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The Future of Bioenergy and Rural Development Policies in Africa and Asia

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Abstract

This special issue has presented some of the specific findings of the RE-Impact Project which was commissioned and funded by the EuropeAid Cooperation Office from 2007 until its conclusion in 2010. The project aimed to provide impact assessment frameworks and influence relevant policies through direct involvement in bioenergy projects and policy analysis in South Africa, Uganda, India and China. The papers summarised here have covered issues related to *Jatropha curcas* and forest-based bioenergy in these countries. Taking an overall look at the project findings we can identify a number of general conclusions relevant for the future of bioenergy and rural development in Africa and Asia. First, only local and context-specific sustainability assessment can identify the risk and responsibilities of the different groups and the exact impact on the environment. Second, many initiatives both in biofuels and forest-based bioenergy are marred by a lack of understanding of the life-cycle financial analysis. Third, careful consideration of local physical and social conditions and the economics of the production chain can identify real opportunities for rural development using bioenergy. The current global impasse in bioenergy policies could actually be advantageous to the development of bioenergy in developing countries. With less pressure from America and Europe to develop bioenergy systems for climate change mitigation, countries in Africa and Asia may have the breathing room to shape bioenergy systems for their own internal energy supply in an orderly fashion. However, in order to avoid environmental and social impacts it will be necessary to jointly articulate elements of a number of measures including market-based certification, national policy formulation, national legislation, impact assessments, sustainability planning, land use planning, research, monitoring and evaluation, taking into account country and project specific sustainability criteria. Unfortunately, many of the countries in Africa and Asia where bioenergy can play an important role still lack institutional structures able to articulate this sustainable development. The formation of necessary capacity and structures, where their absence forms a barrier to sustainable development, is therefore required to achieve this objective.

1. Lessons from the RE-Impact project

This special issue has presented some of the specific findings of the RE-Impact Project which was commissioned and funded by the EuropeAid Cooperation Office from 2007 until its conclusion in 2010. The project aimed to provide impact assessment frameworks and influence relevant policies through direct involvement in bioenergy projects and policy analysis in South Africa, Uganda, India and China. A number of methodologies, under the framework of a planning for sustainability approach, have been devised and tested through the project and are available as an integrated handbook entitled: "Assessing the Sustainability of Bioenergy Projects in Developing Countries: A Framework for Policy Evaluation" [1]. The articles in this special issue provide in-depth analyses of the research behind this assessment framework and the implications for the future of bioenergy and rural development in Africa and Asia.

In the first paper of the issue Bird et al. [2] presented a simple deterministic model that compares the demand and supply of food energy globally or at a country level. This model can be used to estimate indirect land use change if agricultural crops are used to the production of biomass for energy, always a difficult question to answer in the African and Asian context. The model suggests that the deforestation caused by the conversion of food-producing land to biofuel production depends on the amount of food energy that the land produced. For example, a hectare of sugar cane in Kenya causes 2.2 ha of deforestation due to high yields and high energy value while 1 ha of pulses in India causes only 0.04 ha. The results of the model imply that for every increase of 1 TJ of food energy demand there is 18 ha of deforestation worldwide. So, for example, the EU Renewable Energy Directive would cause between 28 and 53 million hectares of deforestation.

The following four papers concentrated on biofuels and in particular on *Jatropha curcas L.*, which at the beginning of the project was one of the most contested issues in the bioenergy field. The *Jatropha* fashion in Africa and Asia had both external and internal drivers. In India, the main driver was national policy which some States took wholeheartedly on board. The paper by Hazelton et al. [3] examined the stakeholder dynamics in bioenergy feedstock production in Chhattisgarh State, one of the champions of the biofuels programme. In this paper the authors proposed a structured approach to analysing stakeholder dynamics enriched by elements of Social Impact Assessment and Sustainability Assessment. Utilising this approach they identified five models of *Jatropha curcas L.*-based seed production, finding that the significant distinctions separating feedstock production models were land ownership and value chain, and market end use and route. Only local and context-specific assessment can identify the risks and responsibilities of the different groups. In Chhattisgarh the marginal farmers stand to gain from the expansion of biofuel production, but are also at high risk of project failure. They should be supported by research and development of production models in which they are involved, and transparent policy to maximise their chance of success. Towards the end of the project, high level initiatives were favouring models based on the intervention of Public Oil Marketing Companies focussed more on national targets than rural development, but also more knowledgeable about the market end use. In the Indian case, where the vast majority of the feedstock production is for internal markets, mechanisms such as certification will not be effective and therefore legislative measures are required to ensure sustainability.

