results from a number of different techniques assessing the sustainability of the proposed woody biomass for gasification project at Anaka trading centre in northern Uganda were reported. This example had already been identified in Chapter 5 as having particular socio-economic requirements, and more baseline information was available from the *Re-Impact* project and other collaborative research identified in relevant sections. The results of the assessments show that, if implemented, the Anaka model would be expected to:

- be economically viable;
- have the potential to reduce carbon dioxide emissions compared to the current use of fossil fuel generators;
- have minimal impact on the catchment water resource availability; but
- face difficulties in terms of acceptance of the technology locally, particularly due to high expectations of oil exploration in the Albertine basin.

The stakeholder workshop held in Kampala in May 2010 led to increased interest from donors and project developers in the Anaka case. However, for this model to contribute to alleviating poverty and supplying electricity needs in the region, scaling up would be required. This could create cumulative impacts which would need to be accounted for when designing it. Without a viable, well planned and monitored pilot project it would be challenging to 'roll out' the gasification technology at any reasonable scale. A pilot could prove useful in encouraging entrepreneurs in other locations to set up their own similar enterprises, and also to encourage financing institutions to provide investment. The importance of strategic planning and coordination between different departments, funders, projects and stakeholders is clear. The use of the planning for sustainability framework and the approaches proposed in this thesis are potentially important in including socio-economic issues and stakeholders in designing the project, and helping policy makers to meet their objectives.

7.1.3 *Cross country learning*

Trying to ensure that bioenergy projects are applied in the case studies is **not** the intention of this research or the sustainability planning framework; they should only be implemented where a need is identified and the context is suitable. From the uncertainties in the Indian context regarding the viability of Jatropha (which could have a major impact on the socio-economic performance of any of the production models), to the range of productivities reported in Uganda for *Eucalyptus grandis* (which could have an impact on carbon sequestration potential and, to a lesser extent, hydrology), the need for robust, field based, context-specific agronomic information is clear.

To date, the policy making procedure in both countries has not been strategic in matching drivers and objectives to the most suitable models. The implementation of policy is haphazard and left to different agencies, institutions and organisations without clear guidance or coordination between them. Both top-down and bottom-up project design has occurred in both cases, suggesting that the need for decentralised bioenergy solutions does exist. From this research it is apparent that there ought to be some level of top-down (from national level) legislation in place to provide an enabling environment, but also a clear definition of goal and principles from the outset, with strict no-go criteria to avoid obvious negative impacts. To identify more subtle indirect and cumulative effects a full, context-specific and detailed sustainability assessment using various methodological tools is required. Stakeholder participation is crucial if projects are to be sustainable; involvement of those groups at whom development is targeted (marginal farmers and landless poor, but also commercial production companies to help develop the sector), is vital. The availability of micro-financing and entrepreneurship opportunities is particularly relevant where poor communities are expected to benefit. In situations where projects are predicted to have positive outcomes across the full sustainability spectrum (as in Anaka and Kasonga) additional efforts, such as a well supported pilot project, need to be made to better understand and demonstrate the benefits to communities in practice. Whenever projects are implemented, monitoring is required to look for unexpected, indirect or cumulative effects. The strategy for monitoring should involve and be designed where possible by the stakeholder community, overseen in the long term by government or donors depending on the institutional structure in place. These sorts of proposals are often avoided because of the perceived high cost to carry them out. The approaches presented in this thesis are designed to require minimal resource input whilst extracting the maximum useful information from stakeholder interactions and remaining robust. In the longer term, the payback for this greater *a priori* appreciation of the potential social impacts and inclusion of local stakeholders is expected to be time and money savings because of well designed, context-specific strategies for implementation and monitoring.

The involvement of higher level agencies is important in both case studies; in India the government is dominant, whilst in Uganda the role of donors remains significant. Ultimately the intention is that the government retains control and will be the driving force behind development activities (as discussed in Chapter 2). Although, in Uganda, there has been a move for the government to have more jurisdictions over the coordination of development funds, it is expected that the role of international donors will remain influential for the foreseeable future (Owomugasho, 2005). The role of community groups is also evident, from the Village Energy Committee in Ranidehra village, Chhattisgarh State set up with the help of Winrock International India, to the Gumtindo Coffee Cooperative Enterprise which operates successfully in the Mt Elgon region of Uganda, exporting Fairtrade certified produce to Europe. Groups such as these, whether existing or set up through a project, are influential in mobilising local stakeholders. In turn, ensuring that they remain organised and well represented contributes towards more collaborative policy making.

7.2 Bioenergy and sustainable development

Achieving sustainable development is the stated aim of most governments and international agencies; bioenergy could provide an option to achieve this in certain situations as well as meeting context-specific development goals if carefully planned and implemented. There are many cross-cutting drivers behind the promotion of bioenergy, but many barriers and opponents also exist. Key to any bioenergy policy is the identification of the country's strategic intent from its promotion, i.e. whether or not they intend to promote the sector; and the expected strategic benefits if they do. Legislation is then required to ensure that these benefits are achieved. The key issues which need to be incorporated in bioenergy policies include: regulatory frameworks and strategies to ensure that the poor are involved but protected, taking advantage of opportunities, lowering trade barriers to bioenergy if necessary and ensuring environmental sustainability. The development of a viable bioenergy sector requires a strong, supportive policy and a firm legal, regulatory and institutional framework to ensure that the contribution to socio-economic development is assured, whilst safeguarding rural livelihoods and the environment. A key limitation of bioenergy policy development globally is the lack of reliable data, as well as country level capacity to undertake the required background studies on feasibility and trade-offs. A lack of commitment to social and environmental concerns could also be problematic, and these might be overruled by national economic development imperatives.

7.2.1 *Social, economic and environmental aspects – managing trade-offs*

A commonly recurring theme throughout this thesis has been the idea that very often in policy and decision-making, trade-offs will have to be agreed upon. This is because it is rare to find absolute win-win solutions even when considering only two factors, as in the Sunderlin *et al*. (2005) classification in Chapter 6 (Table 6.1, page 131). Many developing countries are extremely underprepared due to the lack of legislation and regulation around renewable energy, thereby rendering them unable to adequately protect their natural resources and citizens' interests when foreign investors embark on large-scale biofuel exploitation. In addition, there are commonly indirect and cumulative impacts which need to be considered and often have not, or cannot, be easily predicted in advance. In this case, monitoring is again required. A participative monitoring strategy which has been agreed in advance is crucial because planning is only one phase of project implementation. The *Re-Impact* planning for sustainability framework (Figure 2.2, page 36) includes a monitoring component, and this needs to be a two way process. Monitoring has to be fed back into policy and decision-making in order to inform further planning, as well as mitigate problems in existing projects.

