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Understanding Sustainable Biofuel Development: a sub-Saharan Africa Perspective

Abstract

Considerable effort has been put into developing sustainability assessment frameworks for biofuel production in developing countries. Nevertheless, their successful implementation remains problematic in sub-Saharan Africa. To address this challenge in this paper, through a thorough examination of academic and grey literature, repeatedly occurring sustainability aspects/issues were drawn from internationally recognised biofuel assessment frameworks. Theoretical framings that corresponded with the interlinking socio-environmental-economic qualities and issues for achieving sustainability through ethical implementation conformity (political ecology, development economics, social capital and institutional economics) were then used to inform development of a conceptual framework that could guide biofuel project implementation in sub-Saharan Africa to address complex sustainability issues. The supporting theories pursue sustainable development through, amongst others, an emphasis on the more equitable dispersal of costs and benefits through transparent networking in rural settings and the integration of contrasting viewpoints of diverse stakeholders in emerging economies.

Keywords: developing countries; sustainability; local communities; livelihoods; equality; sustainable biofuel development; Africa; marginalisation; social, economic; environment.

1. Introduction

Access to affordable energy is vital for a nation's development, and a factor that divides populations of developed nations from those in developing nations (Davidson, 2011). At the same time, many countries have realised the necessity to diversify energy supplies external to the influences of Organisation of Petroleum Exporting Countries (OPEC) (McMichael, 2009; Sinclair, 2009). Fossil fuels emit greenhouse gases (GHGs), are uncertain in their supply as well as being a finite resource. Especially since the early 1990s (IPCC, 1995), these considerations have, together, driven the pursuit of alternative and renewable energy sources. Metzcalf and Hedin (2007) explain that socially and environmentally sustainable biofuel production has been explored as one possible solution to the energy challenge. While some experts argue that in many developing countries, biofuels provide an opportunity to address poverty and energy issues (Johnson et al. 2009), others note that challenges such as food security could be exacerbated by the expansion of biofuel production (Drexler 2008).

Von Braun and Meizen-Dick (2009) are concerned that without efficiently and effectively implementing biofuel projects within the guidelines of a sustainability assessment framework, it is unlikely that acceptable sustainability standards will be realised; and energy-poor people are unlikely to benefit from energy developments in their countries (Mandil and Shihab-Eldin, 2010). Indeed, in many developing countries, the situation is complicated further by poor governance (leading to problems such as skills shortages, desertification, poverty and corruption). While the African continent experiences these issues, it nevertheless has significant land (Hoogwijk et al., 2005), a positive feature that presents options for attending to energy needs and food scarcity while also addressing poverty.

As biofuel development is expected to mainly take place in countries vulnerable to socio-economic changes, their biodiversity and populations have most at stake (Lima and Gupta 2009). With the focus on developing nations, if the three central socio-economic issues of poverty, inequality and unemployment are not enhanced in some way, it would be curious to call an investment 'development' (Bass, 2011). Elgahali et al. (2007) declare that if the energy divide is to be bridged, there is a need for approaches that are able to determine and unite the different pursuits and views of diverse stakeholder groups, and not just those of the individual investors. Innovative schemes that involve both the investor and local communities, in which risks and rewards are shared, are likely to have the best chance of long-term sustainable impetus. Elgahali et al. (2007) advise that biofuel project assessments need to encircle all affected stakeholders' concerns, understand and represent diverse scales of power that play out in biofuel systems, identifying knowledge gaps for the successful implementation of sustainable biofuel development.

A set of conditions within which to develop agro-biofuel projects that embrace local sustainability (i.e. long-term views, benefitting today and designing for enhanced future welfare), can help to foster sustained project viability and lessen ecological and social disturbance (Porder et al., 2009). A conceptual framework, derived through an examination of theoretical knowledge and empirical studies, is needed to better explain community marginalisation and disparities in costs and benefits owing to desires to access and control resources (Forsyth, 2008). Such a framework can be used to guide biofuel projects towards sustainability. Likewise, it can help inform the elaboration of processes that tackle head-on some of the difficulties associated with integrating the contrasting viewpoints of diverse stakeholders.

1.1 Sustainability, Policy and Principles

Sustainability, described by Hecht (2007 p.1) as "to keep in existence", is often associated with three pillars – environment, economic and social. These need to exist in harmony for the total system to be sustainable (Hecht, 2007), although they are complicated by their complex relationships and interactions with uneven levels of political and economic power across varying temporal and spatial scales**.** Driven largely by political and institutional organisations and activities across different scales, many policies have been developed to guide the quest towards sustainability (Diaz-Chavez, 2011). Morrissey et al. (2012) affirm that although policy initiatives at local, regional, national and international levels are important in moving towards sustainability, project specific approaches are equally significant. They remark that despite this, existing integrated approaches for addressing sustainability principles are distinctly weak in managing micro-level implementation at a project level. Although, sustainability indicators (typically encased in assessment frameworks) can be useful to inform policy development (Kitzes et al., 2009), the integration of

the three conventional pillars of sustainability is most often driven by policy derived through macro, meso and micro politics (Lozano, 2009).

Hawkins (2011) believes that we are not separate from nature; all systems are connected; humans are intrinsically linked with nature; without exception, living systems are failing. In discussing implementation approaches Hawkins (2011) stresses that sustainability is implied, not as a constraint, but as an opportunity to enhance local livelihoods and natural capital. This is taken from the view of 'strong sustainability', which perceives natural capital as providing some utilities that are not substitutable by man-made capital (Cabeza, 1996; Dietz and Neumayer, 2007). These utilities, labeled 'critical natural capital', are emphasised by describing sustainability as leaving future generations a store of natural capital larger than or equal to the one enjoyed by the current generation. That is, sustainability is viewed in terms of non-decreasing natural capital (Cabeza, 1996; Dietz and Neumayer, 2007).

Counter to this concept, 'weak sustainability' regards sustainability as equivalent to a non-decreasing overall capital store. As no restrictions are introduced on the degree of substitutability between man-made and natural capital, no special treatment is specified to natural capital (Cabeza, 1996; Morrissey et al., 2012). This paper characterises sustainability through strong sustainability as depicted in Dietz and Neumayer (2007); Henderson (1999 p. 102); Williams and Millington (2004) as "a more decentralised way of life based upon greater self-reliance, so as to create a social and economic system less destructive towards nature."