A similar approach was presented by von Maltitz and Setzkorn [4] in the paper where they provide a typology of southern African biofuel feedstock production projects using size and ownership of the feedstock production unit and the intended market as main variables. At the time of the project, biofuel expansion was happening rapidly in the region in a relatively *ad-hoc* fashion responding to a changing policy environment and other external factors such as the recession. The emerging industry is extremely diverse, ranging from under 1 ha intercropped with food crops to tens of thousands of hectares of monocropped commercial plantations. Some projects aim at satisfying local fuel self-sufficiency while others are focussed on export markets driven by mandatory blending targets. The authors also stressed that sustainability concerns vary for different types of projects. Having a clear understanding of the motivation for the biofuel project and the intended market is a pre-requisite for a debate on sustainability.

Around the beginning of the RE-Impact project the South African government imposed a moratorium on all *J. curcas* cultivation outside research areas due to insufficient knowledge

about this species in the country. Two papers in this issue reported research findings relating to the physical behaviour of *J. curcas* in South African conditions and its potential to produce biodiesel from marginal land with low inputs. First, Andersson et al. [5] studied the management of *J. curcas*'s silvopastoral systems, analysing the risk of herbivory by indigenous goats and competition with planted pastures in a research farm in KwaZulu-Natal. The results showed that the low probability of herbivory makes *J. curcas* a suitable candidate for silvopastoral systems in South Africa. However, viable system would require some degree of plantation maintenance to prevent negative competitive effects on growth and productivity. It was recommended that a 60 cm radius around the base of individual plants be kept clear of pasture species to enhance crop growth. The second paper by Everson et al. [6] reported on a field assessment of the agronomic performance and water use of *J. curcas* in South Africa based on a silvopastoral experiment with *Pennisetum clandestinum* also in a research farm in KwaZulu-Natal. The results showed that two- to four-year-old *J. curcas* were conservative water users, with negligible water use during the winter due to the deciduous nature of the species. They also showed that high oil yields are unlikely due to the low seed production. Best yields in *J. curcas* only plots were 348.8 kg ha⁻¹. When pasture competition was a factor it ranged between 77.8 and 166 kg ha⁻¹. Data showed also that mechanical harvesting would be necessary to make seed production economically viable. The plant had low tolerance to pests and was prone to diseases. In summary, under these experimental conditions the plant did not perform well enough to justify extensive deployment in South Africa.

The final paper on *J. curcas* by Borman et al. [7] presented a model of the economic returns to labour for *Jatropha* cultivation in India, South Africa and Zambia at different local fuel prices. The aim of this exercise was to ascertain whether it could be an appropriate driver for rural development, especially if yields proved to be lower than originally predicted. A financial model based on the life-cycle economic analysis of the *J. curcas*-biodiesel production chain was constructed to determine if steady-state income could support labour wages under local wage legislation, different yields, production cost and fuel price scenarios using country specific parameters. Results showed that minimum wages in South Africa were too high to support production at the current fuel price, meanwhile in India and Zambia there was the potential to generate profits under specific circumstances dominated by yield, wages, fuel prices and market opportunities for by-products. In general, profitability was exceptionally sensitive to minimum wages.