7.2.2 *The importance of context, and the role of research and monitoring*

Understanding the context is crucial in any planning procedure, and bioenergy is no exception. Sustainable development is by no means an easy outcome to achieve, or even define, for any situation. It can mean different things in different places to different people. The right option is context-specific and depends on the stakeholders in each case. Therefore, research and monitoring are vital instruments to ensure that, where implemented, bioenergy production is sustainable in practice. International action is required to improve data, models and controls which should in turn aid understanding and managing overall impacts and policy improvement. There are distinct opportunities for advances in research and monitoring approaches given the breadth of recent cross-cultural and even international experience with bioenergy production and consumption in different countries. The monitoring of impacts presents net importing countries with a key role in ensuring sustainable development of the global bioenergy industry (FAO, 2008). This is crucial because of a previously low focus on developing country priorities. The importance of trade and export as vehicles for evaluating developing country producers is obvious; the real challenge is ensuring sustainability of production in practise through sound research and monitoring strategy. Concerns have also been raised over the unreliability of monitoring only what is seen at the large scale, and allowing invested companies to be the monitors when independent actors would be more likely to remain objective (Daño, 2008).

The EU, through various funding streams, has financed global networks and initiatives concerned with identifying impacts from bioenergy production, evaluating existing and producing new methodologies for assessment and generating policy awareness both nationally and internationally. Two such examples are *Re-Impact* and the Competence Platform on Energy Crop and Agroforestry Systems for Arid and Semi-arid Ecosystems – Africa (COMPETE)[16]. Both of these projects involved cooperation of European and local partners, with work packages on wide-ranging aspects such as social, carbon, sustainability, policy, biodiversity and water resource outcomes of biofuel production. The coordination and focus of these initiatives has not been well managed, however, with disconnection between Departments and a poorly articulated institutional stance on bioenergy. The increasing interest from multiple Departments in the United Nations Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD) mechanism could help to streamline the Commission's efforts in this regard. The Global Bioenergy Partnership (GBEP) is a major player in coordinating bioenergy actions worldwide. They have included monitoring as part of their national guidelines and are also promoting dialogue for policy advances in several countries (GBEP, no date). The existence of such high level activities and their relevance to local impacts provides a frame for the discussion of scale in the next section.

7.2.3 *Scale issues*

Scale is a cross-cutting theme which deserves consideration here because of its relevance to all of the Chapters and issues raised throughout this thesis. In bioenergy projects, trade-off

[16] Co-funded by the European Commission in the 6th Framework Programme - Specific Measures in Support of International Cooperation, Contract Number: INCO-CT-2006-032448, project website: http://www.compete-bioafrica.net/index.html (last accessed on 21 September 2010).

decisions have to be made across both spatial scales (for example, in trading of feedstock and indirect land use change) and timescales (e.g., short term gains versus long term consequences). Without scaling up there is no benefit of implementing a pilot project. A planning procedure which takes into account cumulative and indirect impacts is needed for a sustainable pilot to be successfully replicated.

The importance of scale in project level impacts, as discussed above, leads to the crucial question of 'at what level should planning take place?' Dalal-Clayton *et al*. (2003) include an excellent discussion of top-down versus bottom-up approaches and the relative merits of each. What should be appreciated from the analysis conducted by Dalal-Clayton and colleagues (2003) is that some issues are better planned at regional/national scale as long as local level stakeholders are consulted and their concerns built into the process. Locally driven planning is ideal but requires very active civil society organisations that in turn usually need extensive capacity building and support to initiate activity (*ibid.*). Despite these difficulties the importance of a sufficient level of local, context-specific understanding, in terms of planning for successful bioenergy projects which meet wider policy objectives, cannot be emphasised enough. It is also important to note that this sort of planning, whether or not for bioenergy-based rural electrification, should not be rigid; there is no ideal system which is suited to all contexts, however a local scale aspect is a vital component of a successful approach (Modi *et al*., 2006, Woods *et al*., 2006b). On the whole, taking a strategic view, it seems as though securing national energy security ought to be at the forefront of national level planning in developing countries (Schoneveld, 2010), and so supporting projects providing localised energy security should be incorporated in higher level planning.

7.3 Methodological developments

In this section the contribution made by the approaches in this thesis to the mechanisms for driving sustainability (presented in Chapter 2) is reviewed.

7.3.1 *Existing mechanisms for driving sustainability*

Chapters 2 and 3 presented existing mechanisms for driving sustainability, and how they are applied to bioenergy projects, often specifically for liquid biofuels to reflect global market interest. As discussed in Chapter 2, these are regularly successful at meeting their own objectives, but are currently not involved in context-specific planning and implementation on the ground. Market-based approaches such as certification are most effective in an environment where other related laws and policy already exist, as to achieve national or global sustainability of liquid biofuels requires a range of local and global policy input. Some of the shortcomings of certification, such as a requirement for a broad countrywide rather than a project-based approach to sustainability, could be overcome if the majority of producers in a country participate. With such participation, issues such as land use change, protection of high conservation value areas and retention of sufficient land for food production could be dealt with at a broader, more efficient level. However, to achieve this requires strategic regional planning that goes beyond the planning boundary of individual projects. It is unlikely that any but the larger developing nation producers will be able to participate effectively as the costs of certification are high.

National level zoning covers only one aspect of biofuel sustainability, so other processes are also required. In most developing countries there are insufficient resources to carry out detailed site specific assessments across the country, though this would be desirable. Zoning is therefore a broad-based approach to ensure that biofuels are not grown in sensitive areas, but its use in no way negates the need for detailed site specific investigations in proposed development areas. A number of impact assessment methodologies already employed in other fields have been considered; none of them however are able to cover the whole spectrum of evaluation as seen in Figure 2.1 (page 34). This shows that impact assessments cannot be used as standalone tools and are instead each designed to fit certain purposes. The use of tools to integrate different assessment themes (i.e., social, environmental, economic) is vital, but must incorporate specific assessments looking at particular aspects, as important issues could be missed in a broad brush, generic approach.

