

Mitigating indirect impacts of biofuel production

Case studies and Methodology

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Summary

Background – need to address indirect effects

In follow up to the Gallagher Review¹ recommendation to identify demonstrably sustainable biofuels, the RFA commissioned work to develop a methodology that can objectively distinguish biofuels from energy crops with a low risk of indirect effects. The study results are relevant for bioenergy generally (where purpose grown feedstocks are used) rather than biofuel in particular. The work is based on an analysis of six case studies.

Intended use of the methodology to mitigate indirect effects

The methodology should enable individual companies to initiate projects that can demonstrate that the resultant biofuel has a low risk of indirect effects. It sets out the criteria that would need to be complied with for this purpose and how compliance with these criteria could be demonstrated and verified. The RFA intends to include this methodology as an option for fuels supplied under the RTFO from April 2010 and will propose it for consideration for inclusion in other biofuel sustainability schemes such as the Roundtable on Sustainable Biofuels (RSB) and policies such as the EU Renewable Energy Sources Directive (RED).

The DISPLACEMENT-mitigation methodology and underlying case studies

Indirect effects of additional biofuel feedstock production are the result of a displacement of existing production on land that was already in use for other purposes e.g. existing rapeseed oil production that was previously used for the food sector is now used for biodiesel production. The demand for the vegetable oil for food is assumed to remain, and therefore must be met from somewhere else. As the vegetable oil market is quite fungible, the displaced demand could be met from a different feedstock in a different country – e.g. Malaysian palm oil. Unless and until all of the agricultural commodity markets adopt sustainability standards, the risk is that the displaced demand will be met from unsustainable sources.

Preventing displacement, by realising *additional* production instead of displacing existing production, is therefore at the heart of the 'project level'² solutions proposed here to minimise the risk of indirect effects. The proposed criterion for bioenergy feedstock production with a low risk of indirect effects therefore is:

Additional production has been realised without displacing existing provisioning services³ of the land.

¹ http://www.renewablefuelsagency.gov.uk/_db/_documents/Report_of_the_Gallagher_review.pdf

² The term 'project-level' is used to refer to a specific activity or set of activities under the control of single party – it does not necessarily imply a biofuel only 'project' as some fuel chains such as soy or palm oil do not necessarily fit in such an easily identifiable and vertically integrated 'biofuel' project.

³ The Millennium Ecosystem Assessment distinguishes four categories of ecosystem services: provisioning services, regulation services, cultural services and supporting services. Provisioning services are defined as

The methodology focuses on three main options to comply with the above criterion. The feasibility of these options, their economics, barriers, sustainability impacts and their potential were analysed using the following 'real-life' case studies:

- 1** The use of land without provisioning services⁴.
 - a. Expanding oil palm production on Imperata Grassland⁵ in Indonesia
- 2** Increasing land productivity through integration with non-bioenergy feedstock systems
 - a. Integration of sugarcane with cattle in Brazil
 - b. Integration of soy with cattle in a rotational system in Brazil
- 3** Increasing the land productivity of existing bioenergy feedstock systems
 - a. Increasing the yields of an existing sugarcane plantation in the Philippines
 - b. Increasing the yields of existing palm oil production in Liberia

In addition, the report includes an analysis of a specific feedstock-region mix looking at bioethanol from EU-grown wheat with useful co-products replacing soy meal and grains as animal feed. A summary of two of these case studies is included in Table S-2 below.

While the conclusions are specific to each study, overall the case studies demonstrate that there is significant potential to increase bioenergy feedstock production without displacing production for other purposes. For example, the potential for sugarcane expansion in South America through integration with cattle (without displacing the cattle) is several times larger than the current sugar cane area.

The analysis of EU wheat took a different approach to the other case studies, taking a feedstock-region rather than project level approach. The analysis found that, whilst this may offer an interesting approach to identify biofuels with a low risk of indirect effects at a higher level of aggregation than at the individual project level, there would remain an element of displacement. Additional analysis would therefore be required to be able to draw firm conclusions on whether such biofuels offer a low risk of indirect effects.

Whilst the feedstock-region approach requires more analysis, the project level case studies demonstrate significant opportunities that are as economically viable as the dominant production models that put a higher pressure on land-use change. The main barriers to wide- scale adoption are therefore often not of economic nature but typically find their origins in less quantifiable areas such as governance issues, contractual relationships and business models, land right issues and customary practices. For example, in Indonesia it is difficult to get a permit for palm oil on 'degraded' (imperata grassland) areas as many of these are officially still classified as 'forest' by the national government. Given the right incentives, the biofuel sector may be able to overcome

harvestable goods such as fish, timber, bush meat, genetic material, etc. (Commission for Environmental Assessment, 2006).

⁴ See previous footnote.

⁵ Areas of cleared forest in Indonesia have become overgrown by Imperata. This grass prevents the land from developing naturally into secondary forest and is therefore considered to be problematic (Reinhardt et al., 2007).

these barriers – thereby fulfilling (a part of) their feedstock requirements in ways that have a demonstrably low risk of unwanted indirect effects.