Chappell and LaValle (2011) and Habib-Mintz (2010) express the need for approaches that can help implement and achieve the sustainability aspects/issues of biofuel assessment initiatives. Although considerable dialogue and effort has been afforded to the identification of biofuel sustainability indicators, their lack of application and achievement is a critical concern (Hecht 2007; Vermeulen and Cotula, 2010). Often the identification of indicators takes place through lessons learned in practice (Reed et al. 2006). However, at best they can inform whether a project is heading in the desired direction or whether current activities are unsustainable (Hecht 2007). Ordinarily, they simply alert us to existing problems, without informing us of their origin or how to resolve the problem.

This paper seeks to develop a conceptual framework that can help address some of these challenges. Through a review of academic and grey literature concerning development and biofuel discourses, theories are examined for their utility (rather than their strengths and weaknesses) to facilitate an understanding of the sustainability challenges in the context of informing biofuel implementation in developing countries, in particular, in sub-Saharan Africa (Figure 1). We do not attempt to demonstrate a mode of proficiency for the supporting theories, but rather, to draw on their individual and interlinking aspects that are supportive in explaining complex sustainability aspects/issues. Aspects are identified for their recognition of people-environment interactions, emergent political and social relationships (Borras et al., 2010), and how impacts are distributed through the diverse scales of interaction (White and Dasgupta, 2010). Numerous entities have developed frameworks to assist the certification and assessment of sustainability for biofuel development. A synthesis of the aspects/issues included in these assessments is used as the basis for comparing and contrasting the utility of the four theories examined.

Figure 1 approximately here.

The remainder of the paper is structured as follows: section 2 discusses the sustainability concerns associated with biofuels that repeatedly arise in the literature. Section 3 summarises biofuel assessment aspects/issues and their links to the supporting theories. Section 4 communicates the principles of the selected supporting theories that are relevant to biofuel sustainability aspects/issues. Tables are used to summarise the key points of interest that can be drawn upon to help understand biofuel sustainability implementation challenges. Prior to the conclusion, section 5 discusses sustainability limitations and presents biofuels conceptual sustainability framework.

2. Biofuel Sustainability Concerns

Often, decision-making surrounding biofuel development is not holistic and overlooks the importance of comprehensive stakeholder participation – a vital aspect in the quest for more equal distributions of costs and benefits – and centres solely on cost-benefit analyses from a government or industry perspective

(Haywood and de Wet, 2009). Imperative to biofuels' socio-economic sustainability is transparency, between participating stakeholders to whom costs and benefits are attributed, who decide on the distribution of costs and benefits, and how they are dispersed (von Maltitz et al., 2009).

Contentious land-ownership issues owing to the form of (or lack of) property rights in many developing countries (especially in sub-Saharan Africa) cause uncertainties for land tenure, population marginalisation, project security and livelihoods (Boddiger, 2007). Land deals are often performed without the commitment of investors to show transparency or regard for indigenous property and cultural rights. Further research is needed to help understand how different scales of political, economic and knowledge powers reinforce inequalities such as marginalisation (Black, 1990; White and Dasgupta, 2010) through the impacts of property rights (both form and security) (Vermeulen and Cotula, 2010). The displacements that may result, can affect social sustainability by leaving few livelihood alternatives for locals besides menial labouring bonded to investment companies (McMichael, 2010).

Borras et al. (2010) and Eden (2010) point out that unless consideration is directed towards how social-political-economic hierarchal dynamics interrelate with environmental and community integrity (i.e. livelihoods, health, education and freedom), it will be difficult to achieve sustainable biofuel development. Likewise, socio-environmental-economic sustainability issues are likely to persist, unless the issue of integrating the contrasting views of diverse stakeholders can be better explained and tackled (Elgahali, 2007; Forsyth, 2008). Pertaining to the sustainability of biofuel development, von Maltitz et al. (2009) suggest unearthing a theoretical discourse that identifies with the key impacts (benefits and restraints) and solutions that maintain environmental integrity, sustain livelihoods, and are embedded in the views of social equality.

Through an extensive review of the academic literature on biofuels and development and their role in progressing towards sustainability, concerns were identified as key aspects that repeatedly arose, and which were highlighted as being in need of further research. On this basis, four theories were identified that encompass these aspects, and were explored for their links to the core aspects of sustainability assessment frameworks.

3. Sustainability Issues/Aspects

Sustainability aspects/issues, central to sustainable biofuel development, were selected by evaluating internationally recognised biofuel sustainability assessment frameworks via a search of the internet. Table 1 lists the 17 international biofuel certification and assessment frameworks that were evaluated for their breadth and clarity of sustainability aspects/issues.

Table 1. Biofuel Assessment Initiatives

Regulatory Frameworks
EU Renewable Energy Directive (RED)
Renewable Transport Fuel Obligation (RTFO) – UK
Social Fuel Seal – Brazil
Testing Framework for Sustainable Biomass ("Cramer Criteria") – Netherlands
Voluntary Frameworks
Basel Criteria for Responsible Soy Production
Better Sugarcane Initiative (BSI)
Council on Sustainable Biomass Production (CSBP)
Global Biofuel Partnership (GBEP)
Green Gold Label 2: Agriculture Source Criteria (GGLS2)
International Sustainability & Carbon Certification (ISCC)
Roundtable on Sustainable Biofuel (RSB)
Roundtable on Responsible Soy (RTRS)
Roundtable on Sustainable Palm Oil (RSPO)
SEKAB Verified Sustainable Ethanol Initiative
Scorecards
IDB Biofuel Sustainability Scorecard
WB/WWF Biofuel Environmental Sustainability Scorecard
Analytical Framework
Biofuel Environmental Impact Assessment (BIAS) – Analytical Framework

Common sustainability aspects and the issues that may influence their efficient implementation, that were addressed by the seventeen biofuel assessment initiatives were identified. The Food and Agriculture Organisation (FAO) (BEFSCI, 2011) conducted a similar analysis of many of the initiatives listed in Table 1, though focusing on fewer and somewhat different sustainability aspects/issues. Based on attention to detail, breadth of sustainability aspects/issues and a focus on developing economies, drawing on the following five frameworks also delivers a similar set of aspects/issues:

- RSB Principles & Criteria for Sustainable Biofuel Production (Voluntary) (Round Table on Sustainable Biofuel, 2011).
- IDB Biofuel Sustainability Scorecard Sustainability Scorecard (Scorecards), Version Two, Based on the Round Table on Sustainable Biofuel Production, (Inter-American Development Bank, 2011
- International Sustainability & Carbon Certification (ISCC) (ISCC Association, 2010).
- Testing Framework for Sustainable Biomass ("Cramer Criteria") – The Netherlands (Regulatory) (Netherlands, Project Group, 2007).
- Biofuel Environmental Impact Analysis (BIAS): Analytical Framework (FAO, 2010).