Parallel to the research on biofuels and *Jatropha curcas*, the RE-Impact project also devoted considerable resources to the analysis of forest bioenergy policies, concentrating in China and Uganda. The paper by Kahrl et al. [8] examined China's forest bioenergy policies in the face of energy challenges similar to those present in OECD countries and chronic rural energy challenges more characteristic of developing countries. They presented a coherent argument to support the thesis that modern forest bioenergy could contribute to solutions to both of these challenges and that efforts should initially focus on addressing rural energy problems rather than on the commercialization of forest bioenergy. Five strategies are essential in this path: strengthening analysis capacity; improving resource planning and coordination; encouraging interagency coordination and cooperation; securing funding for technology R&D; and more clearly defining public and private sector rules. As land and forest biomass resources are scarce in China, it is important to ensure that policy is informed on the magnitude of trade-offs and that decisions are based on a reasonable assessment of benefits and costs. A second paper on China by Kahrl et al. [9] examined the incentives for carbon sequestration and energy production in low productivity collective forests in Southwest China. The paper developed three scenarios for the management of an existing collective forest plot in a mountainous area, examining economic incentives and how payments for CO₂ sequestration and offsets affect these incentives. The scenarios were: continuation of the status quo, transition to sustainable forest management (SFM) and conversion to a short rotation species for producing biomass for electricity generation. The authors found that SFM was risky for forest managers and highly sensitive to revenues from initial thinning. Also, energy production from stem wood was too low value to compete with timber, even with offsets revenues. Although conversion of existing forest into short rotation species for timber was more profitable than any of the above scenarios, large-scale clear cutting would most likely have disastrous environmental impacts. The results highlight the need for improved regulatory and analysis capacity at China's State Forest Administration, particularly at

local level to provide more flexibility than the current quota system whilst still enforcing environmental standards.

The last three papers are devoted to forest-based biomass for energy in Uganda, where growing energy demand cannot be met by overstretched infrastructure and the majority still rely on traditional biomass use. The paper by Hazelton et al. [10] examined the stakeholder dynamics and potential socio-economic impact of eight modern proposed and existing feedstock production models, using a similar methodology as in Chhattisgarh (India). The main distinctions between models were land ownership (communal or private) and feedstock type (by-product or plantation). Small, privately owned production models can be profitable but are unlikely to benefit the landless poor and, if multiplied, could result in resource depletion. The paper mentioned the example of the Gumtindo Cooperative, an SME with NGO involvement, which is considering the use of small-scale woodlots for gasification. Larger projects can have greater financial benefits but may affect adjacent communities. For example, an international energy company has proposed a 50MW biomass powered plant which would require 35,000 ha of *Eucalyptus grandis* in the Amuru and Gulu Districts in Northern Uganda, although problems with land tenure resulted in the company pulling out. The paper of Buchholz et al. [11] continues this theme, modelling the profitability of power production from short-rotation woody crops (SRWC) coupled with a combined heat and power (CHP) under Ugandan conditions. They analysed a 5 MW (electric) base-case scenario with a 2870 ha *Eucalyptus grandis* plantation and a productivity of 12 t ha⁻¹ y⁻¹ under a 5-year rotation. Highly influential variables included plant efficiency and construction costs, plantation design and harvest technologies. They concluded that growing 12-24 t ha⁻¹ y⁻¹ under a 5-year rotation can produce Internal Rates of Return of 16 and 19% over 30 years. Results suggest that economies of scale level-off after 20MW (electric). Plant capacity might need to be driven by proximity to markets for heating or cooling as well as land accessibility. Implementation-related research should focus on SRWC productivity and energy life cycle analysis. Finally, Zanchi et al. [12] analysed the climate benefits from alternative energy uses of biomass plantations in Uganda. The study evaluated the greenhouse gas benefits that could be produced by biomass based energy in Anaka, a rural settlement in Northern Uganda. They explored two alternative uses: electricity production through wood gasification and traditional fuelwood use. The authors estimated that a small-scale gasifier could provide electricity for basic community services by planting less than 10 ha of new short rotation coppices. This system could save 50-67% of GHG emissions in terms of CO₂-equivalent produced by traditional diesel generators. It was also estimated that traditional wood consumption would require 0.02-0.06 ha per capita of plantations to become sustainable.