7.3.2 *Planning for sustainability framework*

Bioenergy developments are outpacing normal planning and feasibility evaluation. Sustainability Planning is a framework that can be used expressly to prepare and design bioenergy development policy, programme or project with sustainability as the desired outcome, rather than merely to prevent or mitigate potential environmental impacts. This is important because bioenergy projects cannot be described well by high level (top-down), remote (spatially or in terms of political standing) and unsubstantiated (not ground truthed) descriptions. To enable coherent in-country planning for sustainable bioenergy it is proposed here that an overarching planning for sustainability framework is used. Such a framework was presented under the *Re-Impact* project (Figure 2.2, page 36), outputs from which incorporate a suite of associated, targeted (to one issue) methodologies to assess specific aspects. Sustainability planning is an integrative process which provides a framework for better, long lasting decision-making at all levels of development planning. The importance of a clearly defined goal has already been mentioned, and methodologies to enable this need to be situation-specific as well as integrative and flexible. The framework needs to include a monitoring strategy, which would be designed before implementation and involve the local stakeholders. The success of the project should be measured against the criteria set for achieving the sustainability goal – achieving the expected positive benefits and avoiding the negative impacts identified as unacceptable during planning. It is important to note that this type of approach has been developed primarily in Australia and South Africa, where political backing has provided an excellent platform for the philosophy to be applied. It is accepted that it may not be feasible to apply the framework in full in all countries; Haywood *et al*. (2010) report difficulties that would be expected in China, India and Uganda but remain optimistic that the overall principles would be generically applicable if suitable institutional ownership of the whole process could be assured. In particular, the need to improve the understanding of social, economic and environmental aspects prior to policy and decision-making is key.

7.3.3 *Assessing social impacts and stakeholder dynamics in bioenergy projects*

There is a clearly articulated need for approaches which are locally focused and include stakeholders at all levels in decision-making. This has been the objective of the methodological developments described in this thesis. They are designed to facilitate the inclusion of socio-economic issues and stakeholder dynamics in planning for sustainable bioenergy feedstock production, based on the case studies of India and Uganda. Stakeholders are impacted by projects, but also have an influence (either positive or negative) on their likelihood of long term success. With any individual project there are usually multiple stakeholders, and these approaches help to assess what the impacts of particular projects on different groups are likely to be (and whether they would be expected to meet developmental objectives).

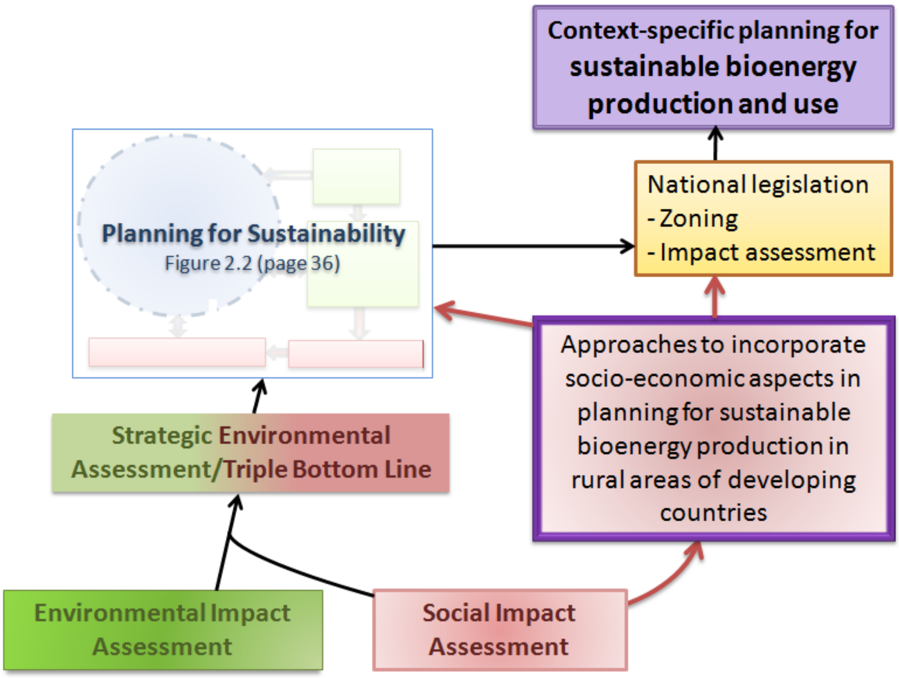
The approach to assessing social impacts of bioenergy feedstock production models presented in Chapter 3 enables an understanding of the wider context within which specific bioenergy projects have been formulated. There is certainly a need to incorporate social issues into planning and be more strategic, coherent and participatory in decision-making. The approach presented, a variant on traditional SIA, was developed following over ten weeks of field research in India. It was found not to require significant resources to complete, whilst nonetheless being robust. Having completed the fieldwork and analysis in India, generated large amounts of data, and spoken to multiple stakeholders, it became clear that considerable efforts were required to analyse the information. The intricacy of stakeholder dynamics and the multiple models of feedstock production that existed (or could exist) would make for complex decision-making and the concern of generalising about bioenergy production when in fact different models would have different social impacts. It also became apparent that enabling stakeholders to get their roles, requirements and risks (their dynamics) understood before planning takes place, and ensuring they are adequately represented in the process, is a major contribution towards a successful outcome. However, achieving this in practice was found to be daunting and not explicitly defined. This discovery led to the development of a second methodology.

A structured approach to assessing and understanding stakeholder dynamics in bioenergy projects, developed and trialled during field work in the Indian State of Chhattisgarh, was described in Chapter 4. In Chapter 5 the approach has been followed for a different bioenergy production situation, primarily woody biomass as a feedstock for gasification in Uganda, on models which are, for the most part, only in conceptual or planning phases. The method has been found to be robust, in that it has allowed for a structured interrogation of both contexts despite there being many differences between them. The differences led to some alteration in the detail of the method to make it more flexible and widely applicable (see Box 7.1 for the final, widely applicable approach).

1) **Context analysis**: identification of stakeholders, their role in feedstock production, their expectations from it, and any assumptions therein;
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.

Box 7.1: the structured approach to understanding socio-economic impacts and stakeholder dynamics in bioenergy projects, designed around the Indian case study.

This adaptability in the method is seen to be a key feature which will be crucial for future applications, and the need for an iterative, context-specific approach to the analysis of each situation is clear. This is not merely a tick box or 'recipe-book' method for stakeholder analysis; rather it provides a logical structure and simple tools to facilitate a deeper understanding of the stakeholder dynamics in individual situations. These can then be used to inform other processes such as multi-stakeholder consultation (MSC) and planning for sustainability. Far from being a constraint, it has been suggested that creating an enabling environment through rural planning is more likely to result in sustainable development than a 'one-size-fits-all' approach, and this holds true here (Dalal-Clayton *et al.*, 2003). Figure 7.1 shows how the approaches that were developed in this thesis, described in the paragraph above, fit into the broader relationship of assessment methodologies introduced in Figure 2.3 (page 37). The approaches build on traditional SIA and are expected to feed into national legislation as tools within a planning for sustainability framework. The intention is for these approaches to contribute towards improving context-specific planning for sustainable bioenergy production and use. Certification and other market-based mechanisms exist alongside. These work from a more global, top-down position to improve the sustainability of internationally-traded bioenergy, predominantly liquid biofuels.