Sustainability aspects and issues identified in the five respective assessment initiatives are displayed in Table 2. Academic literature was then examined in an attempt to unearth relevant theories that may assist us to understand these aspects/issues with a view to developing a framework to guide sustainability in biofuel production in developing countries.

Table 2. Sustainability Aspects/ Issues Addressed by Five Initiatives Reviewed

	Assessment Initiatives				
Aspects/Issues	**RSB**	**IDB**	**ISCC**	**CRAMER**	**BIAS**
Economics					
Planning/Monitoring	✓	✓	✓	✓	✓
Resource Utility	✓	✓	✓	✓	✓
Viability	✓	✓			
Technology	✓				✓
Marketing	✓	✓			
Management	✓	✓	✓	✓	✓
Best practice/Species	✓	✓			✓
International Relations			✓		
Environmental					
Biodiversity Integrity	✓	✓	✓	✓	✓
Migration Impacts	✓		✓		
Water/Soil Management	✓	✓	✓	✓	✓
Waste Management	✓	✓	✓	✓	✓
Chemical Use	✓	✓	✓	✓	✓
Land Degradation	✓	✓	✓	✓	✓
Sustainable Agriculture	✓	✓	✓	✓	✓
Social					
Cultural Respect	✓	✓		✓	✓
Sustenance Security	✓		✓	✓	✓
Health	✓	✓	✓	✓	✓
Education/Skills	✓	✓			
Livelihood Quality	✓	✓	✓	✓	✓
Social Disturbance	✓	✓	✓	✓	✓
Equality/Power Relations	✓	✓			
Equal Costs & Benefits	✓				✓
Energy security	✓	✓		✓	
Participation/Networks	✓	✓	✓	✓	
Enterprise Development	✓		✓		
Rural Development	✓	✓	✓	✓	
Marginalisation	✓	✓	✓	✓	✓
Policy					
Optimal Utility		✓	✓		
Compliancy	✓	✓	✓	✓	✓
Enforcement Capacity	✓		✓		✓
Administrative Capacity	✓	✓			✓
Self-reliance					✓
Land Rights	✓	✓	✓	✓	
Ethics					
Efficiency	✓	✓			✓
Accountability	✓	✓	✓		
Transparency	✓	✓	✓	✓	✓
Responsibility	✓		✓		
Comprehensibility	✓	✓	✓		✓
Communications	✓	✓	✓		

4. Supporting Theories

This paper draws on the "development of knowledge integration approaches enabling multiple views to be considered" (Raymond et al., 2010 p.1774) to support the achievement of sustainable biofuel production in developing countries. Theories were selected for their interlinking principles that support sustainability challenges in developing nations. Likewise, in an effort to add breadth and depth for understanding macro and micro policy relations and the principles of the three pillars of sustainability in biofuel production, a

combination of the diverse principles from four theories were drawn upon. In support of political ecology, which attempts to highlight challenges for achieving sustainability, other theories with similar principles were sought and those that had an interest in providing solutions to these challenges were selected (development economics, institutional economics and social capital). Schubert (2005) points out that key to political ecology is an in-depth study of social structures. These are debated by Nooteboom (2007) through linkages between political ecology and social capital, and Mansuri and Rao (2004) by emphasising the interrelationships of social capital and institutional economics. Each of these theories therefore shares common ground and each is discussed in turn below.

4.1 Political Ecology

Political ecology seeks to explain how power structures, ecological committees and local-level culture are part of broader economic and political structures (Peet and Watts, 1996) that have national and international links (Neumann, 2009). As a key theory in geography to study human-environmental relations (Zimmerman and Bassett, 2003; Neumann, 2009), Blaikie and Brookfield (1987) recognise political ecology as an approach that covers socio-economic hierarchies and the role of varying geographical (temporal and spatial) scale to define and explain biodiversity issues.

Owing to the overriding need for access and control over land, space and environmental resources, Tan-Mullins (2007) implies that power relations are central to the approach – especially, the interest in scalar politics concerning insatiable desires for the environment, or more specifically, resources (Molle, 2007; Swyngedouw, 2007). Scale (geographic, economic, knowledge, political, social) in political ecology remains an evolving conceptualisation (Neumann, 2009).

Largely owing to poor governance, uneven trade policies, wealthy countries bestowing subsidies on their farmers, and tariffs placed on finished products, few African countries have benefitted materially from their rich endowment of land and natural resources through biofuel investments or other means (Prabhakar, 2008). The study of poverty is a significant concern when understanding that people on the verge of starvation, when seeking new land, are unlikely to consider the state of natural bushland, or in the pursuit of sustenance, the rarity of an animal. These concerns may be exacerbated by biofuel development in sub-Saharan Africa, unless projects strive to consider affected stakeholder concerns equally (Diaz Chavez, 2011; Vermeulen and Cotula, 2010).

The wider political economy, influencing the grave agricultural status in much of sub-Saharan Africa (i.e. dated agronomic practices, poor yields and land degradation), is considered via chains of explanation at multiple scales (Blaikie and Brookfield, 1987; Black, 1990). The dependency theory, encompassed by some political ecology theorists (Bryant and Bailey, 1997), considers the power relationships between the global North and global South. It argues that power relations of socio-political forces that are at play are intrinsic to the inequality among nations (Black, 1990; Ferraro, 2008). Prabhakar (2008) says economists who subscribe to the dependency theory, maintain that in order to prosper, poor regions must alter trading ties with developed nations. They argue that the prosperity of North America and Europe relies on the rest of the world remaining in poverty. Sub-Saharan countries are keen to reduce dependence on foreign energy reserves, and to reduce poverty (Ariza-Montobbio et al., 2010).

Major concerns facing sub-Saharan nations are shrinking land resources owing to population increases and competing demands for land from various sectors (food cropping, livestock rearing, urban expansion, land degradation and biofuel production). ‘Regional’ political ecology, seeks an understanding of the effects these diverse socio-economic hierarchies have on biofuel developments in African developing countries; and their consequential impacts on socio-environmental resilience (Blaikie and Brookfield, 1987). Through consideration of a variety of scales, interests of the broad based approach of regional political ecology include processes surrounding land use and consequential causes of land degradation and environmental outcomes, which are a major concern in developing countries – especially sub-Saharan Africa (Blaikie and Brookfield, 1987).