2. The future of bioenergy and rural development policies in Africa and Asia

Much has happened in the bioenergy arena during the short time since the end of RE-Impact. Other projects have also discovered many other problems that occur within bioenergy projects. The CIFOR Bioenergy Team has documented many of these issues specifically with reference to *J. curcas*, palm oil, sugar cane and forestry including:

- a) Legal and institutional requirements (for example, [13], [14], [15], [16], [17])
- b) Local social impacts (for example, [18], [19])
- c) Local environmental impacts
- d) Local and distal climate change benefits (for example, [20], [21]) and
- e) Financial viability of projects (for example, [22])

A result of this proliferation of problems has been the emergence of numerous certification standards to protect against the issues identified. These have been reviewed by Guariguata et al. [23], and more recently by Goovaerts et al. [24]. In the later paper the authors acknowledge that there are numerous challenges associated with the current status of sustainability certification. This proliferation of schemes has led to:

- a) confusion among actors involved,
- b) market distortion and trade barriers,

- c) an increase of commodity costs, and
- d) questions on the adequacy of systems in place and how to develop systems that are effective and cost-efficient.

Most of the problems and confusion of sustainability schemes in bioenergy has arisen from the rapidness of its expansion and the tendency in the bioenergy arena of a “flavour of the year”. When RE-Impact started the bioenergy rage was *J. curcas*. Several papers in this issue have examined its problems and potential in India and Africa. Significantly, it should also be reported that the project’s research work on this plant in China was cut short by the early realisation of the non-viability of large scale exploitation in our case study [25]. Since then, the “flavour of the year” has switched respectively from *J. curcas* to palm oil to algae to wood. Every time there is a switch there is a rush to develop new resources and prove new technologies, often without the necessary forethought and policies in place. The latest trend and acknowledgement of environmental questionability comes from the use of woody-biomass for electricity generation. In all cases, this does produce less carbon emissions than its fossil energy counterpart in the long-term; however it may take decades until this occurs [26].

So at the end of 2013, the bloom is off the rose somewhat for bioenergy. The reasons behind this are four fold:

1. There is currently no international agreement on reducing greenhouse gas emissions post-2012 (Kyoto Protocol);
2. The EU carbon emission trading scheme is near collapse [27];
3. There is a financial crisis in Europe; and
4. The development of “fracking” technology for shale gas has uncovered new sources of natural gas.

While this natural gas has its own associated environmental problems, at the recent European Business Summit there was concern of a transfer of industry either directly or indirectly to the U.S. [28], [29]. All of these factors may lead to a short-term decrease in interest in bioenergy.

This could actually be advantageous to the development of bioenergy in developing countries. With less pressure from America and Europe to develop bioenergy systems for climate change mitigation, developing countries may have the breathing room to shape bioenergy systems for their own internal energy supply in an orderly fashion. If done properly, this could increase energy supply and improve the environment (see for example Zanchi et al. [12]). Thus, in Africa and Asia prospects of economic and rural development together with fuel self-sufficiency and improved trade balance, rather than climate change mitigation, may still drive forward bioenergy production. However, in order to avoid environmental and social impacts it will be necessary to jointly articulate elements of a number of measures including market-based certification, national policy formulation, national legislation, impact assessments, sustainability planning, land use planning, research, monitoring and evaluation, taking into account country and project specific sustainability criteria [30]. Unfortunately, many of the countries in Africa and Asia where bioenergy can play an important role still lack institutional structures able to articulate this sustainable development. The formation of necessary capacity and structures, where their absence forms a barrier to sustainable development, is therefore required to achieve this objective.