The approaches developed in this thesis are represented by the purple edged box

Figure 7.1: The relationship between the approaches developed in this thesis and existing mechanisms for driving sustainability in development projects from Figure 2.3, page 37.

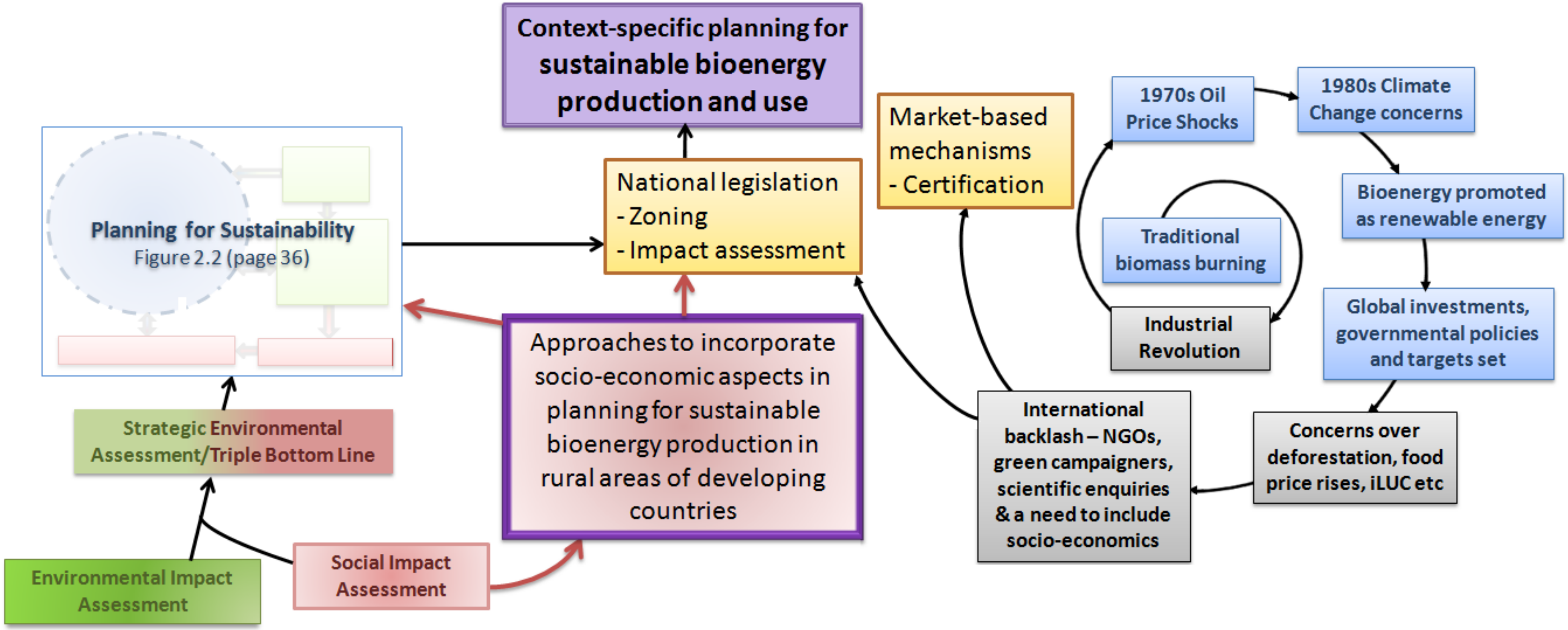
In this Chapter, the results from case studies and the approaches that have been developed in the course of the research have been reviewed. This has enabled assessment as to where and how this study fits the global debates on the production and use of bioenergy and sustainable development (particularly for rural areas of developing countries). The following Chapter will draw conclusions on this aspect particularly, evaluating the contribution of the approaches and case study information to global debates on bioenergy and impact assessment.

Chapter 8.

Reflections and Conclusions

Bioenergy development is now at a stage where there is a separation between global production and trade, which is governed by market forces, and community-based projects focused on improving local energy provision. This is not a clean division, however, and the analysis undertaken in this thesis has shown that there are a number of production models which span both disciplines. It needs to be recognised that, whatever the market use or drivers behind purchasing may be, projects have local implications and must meet the requirements of local communities. This cannot be guaranteed solely using market-based approaches. Planning these projects needs to be context-specific, ideally with sustainability as the goal. Criteria based on sound evidence, with research and monitoring in place to avoid negative consequences whilst achieving the expected benefits, need to be set. The planning for sustainability approach produced under the *Re-Impact* project (see Figure 8.2) provides a practical framework for this, and the approaches developed in this thesis contribute towards the successful incorporation of socio-economic issues, and an understanding of stakeholder dynamics, in the process.

A key message from Chapter 1, regarding the spiralling popularity of bioenergy production and use, was that modern forms of bioenergy have been increasingly promoted worldwide and, in recent years, become the subject of widespread criticisms for multiple, unforeseen negative impacts. This is a rather simplistic view of the situation, which in reality is highly context-specific as demonstrated by the case studies of India and Uganda in Chapters 3-6. As a result of the intense global debates over the sustainability of bioenergy production and use, a number of mechanisms to ensure that internationally-traded feedstock or fuel is deemed sustainable according to set criteria have been proposed, as discussed in Chapter 2. However, many models of feedstock production exist outside of the influence of such measures and therefore context-specific approaches are needed if bioenergy production in developing countries is to be sustainable, particularly those producing for internal consumption such as India. The merging of these fields of interest, namely (i) the requirement for bioenergy feedstock production models which are specifically designed to meet the sustainability goal of local stakeholders and (ii) the need to improve the 'integratedness' (section 2.1.2(d), page 31) of different aspects whilst retaining the 'comprehensiveness' and 'strategicness' of impact assessment in context-specific planning, has been a major focus of this thesis, represented by Figure 8.1.