Table S-1 summarises, for each of the three types of solutions, how companies can demonstrate compliance and what the claims are that they could make.

Table S-1 Summary of methodology.

	'Unused land'¹	Integration with non-bioenergy system	Increased productivity of existing bioenergy feedstock system
Displacement criterion	<u>Additional</u> production has been realised without displacing existing provisioning services of the land		
Demonstrating additionality	Demonstrate the project activity that increases feedstock production is additional: i.e. in absence of the bioenergy feedstock demand the measure would not have been implemented during the crediting period ⁶ .		
	i.e. the land would not have been taken into production	i.e. the integration model would not have been implemented	i.e. the yield increasing measure would not have been implemented
Setting the baseline	Zero (land previously unused)	Business as usual (BAU) production levels of non-bioenergy system (e.g. milk or beef)	BAU production levels of existing bioenergy system, anticipating BAU yield increases
Monitoring	Monitoring of realised bioenergy feedstock production levels	Monitoring that baseline production levels of non-bioenergy feedstock are maintained	Monitoring of realised bioenergy feedstock production levels
Claim that can be made	All realised production has a low risk of indirect effects	All realised bioenergy feedstock production has a low risk of indirect effects	The additional production ('realised production' minus 'baseline production') has a low risk of indirect effects

¹ The term 'unused' land is intended to signify land that is unused from an agricultural perspective but it is recognised that land is unlikely to ever be truly unused and safeguards for land rights for example are recognised in the resulting methodology.

Implications for bioenergy policy

The case studies demonstrate that a significant potential exists to increase bioenergy feedstock production economically with a low risk of unwanted indirect effects. The main barriers faced for this economic sustainable potential revolve around matters such as contractual relationships, land rights and customary practices. Whilst not

⁶ Crediting period is the finite length of time during which the project's claim of low indirect risks is valid, e.g. 5 or 10 years. The crediting period can be renewed, but this requires a new assessment of additionality and the baseline

insurmountable, these barriers are nevertheless sufficient that such opportunities appear unlikely to be realised in the absence of targeted policy incentives. We therefore recommend that the RFA continues to work on this promising methodology and that it puts forward the methodology for inclusion in the RTFO in the future. The RFA can also raise awareness of the methodology with other organisations, including biofuel sustainability standards, national governments and the European Commission. Feedback on the approach and practicalities of implementing the methodology from parties willing and able to pilot this approach is welcome.

Table S-2 – Summary of selected case studies.

Case study	How it prevents displacement	Economic viability	Key barriers	GHG & Sustainability	Potential
Expanding onto 'unused' land					
Palm oil on Imperata Grassland	Increase palm oil production without displacement by expanding onto 'unused land'	Neutral/Positive -Lower planting costs -Lower/equal operational costs -Good yields with good practices -No timber income, but places with high value timber scarcer	-Land right conflicts -Technical barriers for smallholders -Preference for (secondary) forest -Perceived soil fertility -No policy incentives	<u>Risks</u> -Informal land rights and uses -Use of pesticides <u>Opportunities</u> -Increased carbon stocks -Economic development	>35 Mha Imperata in Asia >8.5 Mha in Indonesia 3-4 Mha suitable for oil palm in Indonesia, compared to 4.5 Mha today
Increasing land productivity of non-bioenergy systems					
Sugarcane-cattle integration	Sugar cane production is introduced while maintaining/increasing milk/beef production.	For the mill owner: neutral -Few additional investments -Some missed income from excess electricity -Bagasse animal feed sold at cost price For the cattle owner: positive -Income increased > 7-fold	-Mill owner has to deal with several cattle farmers -Dependency of cattle farmer for bagasse -Preference for 100% sugar cane for infra investment -Knowledge	<u>Risks</u> -Dependence of cattle farmer on mill for their feed -Biodiversity pasture <u>Opportunities</u> -Higher income cattle farmers -Reduced land conflicts -Reduced pressure on land from cattle	> 450 Mha extensive cattle in South America > 200 Mha in Brazil > 140 Mha suitable for sugar cane in South America, compared to 8 Mha today

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Table of contents

1	Introduction to the document and its scope	1
1.1	Project scope	1
1.2	Approach	2
1.3	How to read this document	3
2	Case study of oil palm cultivation on Imperata grassland in Indonesia	4
2.1	General project description	4
2.2	Background	4
2.3	Suggested solution to prevent displacement	6
2.4	Effectiveness & verifiability	9
2.5	Barriers to the wide scale implementation of the displacement measure	10
2.6	Economic viability	12
2.7	Sustainability and GHG-performance	13
2.8	Potential	15
	References	16
3	Case study of a sugarcane cattle integration model in Brazil	19
3.1	General project description	19
3.2	Background	19
3.3	Suggested solution to prevent displacement	20
3.4	Effectiveness & verifiability	22
3.5	Barriers to the wide scale implementation of the displacement measure	24
3.6	Economic viability	26
3.7	Sustainability and GHG performance	28
3.8	Potential	29
	References	30
4	Case study of integrated soy and cattle farming in Brazil	31
4.1	General project description	31
4.2	Background	32