Many academic discourses on biofuel development in Africa (e.g. Amezaga et al., 2010; Dauvergne and Neville, 2010; von Maltitz and Stafford, 2011) discuss marginalisation concerns of small-scale producers, through governmental land expropriations or agri-business interests (Naranjo, 2012). Black (1990) and Blaikie (1985) identify two forms of marginalisation. Firstly, small-scale producers enter a capitalistic mode

of production. In this case, producers abandon traditional production and, unsustainably, extract surplus from the land (O'Flanagan, 1978). In the second case of eco-demographic marginality, local populations are displaced to areas of environmental vulnerability or locations of lower fertility (Wisner et al., 1977). In both cases, locals necessarily over-exploit restricted land resources. These outcomes remain a risk for biofuel projects should sustainability principles fail to be employed. Table 3 summarises political ecology perceptions pertinent to some of the complex issues relating to sustainability limitations that affect biofuel implementation in developing countries.

Table 3. Political Ecology: Linking Sustainability to Biofuel Implementation in sub-Saharan Africa

Utility of Political Ecology on Sustainable Biofuel Development
Seeks to understand national and international relationships in the context of political, economic and knowledge power structures (Peet and Watts, 1996) to assist local economic advancement
Explains the socio-economic hierarchal scales and their effect on environmental issues (Blaikie and Brookfield, 1987) in an effort to harmonise environmental, social and economic sustainability
Examines power relations and their impacts through the insatiable need for land and environmental resources (Zimmerman and Bassett 2003), which is a challenge for biofuel cultivation in developing countries
Seeks to explain uneven power relations and uneven cost and benefits, leading to social, environmental and economic inequalities (Bryant and Bailey, 1997)
Through chains of explanation (Blaikie and Brookfield, 1987), reviews the quandary of agriculture in developing countries (Black 1990), which is further impacted by the expansion of biofuel production
Drawing on the dependency theory, examines the uneven global power relations (Black, 1990; Ferraro, 2008), thus, pursuing an explanation for environmental degradation and social decline through an uneven distribution of natural resources
Explains sustenance and energy security via self-reliance (Ferraro, 2008)
Examines competing land issues through government acquisitions and agro-industry demands that leads to marginalisation (Amazega et al., 2010; Dauvergne and Neville, 2010; von Maltitz and Stafford, 2011), and the subsequent environmental degradation and social welfare decline
Strives to identify biofuel development processes causing land and environmental degradation (Blaikie and Brookfield, 1987)

4.2 Development Economics

In the search for sustainability, development economics seeks the most efficient allocation of scare resources; and for maximum growth of these resources (Bass, 2011) – in other words, maximising utility under conditions of scarcity. Development economics uses economic theory, sociology, political science, anthropology, econometric methods, biology and demographics to study economics in the developing world (Ray, 2007).

Unlike many other fields of economics, social and political factors (Todaro and Smith, 2006) are included (Bell 1987; Ray 2007). Amongst others, development economics envelopes: reasons poverty appears alongside affluence (i.e. to what extent is economic growth of developing nations hindered by the activities of wealthy nations) and assesses the causes of corruption (i.e. whether wealth and democracy are related) (Bass, 2011). There is a drive to examine success stories of economic development, to ask how we can learn and what can be learnt from past failures, and how sense can be made of the vast inequities within and across borders (Ray, 2007). With this knowledge, and a focus on community integrity (e.g. health, sustenance, self-esteem and freedom), development economics strives to turn the cycle of poverty into a virtuous cycle of growth (Sen, 1983).

As mentioned in the World Development Report in 1998-1999, it is not just the gap in resources that differentiates developing countries and developed countries but also a disparity in knowledge (World Bank, 1999). Arguing that markets on their own can lead to successful economic growth outcomes, Stiglitz (2011) believes that at the centre of successful development is the absorption, accumulation, production, adaptation and transfer of knowledge. He adds, in short, countries should not limit progress by their patterns of endowments (land, labour, capital), but should place an emphasis on entrepreneurship and knowledge. By identifying local sectors that are more amenable to learning, and engendering the learning capacities of citizens, knowledge transformation will be pro-poor (Stiglitz, 2011).

Since most people in low-income countries depend on agriculture for their livelihoods, improvements in agricultural technology are central to reducing poverty (Lin 2011). Ruttan (2008) mentions that the leading agricultural resource constraints in the developing world are soil degradation, water scarcity, environmental impacts from agricultural intensification and impacts of climate change. Technology has helped small-scale farmers avoid crop failures through early adverse weather warnings (Kumar, 2012), and advice sent via mobile phones on advanced forage and feeding techniques has reduced livestock mortalities (Kahumbu, 2011).

Lin (2011) suggests that well-designed policies on social capital development must be an integral part of a country's development strategy. This can assist to upgrade industry to position the economy to fully utilise its resources. Sachs (2008) explains that development economics seeks reasons for poverty beyond the norm of poor governance (regularly code words for 'corruption') and the poor themselves. Table 4 summarises the sustainability concerns that development economics seeks to explain, and which can inform implementation approaches for biofuel development in sub-Saharan Africa.

Table 4. Development Economics: Linking Sustainability to Biofuel Implementation in sub-Saharan Africa

Utility of Development Economics on Sustainable Biofuel Development
Studies developing country economies (Bell, 1987)
Reinforces the maximum utility of scarce resources (Bass, 2011) – emphasising environmental sustainability
Includes political and social factors (Todaro and Smith, 2006), which are both key sustainability limitations for biofuel development in countries with weak property and environmental rights
Studies reason for poverty emergence alongside prosperity (Bass, 2011), informing biofuel development on more equitable socio-economic implementation
Explains the interference by developed nations on prosperity of developing nations (Bass, 2011) – demands for biofuels in the developed world can influence the sustainability of biofuel cultivation in developing countries
Seeks the causes of corruption and inequities within and across borders (Ray, 2007)
Focuses on community integrity (i.e. health, freedom, self-sufficiency) (Eden, 2010), which can assist local confidence and enhanced powers for negotiating with biofuel developers
Recognises that the strength of development potential is linked the disparity in knowledge (including technological) (Lin 2011; World Bank, 1999)
Strengthens local understanding of biofuel projects by emphasizing the need for education, training and transfer of knowledge (Stiglitz, 2011) to help harmonise the three pillars of sustainability
Recognises the need to engender citizen learning capacities (i.e. Agriculture in rural Africa) (Stiglitz, 2011)
Investigates past successes and failures to enhance decision making (Ray 2007)
Examines the potential for improved agricultural output (causes and responses) (Ruttan, 2008), thus, strengthening environmental sustainability, social welfare and economic wealth

4.3 Social Capital

Social capital is described by Putnam et al. (1993: 167) as "trust, networks and norms that can improve the efficiency of society by facilitating coordinated actions that improve the efficiency of society through features of organisation." Social Capital is sometimes inferred as generating assets for poor populations (Dongier et al., 2001). It is thus a stock from which to support economic growth and development via an organisation of links between and among actors (Coleman, 1988). Social capital has to be considered within its political and cultural circumstances (Rao, 2001), as there is an understanding that norms and trust may differ by groups within a social system (Carolan, 2006).