The left hand side of the diagram relates to improvements made in planning and assessment of projects to improve sustainability, the right hand side represents the spiral of bioenergy popularity. The boxes in the centre represent how the two areas combine, and in particular the purple edged box shows how my approaches, which straddle the two disciplines, contribute to improving the sustainability of bioenergy projects through the incorporation of socio-economic aspects.

Figure 8.1: The contribution of my thesis towards the inclusion of socio-economic considerations in planning for sustainable bioenergy production in rural areas of developing countries. Author's own.

8.1 Recap of research aim and objectives

The aim of this thesis has been to provide approaches to incorporate socio-economic aspects in planning for sustainable bioenergy feedstock production in rural areas of developing countries, taking India and Uganda as representative case studies. This has been achieved through meeting three objectives:

[A] Methodology assessment and development – building on traditional Social Impact Assessment (SIA) and case study information, straightforward yet robust and context-specific methodologies have been designed specifically for identifying social impacts of bioenergy projects and understanding stakeholder dynamics.

[B] Through case study experiences in (i) India and (ii) Uganda – existing and proposed examples of bioenergy feedstock production (referred to as models) were identified and their individual contributions and potential contributions to national and local objectives, particularly in terms of socio-economic outcomes, analysed in detail. Typologies were created for production models in both countries, and compared.

[C] The wider applicability of the approaches and analysis presented has been evaluated in order to assess whether bioenergy production can result in sustainable socio-economic development in rural areas of developing countries, and how future planning could be targeted towards better achieving this.

The key assumption of the thesis was: there are certain situations in which bioenergy production and use could provide a genuine opportunity for sustainable rural development in developing countries, (i) meeting the needs and requirements of stakeholders, (ii) reducing environmental degradation and (iii) potentially bridging the gap between existing and more sophisticated energy supply technologies. Based on the assessment of the Anaka case in Chapter 6, selected following the improved understanding of socio-economic aspects and stakeholder dynamics in a range of projects in India and Uganda, it has been found to be possible to incorporate these three components into an individual case. Therefore the key assumption remains valid, insofar as *a priori* evaluation of multiple aspects suggests that the model would meet the stakeholders' requirements, reduce environmental degradation (in terms of avoided deforestation, negligible water resource impact, positive carbon balance), and provide electricity at least in the short term until alternatives become available. Ongoing monitoring and assessment of impacts would be required if the model were implemented in order to validate these results and conclusion. The same model would not necessarily meet these criteria in other locations, each project must be carefully adapted to local conditions and expectations.

This Chapter will first reflect on the benefits afforded through working within the *Re-Impact* project, despite it being a fundamentally different entity with separate objectives. The conclusions drawn throughout, in relation to objectives [A] to [C], are then summarised. An evaluation of how successful the thesis has been in achieving its aim, and assessment of the validity of the key assumption, are presented. Finally, some future applications of my approaches and challenges for further research will conclude the study.

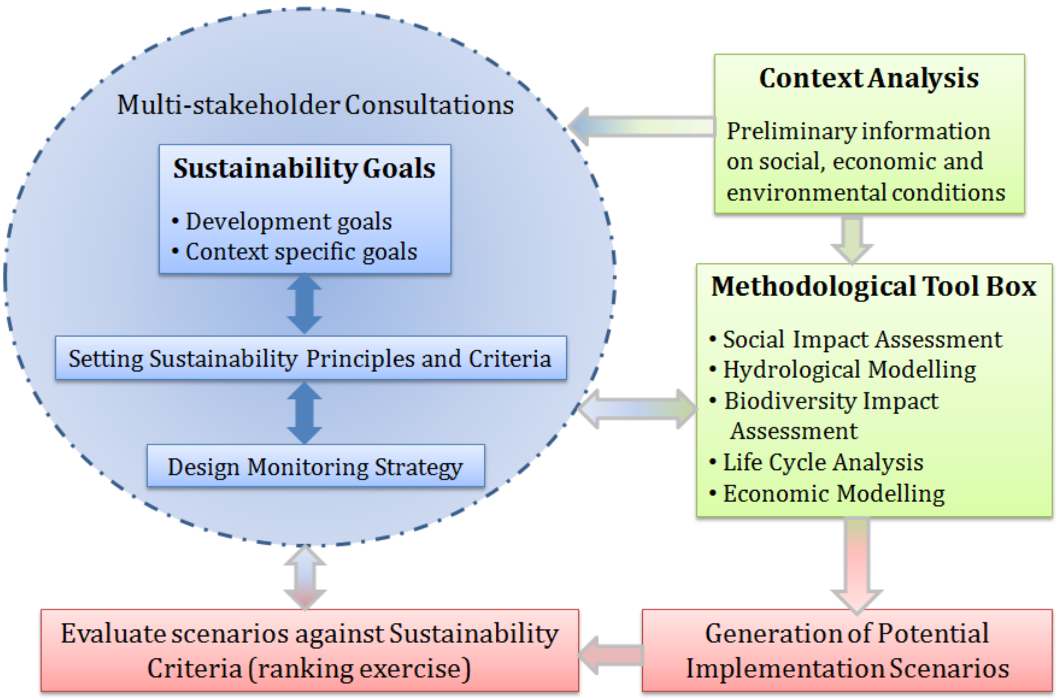
8.2 Working within *Re-Impact*

In assessing this thesis in its wider context, the contribution of the *Re-Impact* project to my research, and *vice versa*, needs to be evaluated. Involvement in this interdisciplinary, international initiative provided valuable access to stakeholders and field sites in both countries. Accessing these outside of the project would have been time- and resource-consuming, though certainly not impossible. The existing network and logistical support available through *Re-Impact* afforded me more field-based time and, as a result, a greater opportunity to develop my unique research focus than perhaps would have been otherwise achievable. Though being constrained to a certain extent by the agenda of the wider project, on each visit I was able to allocate sufficient additional time to pursue my own, separate, research objectives. This included extensive discussions of my findings and approaches with in-country partners and international experts associated with the project. Again, while this would have been achievable, it would have been logistically considerably more difficult without my involvement in *Re-Impact*.

On a practical level, I selected case studies and sites from the project which would enable me to explore my separate, academically-robust objectives. Sharing case studies meant that some of the same research questions were explored in *Re-Impact*, but my independent research aim and development of unique approaches mean that these questions have been dealt with differently in this thesis compared to the project. Whilst *Re-Impact* provided an excellent context and platform for my study, the two are fundamentally separate entities with distinct objectives, academic and practical findings and conclusions. Nonetheless, they are complementary and mutually beneficial. My research has added significantly to *Re-Impact* because of the publication of my findings in association with the project, which were originally outside the project scope. My individual input to collaborative work, which I led but was carried out under *Re-Impact,* has been highlighted at the beginning of Chapters 2, 3 and 6.