3. References

- [1] Amezaga JM, von Maltitz G, Boyes S, editors. Assessing the sustainability of bioenergy projects in developing countries: a framework for policy evaluation. Newcastle upon Tyne, UK: Newcastle University; 2010, ISBN 978-9937-8219-1-9. Available from: <http://research.ncl.ac.uk/reimpact/publications.htm>
- [2] Bird DN, Zanchi G, Pena N. A method for estimating the indirect land use change from bioenergy activities based on the supply and demand of agricultural-based energy, this issue.
- [3] Hazelton JA, Tiwari S, Amezaga JM. Stakeholder dynamics in bioenergy feedstock production; The case of *Jatropha curcas* L. for biofuel in Chhattisgarh State, India, this issue.

- 1 [4] von Maltitz GP, Setzkorn KA. A typology of Southern African biofuel feedstock production
2 projects, this issue.
- 3 [5] Andersson CEF, Everson TE, Everson CS. Management of oil producing *Jatropha curcas*
4 silvopastoral systems : Risk of herbivory by indigenous goats and competition with planted
5 pastures, this issue.
- 6 [6] Everson CS, Mengistu MG, Gush MB. A field assessment of the agronomic performance and
7 water use of *Jatropha curcas* in South Africa, this issue.
- 8 [7] Borman GD, von Maltitz GP, Tiwari S, Scholes MC. Modelling the economic returns to labour
9 for *Jatropha* cultivation in southern Africa and India at different local fuel prices, this issue.
- 10 [8] Kahrl F, Su Y, Tennigkeit T, Yang Y, Xu J. Large or small? Rethinking China's forest bioenergy
11 policies, this issue.
- 12 [9] Kahrl F, Su Y, Tennigkeit T, Wilkes A, Xu J, Yan M. Incentives for carbon sequestration and
13 energy production in low productivity collective forests in Southwest China, this issue.
- 14 [10] Hazelton JA, Windhorst K, Amezaga JM. Forest based biomass for energy in Uganda:
15 Stakeholder dynamics in feedstock production, this issue.
- 16 [11] Buchholz T, Tennigkeit T, Weinreich A, Windhorst K, DaSilva I. Modelling the profitability of
17 power production from short-rotation woody crops in Sub-Saharan Africa, this issue.
- 18 [12] Zanchi G, Frieden D, Pucker J, Bird DN, Buchholz T, Windhorst K. Climate benefits from
19 alternative energy uses of biomass plantations in Uganda, this issue.
- 20 [13] Caroko W, Komarudin H, Obidzinski K, Gunarso P. Policy and institutional frameworks for
21 the development of palm oil-based biodiesel in Indonesia. . Bogor (Indonesia): Center for
22 International Forestry Research; 2011. p 40. Working Paper 62
- 23 [14] Chin M. Biofuels in Malaysia: an analysis of the legal and institutional framework. Bogor
24 (Indonesia): Center for International Forestry Research; 2011. p 40. Working Paper 64
- 25 [15] de Andrade RMT, Miccolis A. Policies and institutional and legal frameworks in the
26 expansion of Brazilian biofuels. Bogor (Indonesia): Center for International Forestry Research;
27 2011. p 52. Working Paper 71
- 28 [16] German LA, Schoneveld G. Biofuel Investments in Sub-Saharan Africa: A Review of the Early
29 Legal and Institutional Framework in Zambia. Rev Policy Res 2012; 29(4);467–91.
- 30 [17] Romero-Hernández O, Masera O, Romero S, Grunstein M. Legal and institutional
31 frameworks at national and subnational levels for biofuel promotion in Mexico. Bogor
32 (Indonesia): Center for International Forestry Research; 2011. p 42. Working Paper 63
- 33 [18] German L, Schoneveld G. Social sustainability of EU-approved voluntary schemes for
34 biofuels: Implications for rural livelihoods. Bogor (Indonesia): Center for International Forestry
35 Research; 2011. p 34. Working Paper 75
- 36 [19] Schoneveld GC. The anatomy of large-scale farmland acquisitions in sub-Saharan Africa.
37 Bogor (Indonesia): Center for International Forestry Research; 2011. p 32. Working Paper 85
- 38 [20] Frieden D, Pena N, Bird DN, Schwaiger H, Canella L. Emission balances of first- and second-
39 generation biofuels: case studies from Africa, Mexico and Indonesia. Bogor (Indonesia): Center
40 for International Forestry Research; 2011. p 76. Working Paper 70
- 41 [21] Bird DN, Pena N, Zanchi G, Frieden D. Zero, 1, or in between: evaluation of alternative
42 national and entity-level accounting for bioenergy. Global Change Biology Bioenergy 2012;4/5;
43 576–87.
- 44 [22] van Gelder JW, Kouwenhoven D. Enhancing financiers' accountability for the social and
45 environmental impacts of biofuels. Bogor (Indonesia): Center for International Forestry
46 Research; 2011. p 38. Working Paper 60
- 47 [23] Guariguata MR, Masera OR, Johnson FX, von Maltitz G, Bird N, Tella P, et al. . A review of
48 environmental issues in the context of biofuel sustainability frameworks. Bogor (Indonesia):
49 Center for International Forestry Research; 2011. p 36. Occasional Paper 69.