Coleman (1988) believes in building rapport, within communities or unions with other communities, with the belief that quantity and quality of interaction are key sources for strength for the communities' own betterment. Community is defined as an endogenous construct identified by project parameters or project-facilitators, or by environment or identified precincts, rather than a physical form (Mansuri and Rao, 2004). Astone et al. (1999) recognise that intra-community ties can provide communities with a common purpose and sense of identity, which advances self-esteem and provides a basis from which to negotiate more even terms.

Local notions of what is fair and just and how a project would best benefit communities often varies from those of project implementers and/or project inter-mediators (Harrigan, 2004). Likewise, projects that draw

on community involvement are no less immune to inequities through disparities in hierarchal power (political, financial and knowledge). In cases of superior political or economic groups within a community, outcomes may be derived at the expense of inferior groups (Woolcock and Narayan, 2000), which can reinforce existing inequalities.

Finsterbusch and van Wicklin (1989) found participatory projects to have an intrinsic value – without participation people may benefit but are unlikely to develop from a project in developed economies, suggesting that support may be found through broader institutional settings. Echoing Newman et al. (2002), Kleemeier (2000) argues that the lack of sustainability of participatory projects stems from a lack of support from an external enabling institutional environment. The view of institutionalism is that civil society and the strength of community networks is largely reliant upon institutional environments (Woolcock and Narayan, 2000). They add that the quality of formal institutions, under which communities reside, determines the capacity with which communities are able to act for their best interests. Table 5 summarises the sustainability concerns that social capital seeks to explain, which can inform sustainability implementation approaches for biofuel development in sub-Saharan Africa.

Table 5. Social Capital: Linking Sustainability to Biofuel Implementation in sub-Saharan Africa

Utility of Social Capital on Sustainable Biofuel Development
Discusses integrating norms (informal rules), social networking, and transparency (confidence) Putnam et al., (1993), to benefit communities own betterment (Dongier et al., 2001)
Via networking, promotes economic opportunities through increased market efficiency and reduced transactional costs (Coleman, 1988)
Promotes cooperative behaviour, generating better societal outcomes (avoiding narrow egoism) (Putnam et al. ,1993), which can assist local negotiating power for equal costs and benefits involving biofuel developments
Recognises community participation projects are no less susceptible to exploitation via scales of power (political, financial and knowledge) (Harrigan, 2004)
Considers the enhancement of a sense of identity and negotiating strength through social support via inter- and intra-community interaction (e.g. health, jobs, education) (Astone et al., 1999; Putnam et al., 1993), thus, increasing environmental protection, economic opportunity and social wellbeing with regards to biofuel developments

4.4 Institutional Economics

To support flows of information, enforce defined property rights and to reduce transaction costs, institutions permit, require or prohibit specific social, economic or political actions. Williamson (2000) considers institutions to include regulatory frameworks, procedural devices, and organisational entities. Formal (laws, rules and constitutions) and informal (norms of behaviour, codes of conduct, conventions) institutions are defined by North (1990) as constraints people enforce on themselves. As economies become more advanced, increased transactions provoke more complications with market partners. This induces a shift from informal institutions towards formal institutions to facilitate fairness and efficiency (Jutting, 2003), and emphasises the need to devise policies to improve the links between informal and formal institutions.

According to North (1990), employing appropriate institutional frameworks for projects in developing countries is paramount for achieving sustainability. He adds that the learning process of organisations, the network externalities, and the traditionally shaped subjectivity of issues reinforces the set path for development. Rampant corruption, inequality, insecure property rights, bureaucratic delays, suppressed civil liberties and ethnic tensions are increasingly recognised as barriers to well-being (World Bank, 1999). The existence of these conditions undermines well-intentioned efforts of infrastructure development such as roads, communications, hospitals and schools (Woolcock and Narayan, 2000). It follows that investment in informal and formal forms of civil and government social capital complements more conventional investments.

The competency of property rights and the propensity to enforce them is argued as key to economic development (Chang, 2011). Kimenyi (2011) also points out that secure property rights are not always better for economic development. Chang (2011) argues for sustainable development, the form of property right is as significant as the security of property rights. Owing to the large expanses of land that are needed for

cultivating biofuels and the contentious food versus fuel debates, it is essential for biofuel implementers to grasp the different forms of property rights (Boddiger, 2007; Vermeulen Cotula, 2010).

Institutional economics has largely exhausted itself in attempting to rationalise emerging economics through the perspective of developed country institutions (Maseland, 2011). This signifies that it may be more productive to look at institutions on a country-specific basis. Woolcock and Narayan (2000) advise that the weakness of institutional economics lies with its strength of attending to macro policy concerns – it lacks in-depth micro policy components. For example, they mention that liberties, rights and freedoms are entities inevitably established by governments; rational and proficient bureaucracies are removed from the lives of the poor in many rural communities, and may take years to be developed.

Jutting et al. (2007) suggest that development outcomes cannot be ascribed to an individual institution as they depend on several dynamics. These include the interactions between informal and formal institutions and the actions of powerful individuals, groups or political players (Ostrom, 2005). In many developing countries informal institutions may improve efficiency alongside formal institutions; especially in cases of weak law enforcement, or the lack of desire to enforce (Mwangi and Ostrom, 2009). In such cases, conforming to law may be achieved by forming committees and partaking in meetings that review issues according to formal rules, however, outcomes are agreed informally (Jutting et al. 2007). This can enhance enforcement effectiveness and reduce resources expended through fruitless debate and players vetoing the process. Jutting et al. (2007) convey an example: in a country that introduces a stronger anti-corruption law, despite lacking the capacity to impose it, informal self-enforcement can take place by way of obligation, expectations of reciprocity, shaming, threats, boycotting and ostracism. Conversely, cases in which countries lack the enforcement capacity or ignore laws such as gender rights, informal traditional laws that customarily contravene these rights take precedence (Ostrom, 2005). Table 6 summarises the sustainability concerns that institutional economics seeks to explain, which may help biofuel development in sub-Saharan Africa move towards sustainable biofuel development.