8.3 Methodology assessment and development, thesis objective [A]

Chapters 2 to 5 have documented the meeting of thesis objective [A] and this was further discussed in Chapter 7. A range of existing methodologies, which could be employed in driving sustainability in bioenergy feedstock production and use, was outlined in Chapters 2 and 3. From this it was concluded that a gap existed for a context-specific approach, involving stakeholders at the planning phase, to identify potential social impacts of bioenergy feedstock production. The social impact assessment (SIA) methodology aimed particularly at bioenergy projects was designed to fill this gap. The testing of the two-step methodology in India was reported in Chapter 3. The approach is straightforward enough to be completed by relative non-experts and interpreted by policy makers, but sufficiently robust to provide an understanding of potential direct, indirect and cumulative impacts, both positive and negative. It is intended that this be used as a tool within a sustainability planning framework, as presented in Figure 8.2.



Blue section: stakeholder participation (feeds into all other aspects), green: expert-led procedures (need direction from stakeholders), red: formulation and evaluation of scenarios (using tool box and stakeholders' sustainability principles and criteria)

Figure 8.2: Re-Impact sustainability planning framework for bioenergy projects (repeat of Figure 2.2, page 36).

Through discussion with sustainability planning experts from *Re-Impact*, another gap was identified in relation to planning for sustainability and SIA. This gap concerned the equal inclusion of stakeholders, and getting agreement on a goal and principles for sustainability in a particular situation. Appreciation of the inherent difficulties in the required multi-stakeholder consultation (MSC) led to the development of the structured approach to understanding stakeholder dynamics in bioenergy projects. The approach was developed for biodiesel feedstock production in the Indian State of Chhattisgarh, and then its flexibility and replicability were tested on models of (predominantly) woody biomass for gasification in Uganda. It is intended that this would be carried out in advance to assist facilitators of MSC to gain an understanding of the stakeholder dynamics and prepare the involved groups for their interaction with the process. The approach built on background (desk-based) knowledge and initial stakeholder contacts with simple, replicable techniques to broaden the comprehension gathered from SIA. The additional insights gained from this approach enabled context-specific typologies of bioenergy feedstock production models to be drawn up for the case studies. The typologies are seen to be an excellent way for policy makers to appreciate the significant difference in impacts that can exist between types, and understand which particular benefits are expected from each.

It is expected that successful application of the proposed methodologies in rural areas of developing countries would help to bring socio-economic considerations into local planning for sustainable bioenergy feedstock production. This means that, where conditions are appropriate for production, the planning and implementation of projects would be more participatory and provide optimum benefits for the full range of stakeholders. A variety of models could be implemented to achieve this, as it is unlikely that one can individually meet all objectives. Of course, the outcome may certainly be that the required objectives cannot be met through bioenergy, or that there needs to be a variety of energy supply initiatives. Despite this risk, a very relevant and important role of the approaches developed remains; identifying where projects do or do not meet local socio-economic needs in order to support planning and decision-making.

The outcomes, including typologies, from both case studies contributed towards the comprehensive analysis for objective [B] but also demonstrated the positive contribution of the approach in meeting objective [A].

8.4 Comprehensive case study analysis, thesis objective [B]

Chapters 3 to 6 addressed thesis objective [B], and findings from this activity were further discussed in Chapter 7. Existing and proposed bioenergy feedstock models were identified in the

Indian State of Chhattisgarh and across Uganda. Comprehensive analysis of their contribution to national and local socio-economic objectives has been completed using the specially designed approaches. The typologies of production models have been created and compared.

In India the need to include marginal farmers and landless poor, and provide them with opportunities to diversify their livelihoods, is a national priority. This is one of the principles of the Biofuels Policy. Achieving this seems possible predominantly where these groups are involved explicitly, so that they have both power (in terms of taking decisions) and a controlled level of risk (of failure). Without being included it is unlikely that these groups will directly benefit from bioenergy feedstock production, although there may be alternative reasons behind promoting different models. Because the provision of livelihood diversity opportunities is identified to be a driver of biofuel production and a principle identified for sustainable development, it is important that these groups are included. In order to reduce the level of risk for individuals, steps must be taken to ensure that favourable finance options, high quality agronomic support and up to date research are available. In order to better understand the sustainability of a particular model, a comprehensive Sustainability Assessment covering environmental issues as well as purely social and economic would be required prior to implementation.

In Uganda there is no specific Bioenergy Policy, but biomass is included as one of a suite of options contributing towards the renewable energy policy. If the government is to meet its goal of eradicating poverty through increasing access to modern, affordable and reliable energy services then decentralised supplies in remote rural areas will be required, even if only as a short term solution before national grid improvements are made. Energy availability and security are major barriers to sustainable development in the country. There is also a need, articulated by stakeholders from government, NGOs, the cooperative and farmers, for the rural landless poor (colloquially termed ‘idlers’) to have livelihood generating activities available to them. This group are particularly vulnerable and in some cases are contributing to increased crime rates in rural areas because of a lack of employment prospects. According to various stakeholders, without generating opportunities for this group it would be impossible to eradicate poverty. In the same way as in India, the landless poor need to be involved in a production model to really achieve socio-economic benefits. Again, the level of risks these vulnerable individuals are exposed to needs to be managed by donors, the government or NGOs, whoever is responsible for the planning and implementation of contributing projects and policies. Chapter 6 gave an in-depth assessment of a production model which was identified in

Chapter 5 as having a potentially positive socio-economic contribution towards meeting developmental objectives.

In both India and Uganda, end use and market factors were found to be important in classifying models as well as understanding the potential impacts expected. If domestic supply is a major driver of a bioenergy policy (as is the case in both countries), then producing feedstock for export is not going to meet those needs directly. Whilst there may be multiple drivers behind certain policies, they need to be properly understood and the reasons for promoting a particular model articulated in order to avoid unintended negative consequences, or the further marginalisation of particular vulnerable stakeholder groups.

8.5 Evaluating bioenergy and socio-economic development, thesis objective [C]

The Chapters of this thesis have all contributed towards contextualising the approaches developed, though in particular the wider applicability was introduced in Chapter 2 and explored in depth in Chapter 7. The ensuing discussion has clearly played a part in deciding whether bioenergy production can result in sustainable socio-economic development in rural areas of developing countries, and how future planning could be targeted towards achieving this. The production and use of bioenergy does **not** guarantee sustainable development, however it can contribute to a sustainable range of options where the context is appropriate.