- 1 [24] Pelkmans L, Goovaerts L, Goh CS, Stupak I, Smith CT, et al. Sustainability Certification of
2 Bioenergy. IEA Bioenergy. - Short Summary. Strategic Inter-Task Study [Monograph on the
3 Internet]. Dublin (IRL): IEA Bioenergy; 2013 Jun [cited 2013 Oct 13]. Available from:
4 <http://www.bioenergytrade.org/downloads/iea-sust-cert-summary.pdf>
- 5 [25] Weyerhaeuser H, Tennigkeit T, Su Y, Kahrl F. Biofuels in China: An Analysis of the
6 Opportunities and Challenges of Jatropha Curcas in Southwest China. Bieijing (PR): ICRAF China.
7 2007. P 27. CRAF Working Paper Number 53.
- 8 [26] Agostini A, Giuntoli J, Boulamanti A. Carbon accounting of forest bioenergy. Ispra (IT): Joint
9 Research Centre, Institute for Energy and Transport. 2013. P 88. Report no. EUR 25354 EN.
- 10 [27] Harvey F. Europe's climate chief vows to fight on to save emissions trading scheme.
11 Guardian [Internet]. 2013 Apr 17 [cited 2013 Jun 03]. Available from:
12 [http://www.guardian.co.uk/environment/2013/apr/17/europe-climate-chief-vow-save-](http://www.guardian.co.uk/environment/2013/apr/17/europe-climate-chief-vow-save-emissions-trading)
13 [emissions-trading](http://www.guardian.co.uk/environment/2013/apr/17/europe-climate-chief-vow-save-emissions-trading)
- 14 [28] Vincenti D. Thumann: EU must cur green tape to boost industrial competitiveness.
15 [Newsletter on the Internet]. Brussels (B): Euractiv Network; [Updated 17 May 2013 May 17;
16 cited 2013 Jun 03]. Available from [http://www.euractiv.com/specialreport-ebs/thumann-EU-must-](http://www.euractiv.com/specialreport-ebs/thumann-EU-must-cut-green-tape-519718)
17 [cut-green-tape-519718](http://www.euractiv.com/specialreport-ebs/thumann-EU-must-cut-green-tape-519718)
- 18 [29] Hall M. Hedegaard Forget US-style shale gas revolution. [Newsletter on the Internet].
19 Brussels (B): Euractiv Network; [Updated 17 May 2013 May 17; cited 2013 Jun 03]. Available
20 from <http://www.euractiv.com/sustainability/cooperation-shale-answer-europe-news-519803>
- 21 [30] Harrison JA, Von Maltitz G, Haywood L, Sugrue A, Diaz-Chavez R, Amezaga JM. Mechanisms
22 for Driving Sustainability of Biofuels in Developing Countries. Renew Energ Law Policy Rev 2010,
23 2, 197-211.