Table 6. Institutional Economics: Linking Sustainability to Biofuel Implementation in sub-Saharan Africa

Utility of Institutional Economics on Sustainable Biofuel Development
Examines informal institutions (behavioural norms, conventions and codes of conduct) in cases of weak policy compliance and enforcement capacities (North, 1990). Biofuel developers can take advantage of weak enforcement capacities unless institutions are in place to ensure equitable costs and benefits
Informal institutions facilitate efficiency and fairness in developing countries until a capacity is reached for a transfer to effective formal institutions (Jutting, 2003)
Property Rights – considers the significance of form and security of property rights (Chang, 2011)
Considers it to be more productive to examine institutions on a country specific basis (Maseland, 2011). This is important as each biofuel project has a unique set of environmental, social and economic challenges
Examines forms of social capital investment to minimise weak governance (e.g. corruption, inequality, insecure property rights, bureaucratic delay) (World Bank, 1999). This may provide local stakeholders with a collective negotiating voice and help achieve equality in relation to biofuel development in sub-Saharan Africa
Consideration for macro policy concerns (Woolcock and Narayan, 2000) may assist the integration of micro, meso and macro sustainability aspects

4.5 Relationships with Sustainability Aspects/issues

Table 7 conveys the emphasis that each specific supporting theory places on designated sustainability aspects/issues in relation to biofuel implementation approaches. The interlinking qualities were drawn on to expand understanding of the interrelationships between environmental, social, and economic aspects.

Checkmarks in Table 7 signify the scale of utility that a supporting theory may have for analysing a designated sustainability principle. Two checkmarks signify that the supporting theory has interests predisposed towards a designated biofuel sustainability principle. A single checkmark signifies that although a supporting theory confers less significance for a designated sustainability principle, the theory is likely to extend considerations that may assist biofuel implementation approaches. The absence of a checkmark may not essentially signify a lack of insight that a theory confers for a principle, but is merely the perception of this paper that the explanations of another supporting theory proffer greater utility for analysing the sustainability principle.

Table 7. Supporting Theoretical Influences on Biofuel Sustainability Aspects/issues

Aspects/issues	Political Ecology	Development Economics	Institutional Economics	Social Capital
Economics				
Planning/Monitoring		✓ 45		✓ 26
Resource Utility	✓✓ 28	✓✓ 3		✓ 25
Viability		✓✓ 37		✓ 6,31
Technology		✓✓		✓✓
Marketing	✓ 16,35	✓✓ 37,45		✓✓ 6
Management	✓✓ 8	✓ 41		✓✓ 15
Best practice/Species		✓✓ 37		✓✓ 26
International Relations	✓✓ 7,32,35	✓✓ 37,45		✓ 37
Environmental				
Environmental Integrity	✓✓ 35	✓ 44		✓ 26, 29
Migration Impacts	✓✓ 43,50			✓ 29
Land Utility	✓✓ 28	✓ 3,37		✓ 29,45
Waste Control	✓ 28	✓ 41		✓ 26
Chemical Use	✓ 28	✓ 41		✓ 26
Land Degradation	✓✓ 8,35	✓ 41	✓✓ 10, 22,25	✓ 29, 45
Sustainable Agriculture	✓✓ 38	✓ 41	✓ 25	✓✓ 26,45
Social				
Cultural Respect	✓✓ 34	✓ 44		✓✓ 19,24
Sustenance Security	✓✓ 39	✓✓ 44		
Health	✓✓ 35	✓ 4,20,44		✓✓ 14,24
Education/Skills	✓✓ 30	✓✓ 23,45		✓✓ 14,17
Livelihood Quality	✓✓ 2	✓ 44,47		✓✓ 14
Social Disturbance	✓✓ 43,49		✓ 10	✓✓ 29
Equality/Power Relations	✓✓ 8	✓✓ 3,37,45		✓✓ 19
Equal Costs & Benefits	✓✓ 9	✓✓ 3,42	✓ 21	✓ 15
Energy security	✓✓ 39			
Participation/Networks		✓ 3	✓✓ 12,32	✓✓ 36
Enterprise Development	✓ 43	✓✓ 3,42		✓✓ 11,17,45
Rural Development		✓✓ 25,37		✓ 26
Marginalisation	✓✓ 1,38	✓ 48	✓ 22	
Policy				
Optimal Utility	✓✓ 9,16	✓✓ 25	✓ 21	✓✓ 11
Compliancy			✓✓ 21	
Enforcement			✓✓ 22	
Capacity		✓ 5	✓✓ 21	
Self-reliance	✓✓ 2,39	✓✓ 23	✓✓ 27	
Land Rights	✓✓ 9,46		✓✓ 10,21,22	
Ethics				
Efficiency		✓ 45	✓ 21	✓ 36
Accountability	*	✓ 18,25	✓✓ 10,15,29	✓✓ 11
Transparency	✓✓ 38	✓ 25	✓ 21	✓✓ 36
Responsibility	✓ 49	*	*	✓ 13,26
Comprehensibility	*	*	*	*
Communications	✓ 8	✓✓ 45	✓✓ 10	✓✓ 36

Supporting Literature: 1] Amezaga et al. (2010); 2] Ariza-Montobbio et al. (2010); 3] Bass (2011); 4] Becker (1975); 5] Bell (1987); 6] Bigsten et al. (2000); 7] Black (1990); 8] Blaikie and Brookfield (1987); 9] Bryant and Bailey (1997); 10] Chang (2011); 11] Coleman (1988); 12] Commons (1931); 13] Cotula et al.(2008); 14] Dongier et al. (2001); 15] Fafchamps (2006); 16] Ferraro (2008); 17] Fukuyama (2001); 18] Granovetter(1995) ; 19] Harrigan (2004); 20] Jones and Romer (2009); 21] Jutting (2003); 22] Kimenyi (2011); 23] Klein and DiCola (2004); 24] Krishna (2002); 25] Lin (2011); 26] Mansuri and Rao (2004); 27] Maseland (2011); 28] Molle (2007); 29] Mosse (1997); 30] Neumann (2009); 31] Nooteboom (2007); 32] North (1990); 33] O'Laughlan (2008); 34] Peet and Watts(1996); 35] Prabhakar (2008); 36] Putnam (1993); 37] Ray (2007); 38] Robbins (2004); 39] Romanova (2010); 40] Rossioud and Locatelli (2010); 41] Ruttan (2008); 42] Sachs (2008); 43] Schubert (2005); 44] Sen (1983); 45] Stiglitz (2011); 46] Swyngedouw (2007); 47] Todaro (2006); 48] von Maltitz and Stafford (2011); 49] Wisner et al. (1977) ; 50] Zimmerman and Bassett (2003). *Denotes: indirect explanations emerge by drawing on characteristics of the demarcated supporting theory.