Policy decisions in developing countries need to be based on identification of their individual developmental needs, and stakeholders from all levels should be invited to participate in articulating those needs. Policy making should ideally be participatory, transparent and collaborative. In India there is already a Freedom of Information Act, as well as very active local democracy. National policies are consulted on but, as in the case of the Biofuels Policy, changes are not always brought in the final documents. In addition, States are often autonomously left to implement policies however they see fit. It is suggested that implementing agencies (such as those referred to in footnote 3 (page 15) adopt a strategy such as the *Re-Impact* planning for sustainability framework in implementing bioenergy initiatives, including my approaches for including socio-economic impacts and understanding stakeholder dynamics. This will enable them to be more strategic in deciding which production models, if any, will meet their particular development requirements prior to implementation.

There is scope for developing countries to provide feedstock, or processed oil, to international markets. This should only happen where safeguards are in place to ensure local benefits and retained access to sufficient resources. Account must be taken of indirect or cumulative social and physical impacts as well as direct ones. Local options for value-addition, such as processing of feedstock, should be considered in order to retain social benefits. International marketing and certification schemes should support and take national legislation and decisions into account to ensure that feedstock export is the best option locally. Supply should not rely overly on one production model and the factors constraining other models should be identified and minimised. In general, to meet local energy needs, it makes sense to set up decentralised units to provide energy *in situ*. This type of model also seems to provide more opportunities for the marginalised and more vulnerable stakeholder groups. It can be used alongside NGO/donor/government funded programmes for rural development/industrial support as shown in the case studies, and represents a good way to begin implementation – with a well funded pilot to demonstrate possibilities and troubleshoot problems (to reduce risks).

It can be concluded that, where planned and implemented in a participatory and environmentally-aware manner, considerable scope exists for bioenergy projects to result in socio-economic benefits; particularly for rural areas. There need to be opportunities for the marginal farmers and landless poor in order for real socio-economic development to take place, particularly in remote locations. The focus should not just be on the export of raw materials (although this can undoubtedly bring tangible national benefits), but also on projects where locals have ownership and there is a high probability of community value-addition. There are many potential negative indirect or cumulative impacts which need to be identified, accounted for, minimised or eradicated if possible, and then balanced to assess whether a project is suitable for a particular context. Ideally, all of this should happen in advance of the design and planning phases and so before the predicted impacts actually occur. Flexibility in these phases means that the end results are likely to be more beneficial. Having well-funded, working pilot projects is likely to reduce the risk for vulnerable groups.

8.6 Achieving the thesis aim and key messages

I have developed two approaches which would help policy makers to incorporate socio-economic aspects in planning for sustainable bioenergy feedstock production in rural areas of developing countries. These approaches have been successfully applied to the representative case studies of India and Uganda. They are robust, flexible and provide comparable results, therefore meeting the thesis aim. In achieving this I found that the three components of the key assumption remain valid. Therefore it can be concluded that there are certain situations in which bioenergy production and use could provide a genuine opportunity for sustainable rural development in developing countries by (i) meeting the needs and requirements of stakeholders, (ii) reducing environmental degradation and (iii) potentially bridging the gap between existing and more sophisticated energy supply technologies. Other key messages from my thesis are summarised in Table 8.1.

Table 8.1: Key messages from this thesis in relation to its objectives.

Objectives		Key messages
[A] Methodology Assessment and Development	Gaps	Need for a context-specific approach, involving stakeholders at the planning phase, to identify potential social impacts of bioenergy feedstock production.
		Equal inclusion of stakeholders, and getting agreement on a goal and principles for sustainability in a particular situation, is hard.
	Solutions	Assessment of social impacts and effects in bioenergy projects.
		Structured approach to understanding stakeholder dynamics in bioenergy.
		Bring socio-economic considerations into local planning for sustainable bioenergy feedstock production.
[B] Case Studies	India	Context-specific, comparable typologies of bioenergy feedstock production models for the case studies were produced.
		Need to include marginal farmers and landless poor in planning, and provide them with opportunities to diversify their livelihoods.
		To reduce the level of risk on the individuals, steps must be taken to ensure that favourable finance options, high quality agronomic support and up to date research are available.
	Uganda	Meeting the goal of eradicating poverty through increasing access to modern, affordable, reliable energy services requires decentralised supplies in remote rural areas.
		There is a need for the rural landless poor (or 'idlers') to have livelihood generating activities available to them, without which it would be impossible to eradicate poverty.
		Landless poor need to be involved (power and risk) in a production model to achieve socio-economic benefits. Risk needs to be managed at a higher institutional level, as in India.
[C] Wider Applicability	Bioenergy use does **not** guarantee sustainable development, but can be part of a sustainable solution. Having well-funded, working pilot projects managed by NGO/ government is likely to reduce the risk for vulnerable groups.	
	End use and market factors are important in classifying models, as well as understanding the potential impacts expected.	
	Supply should not rely overly on one production model and factors constraining other models should be identified and minimised.	
	If domestic supply is a major policy driver, then solely producing feedstock for export is unsustainable. Need projects with local ownership and community value-addition.	
	International certification schemes should support and take into account national legislation to ensure that feedstock export is the best option locally.	
	Policy decisions in developing countries should be based on identification of their individual developmental needs, and stakeholders from all levels should be invited to participate in articulating those needs.	

Local, context-specific planning and assessment are essential if sustainable rural development in developing countries is to be achieved through bioenergy feedstock production, and should include stakeholder participation (with a focus on full collaboration as opposed to one-way information sharing). I do not believe that bioenergy alone will solve either the global energy, environmental degradation or poverty alleviation crises discussed in Chapter 1, but in certain situations where the context is favourable and local stakeholders are driving (or at least have decision-making power in) the planning process, I have found that modern bioenergy projects can be sustainable (according to collaborative definition) and result in improved socio-economic prospects for targeted groups.