5. Discussion

This paper has explored the principles of various supporting theories and the utility they may offer for exploring a broad range of complexities that challenge biofuel implementation in developing countries. An approach was sought that strives for a balanced integration of the three pillars of sustainability; one that is supported by informed ethical policy that can inform biofuel development in sub-Saharan Africa.

Drawing on the political ecology and development economics principles that consider key social capital and institutional economics interests may support a conceptual framework that is more inclusively informed on sustainability challenges, and which can be used to avail the implementation of biofuel developments in sub-Saharan Africa. Seeking a more equitable approach for integrating economic, environment and social sustainability, political ecology perspectives on socio-environmental concerns can be synthesised via the micro socio-economic influences of development economics. Likewise, drawing on the macro socio-economic perceptions of institutional economics can maintain a link between broader based policy outlooks and the more localized informal institutional settings. This can assist biofuel implementation to analyse equality and a form of social ordinance in the absence of a formal institutional enabling capacity – especially concerning sub-Saharan African land and resource utility. The relationship of biofuel sustainability aspects/issues and supporting theories to inform biofuel implementation (which can inform policy) are illustrated in Figure 2. Institutional Economics (supporting macro elements and institutional settings) in conjunction with social capital (supporting micro and meso elements of local and regional networking) can expand upon and support the explanations derived through development economics in response to sustainability concerns raised by political ecology.

Figure 2 approximately here.

Studying the uneven links of international and national power organisations and the role they play in ecological integrity and respect for local cultures (Peet and Watts, 1996; Neumann, 2009), may provide explanations for the concerns regarding biofuel investment hierarchal power relations and their adverse impacts on environmental preservation (Borras et al., 2010) and social inequality (White and Dasgupta, 2010). An explanation in relation to the root of marginalisation of local communities (Amezaga et al., 2010; Dauvergne and Neville, 2010; von Maltitz and Stafford, 2011), human-environmental behaviour (Zimmerer and Bassett, 2003; Neumann, 2009), and livelihood resilience (Wisner et al. 1977), may be derived through the considerations of political ecology of socio-economic hierarchies at varying scales (Black 1990; Blaikie and Brookfield, 1987). The discussions through political ecology on the impacts on community integrity and marginalisation (Molle, 2007; Swyngedouw, 2007; O'Flanagan, 1978), through the avid desire for natural capital for biofuel cultivation, may contribute towards social sustainability implementation debates to uphold community integrity (Eden, 2010) and offer insights into the distribution of biofuel development costs and benefits (von Maltitz et al. 2009).

Drawing on Black's (1990) and Ferraro's (2008) reasoning through the dependency theory, regarding uneven socio-political power relations between the Global North and Global South, can advance debates concerning insecure property rights (Vermeulen and Cotula, 2010), political scalar dynamics impacting environmental and community integrity (Borras et al., 2010; Eden, 2010) and the distribution of costs and benefits (von Maltitz et al., 2009; White and Dasgupta, 2010). Likewise, Romanova (2010) advises that, through domestication, nations should strive for energy and sustenance security to offset the uneven costs and benefits seized through uneven power relationships (Bryant and Bailey, 1997). This emphasis on the localisation of energy production highlights the need for biofuel implementation approaches that can equally and simultaneously consider the three pillars of sustainability.

By drawing on political and social aspects, development economics' efforts to enhance developing countries' economic opportunities (Bell 1987), can assist the understanding of diverse sustainability viewpoints between players with uneven levels of economic and political power that are involved with biofuel production in developing countries (Elgahali 2007). Dealing with economics in developing countries, and recognising the impacts of political and social factors (Todaro and Smith 2006), development economics can present a base from which to debate the biofuel development activities of wealthy nations (Bass 2011) and their impact on economic and natural capital inequalities (von Maltitz et al., 2009; White and Dasgupta, 2010). Seeking a rationale for surplus and scarcity appearing side-by-side (Todaro and Smith,

2006) is important for understanding the complexities surrounding the integration of biofuel development interests between stakeholders of diverse economic, political and knowledge levels of influence (Elgahali, 2007; Forsyth, 2008).

Also fundamental for understanding diverse viewpoints, the accumulation and transferral of knowledge between different scales of power (World Bank, 1999; Stiglitz, 2011) transcends towards equitable stakeholder participation. In addition, the recognition that education and knowledge (including technological) must be directed towards learning capacities (Stiglitz, 2011) is key to addressing poverty. For example, emphasising agricultural education and knowledge in rural developing nations is pro-poor, and is likely to realise maximum livelihood benefits (Lin, 2011) in agriculturally aligned biofuel production. On such occasions, the promotion of sustainable agricultural yields have far from reached their potential in developing countries, and examining the reasons for soil degradation, Ruttan (2008) emphasises the benefits for enhancing agricultural technical knowledge within well-informed policies for social capital development (Lin, 2011).

In relation to the implementation of biofuels projects, Coleman's (1988) belief in liberal interaction as a key strength to regulating the balance of negotiating powers (Astone et al., 1999) can inform local notions of 'what is fair and just' (Harrigan, 2004). The combination of reinforcing elements of trust, understanding locally accepted rules (informal institutions) and intra- and inter-community networking (Putnam et al., 1993), can support local stakeholders to grasp established sustainability principles, thus, gathering confidence for negotiating more equitable costs and benefits. The promotion of transparent societal networking (Coleman 1988; Putnam et al. 1993), besides reducing transactional costs and increasing marketing opportunities, departs from selfish egotism. This integrated economic interaction, which upholds a sense of identity (Astone et al., 1999), can be further developed in relation to biofuel production in developing countries (Harrison et al. 2009) through the formation of cooperatives. These theoretical perceptions of social capital may offer insight into the concerns of enviro-socio-economic equality raised by von Maltitz et al., (2009), and facilitate sustainability by embedding participatory fairness in biofuel implementation approaches.

In relation to contentious property rights, understanding and adopting informal institutional roles in nations that display a weak capacity to administer and enforce formal institutions (i.e. many countries in sub-Saharan Africa) (Jutting, 2003), may conceptualise approaches to concerns regarding marginalisation through biofuel development in sub-Saharan Africa (Elghali, 2007; Forsyth, 2008; Cotula et al., 2008). Through the perceptions of institutional economics, discussing the forms of property rights, in addition to the security of property rights (Chang, 2011), informs biofuel implementation approaches that aim to enhance local livelihoods, the security of project tenancy and environmental maintenance. The study of informal institutions on a country-specific basis, (Jutting et al., 2007; Maseland 2011), is likely to have utility for sub-Saharan Africa owing to the variations of macro conditions between countries on many levels, including: political stability; formal institutional enforcement capacity; administrative capacities; property rights; access to natural resources; and a lack of policy standardisation.

6. Conclusion

The discourse throughout this paper has maintained focus on a conceptual framework to inform implementation approaches for biofuel sustainability in developing countries in sub-Saharan Africa. Drawing on institutional economics strengthens the development economic perspective on macro concerns. Social interaction and networking, embedded in forms of informal institutions, interlink the interests of social capital and institutional economics.

Sachs's (2008) call for a development economics that centres on growth and that considers equal cost and benefits, especially in disadvantaged communities; one that seeks causes beyond the norms of weak governance and out-dated procedures embedded in local customs, can inform biofuel implementation approaches to help achieve environmental, social and economic sustainability in developing countries. Understandings of social capital and institutional economics interlink with societal norms or informal institutions that are often embedded with the challenges of integrating diverse stakeholder views in sub-Sahara African nations (Forsyth 2008). Drawing on social capital and institutional economics adds depth and breadth to the study of political ecology and development economics in seeking reasons for inequality – why poverty is found alongside affluence.

The concerns of land insecurity through biofuel developments, and the resultant impacts on marginalised communities, can be better understood and avoided if focus is equally placed on the form and the security of property rights. In seeking better forms of sustainability, effective biofuel implementation approaches are more likely if sustainable development is recognised as an evolving inquiry – on a site-specific basis.

The holistic approach of political ecology, and the common themes (e.g. social-political-economic hierarchal dynamics; environmental protection; uneven knowledge, political and economic powers, and their influence on equality; dispersion of costs and benefits, property rights and the impacts on marginalisation and community integrity) referred to by the supporting theories, suggests that to meet sustainability standards and the principles therein, ethical implementation attitudes must be prioritised.

The efforts of political ecology to unearth and understand complex sustainability concerns can be complemented through development economics, which seeks to understand causes and explain responses to the matching developmental inquiries through the examination of past successes and failures. Amalgamating the interests of four supporting theories that displayed interlinking qualities has provided a more inclusive theoretical understanding in an effort to move towards sustainable biofuel development. While this analysis of key theories with regard to biofuel implementation approaches in sub-Saharan Africa may have merit, moving forward the agenda requires empirically based work to bring the concepts together.

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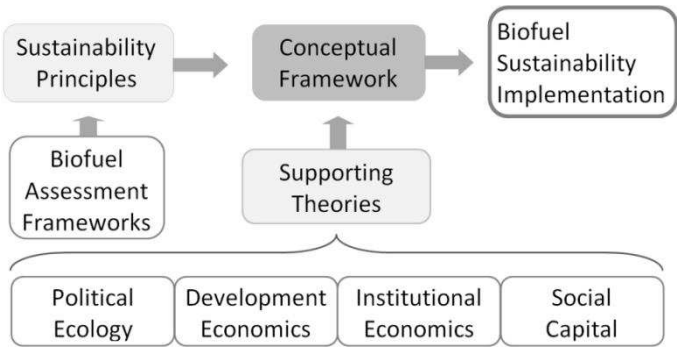

Figure 1. Process for developing a conceptual framework to inform biofuel implementation

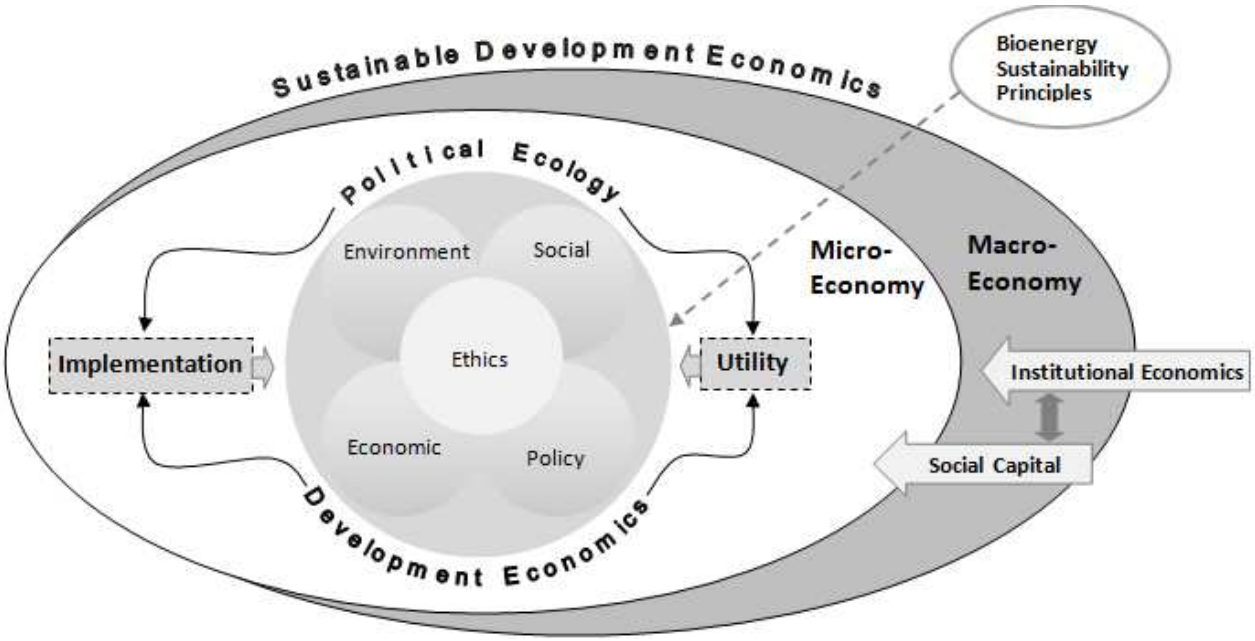

Figure 2. Towards a conceptual framework for sustainable biofuel development