8.7 Future applications and challenges for further research

It has been found through this research that even just defining sustainability in bioenergy feedstock production is extremely site-specific and relates directly to the local community. There are, quite rightly, global concerns relating to international issues of sustainability such as climate change, biodiversity and energy availability, all of which feed into discussions around bioenergy. Governments and policy makers in developing countries have been rushing to keep up with international demand and provide legislation or funding for projects. However, it must be understood that, without adequate, robust planning and assessment which is either locally-driven or involves the relevant communities and stakeholders, there is potential for negative consequences across spatial and temporal scales. Despite this potential, there are still situations in which bioenergy feedstock production can provide socio-economic and other benefits as this thesis has demonstrated. Designing projects to achieve these benefits requires integrated thinking and a sound planning process. Decision-making needs to be evidence-based and participatory, including the defining of an overall, mutually-agreed sustainability goal for a location through facilitated MSC. This thesis has focused primarily on socio-economic aspects and stakeholder dynamics, rather than considering biophysical issues at a global scale. The need for integrated planning and monitoring has been highlighted, and of course improving the agronomic understanding of individual crops is also necessary. These are, quite rightly, areas of ongoing global debate and research. Due to this extensive arena of expertise and debate, I will focus here on a couple of future challenges that I believe to be particularly pertinent and relevant, following on from my own research.

Further testing of the approaches developed in this thesis with policy makers and project developers would be beneficial to streamline and optimise results. This could be widened to other countries, but should also examine the urban dimension of bioenergy production and use in developing countries. The use of waste and by-products is more likely in urban areas, and so it would be expected that a typology of these production models would look quite different. Provision of energy in urban areas is a significant challenge, and it would be interesting to apply the approaches developed here to investigate whether or not bioenergy could be used to improve socio-economic conditions in poor urban locations.

There are linked areas of research which lead on from the conclusions provided in this Chapter. Many of these have been touched upon throughout the thesis, but constitute distinct research agenda in themselves which could not be satisfied fully within this study. I will articulate here three which I believe to be especially significant, in no particular order.

- The ongoing role and direction of donor agendas and NGO focus in Uganda and other developing countries is a prominent research area. There are many international and even inter-continental lessons to be learned because of countries being in different phases of donor cooperation. Understanding and articulating exit strategies is already the subject of existing research programmes; the impact of a gradual reduction in donor influence on policy implementation and development planning should be incorporated. This is something which is receiving significant attention, not least from donor agencies themselves. From my research I would add that ensuring planning procedures fully incorporate understanding of socio-economic issues and stakeholder dynamics, and are participative, sustainability-focused, and context-specific, is vital. Robust research and effective monitoring should always be built into implementation strategies.
- The reduction of deforestation (and population pressure on resources in developing countries) is a major concern. This has two roots: (i) protecting and preserving the natural resource base and (ii) reducing poverty. The second is relevant particularly in rural areas where people rely on woodfuel for heating but the opportunity cost of collecting and using this fuel and impacts on health (both of which mainly effect women and children) make it very difficult to pursue other activities for income generation and personal development. Strategies for reducing deforestation pressure (such as the globally-debated REDD and REDD+ mechanisms, see Parker *et al*., 2008) have wide ranging implications, but implementing these effectively is often problematic in practice. From my research, the most successful approaches seem to be those where communities are involved as stakeholders in deciding how best to preserve the forest resource, whilst not being excluded or prohibited from generating livelihood opportunities. Bioenergy projects are

only one such way to achieve this, and may not be the most sustainable option in any particular case.

- The efficiency and viability of using liquid biofuels to either blend with existing transport infrastructure, or indeed replace fossil fuels, is a highly contentious topic of global significance. Research, both public and by private companies, is being undertaken but as yet there is little consensus. There are numerous aspects which require scientifically-robust confirmation, including: (i) the performance of liquid biofuels in existing engines in terms of efficiency, compatibility with current engines, chemical properties etc; (ii) the true economic competitiveness of liquid biofuels as compared to fossil fuels; (iii) the reality of producing sufficient quantities of biofuel to reduce the burden on petroleum products and the indirect land use implications this would have. Without addressing these issues, fully understanding the socio-economic consequences of individual projects for the stakeholders is a significant challenge. Innovative technologies such as next generation biofuels from, e.g., algae are thought to have the potential to produce much greater quantities of fuel more efficiently and with less risk of indirect land use change, but the commercial viability of such options remains to be robustly established.

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Appendix 1: Indian Focus Groups

Focus groups (see Pini, 2002; Robson, 2002) were used in the Indian case study in order to get the participation of a wider group of villagers and include people who would not have been as comfortable with individual interviews. It also enabled the use of participatory tools as discussed in the Durham University Centre for Social Justice and Community Action 'collaborating in research for social justice' group, of which I am a member.

In Ranidehra and Narayanpal Villages, the focus group events were ‘advertised’ in advance through the local women’s Self Help Groups (SHG) and, in Ranidehra, the Village Energy Committee (VEC). Wide participation was invited (“anyone is welcome”) and there were between 12 and 16 participants at each event. With hindsight this was a useful number because each attendee was able to get an opportunity to input, without the sessions being overly cumbersome to facilitate. It has been reported that figures of 8-12 are thought to be most suitable (Stewart and Shamdasani, 1990), however everyone present was able to participate and so we did not have any difficulties. The group sessions took place in the village meeting areas, in Ranidehra the women’s SHG and the VEC shared an indoor meeting area attached to the Jatropha oil power plant, in Narayanpal we sat outside infront of the village leader’s residence.

At the start of each session I spoke a few brief introductory words in Hindi (in Narayanpal these had to be translated to the local dialect) and then the team from Winrock India outlined the idea of the community resource mapping exercise. Pens and paper were provided, and the participants were asked to draw a map of their community resources. This could include any resources they wanted to identify, but particularly those relating to biofuel feedstock production. Both communities drew water supplies, fuelwood areas, agricultural sites, Jatropha plantations and their accommodation.

The mapping stimulated a lot of discussion amongst the participants, which was translated for me to note down. Interestingly, in both cases the male “leader” of the village started the drawing, and increasingly the other participants would begin to input verbally with comments and suggestions. In general the women would take a back seat to begin with but came forwards when the initial maps were finished with comments (particularly around management of the different areas, access routes to the fields and plantations during different seasons, length of time required for different activities, etc.). This added a whole layer of understanding to the exercise which would have been entirely lost without their participation, because it became obvious that they had a greater practical understanding of the situation. Through questioning it was observed, in both villages, that the majority of the practical labour was completed by the women and therefore they could provide an additional layer of knowledge and input to the maps.

I was involved in writing notes during both group sessions, but do have some photographs from colleagues from the Ranidehra event to show the type of interaction and output that was produced. With hindsight it would have been extremely useful to designate a photographer to take many more pictures as the time passed to show the changes in body language, level of participation and group dynamics (not to mention the finished maps). The photographs that were taken are included on the following page. They are all from Arvind Reddy of Winrock International India, with his permission to reproduce them here, from the Ranidehra focus group. The remaining materials (paper and pens) were donated to the children in the village to use in their local schooling sessions.