4.3	Suggested solution to prevent displacement	35
4.4	Effectiveness & verifiability	37
4.5	Barriers to the wide scale implementation of the displacement measure	37
4.6	Economic viability	39
4.7	Sustainability and GHG-performance.....	40
4.8	Potential.....	41
	References	42
5	Case study of sugarcane yield increases in the Philippines.....	43
5.1	General project description	43
5.2	Background	44
5.3	Suggested solution to prevent displacement	45
5.4	Effectiveness & verifiability	47
5.5	Barriers to the wide scale implementation of the displacement measure	49
5.6	Economic viability	51
5.7	Sustainability and GHG-performance.....	51
5.8	Potential.....	52
6	Case Study of smallholder yield increases in Liberia.....	54
6.1	General project description	54
6.2	Background	55
6.3	Suggested solution to prevent displacement	57
6.4	Effectiveness and verifiability	60
6.5	Barriers to the wide scale implementation of the displacement measure	61
6.6	Economic viability	62
6.7	Sustainability and GHG-performance.....	63
6.8	Potential.....	65
	References	66
7	Case study of a feedstock-region-level approach to EU wheat.....	67
7.1	Arguments for a low risk of indirect effects of EU-wheat-ethanol.....	67
7.2	Feasibility of a feedstock-region-level approach to displacement mitigation..	70
7.3	Does a region-feedstock approach fit with a project-level approach?	71
7.4	Conclusions.....	72

References	73
8 Methodology	74
8.1 Scope	75
8.2 Mitigation criterion for unwanted indirect effects	76
8.3 Demonstrating compliance: Baseline, additionality and registration.....	76
8.4 Verification	81
8.5 Claims	81
8.6 Summary of the methodology	83
9 Towards implementation: barriers and next steps.....	84
9.1 Barriers to implementation.....	84
9.2 Next steps	86
Appendix A Introduction to indirect effects.....	90
A 1 Indirect impacts of biofuel production.....	90
A 2 Difficulties in assessing and mitigating indirect impacts	91

1 Introduction to the document and its scope

This document describes six case studies that demonstrate biofuel feedstock production with a low risk of unwanted indirect effects. Based on these case studies, a methodological framework is proposed that can be used in the RTFO and in other policies or voluntary initiatives, to distinguish and credit biofuels with a low risk of indirect effects. Draft results have been presented to and discussed with stakeholders from industry, Government, universities and NGOs at two workshops in London, UK. This chapter sets out the project's scope and introduces the remaining chapters.

1.1 Project scope

This project was initiated by the RFA with the aim to develop a framework for a methodology that can be used in the RTFO and in other policies or voluntary initiatives, to distinguish and credit biofuels with a low risk of indirect effects. In essence the methodology should enable individual companies to practically demonstrate whether their biofuel have a low risk of indirect effects, by setting out the criteria that would need to be complied with for this purpose and how compliance with these criteria could be demonstrated and verified.

To keep the scope manageable the RFA has defined the following starting points for this project:

- 1** The RFA considers that indirect effects form a serious risk that the RFA want to address in follow up to the Gallagher review.
 - a. This project is not intended to debate whether indirect effects are a significant risk for biofuels.
- 2** Direct impacts may not be addressed directly in the sectors in which they occur.
 - a. As outlined in the Gallagher Review, the most efficient means of addressing indirect effects in biofuels would be to ensure that all sectors address their own direct impacts (e.g. agriculture; forestry etc.) However, as long as this is not effective worldwide, to ensure that biofuels offer genuine benefits, their production must demonstrably avoid indirect effects.
- 3** Under the RED, Europe has adopted a biofuels target for 2020.
 - a. This project is not intended to consider whether biofuels are a cost-effective GHG abatement option; but rather to ensure as far as possible that biofuels genuinely contribute to GHG abatement and that this is maximised.
- 4** Areas deemed suitable for bioenergy expansion (sometimes referred to as 'idle/degraded/marginal land') must meet the requirements already specified in the RFA's Carbon and Sustainability Technical Guidance.

- a. The RFA's C&S Technical Guidance provides a starting point for the methodology on avoiding indirect effects.

In addition to the above starting points, this methodological framework in this project takes a project-level approach – meaning that the low risk of indirect effects can be demonstrated for individual feedstock production units. This in contrast to approaches that take a more regional or crop-by-crop approach in which certain regions or crops (or combinations thereof) are claimed to have a low risk of indirect effects. That is not to say that such other approaches cannot be effective but their effectiveness and design is simply not analysed in detail within the scope of this project. Nonetheless, one of the case studies that form the basis of this project has focussed on such a regional crop-specific approach, see Chapter 7.

1.2 Approach

The methodological framework discussed here is based on six case studies that could potentially claim a low risk of indirect effects:

- 1** Integration of sugarcane with cattle in Brazil
- 2** Integration of soy with cattle in a rotational system in Brazil
- 3** Increasing the yields of an existing sugarcane plantation in the Philippines
- 4** Increasing the yields of existing palm oil production in Liberia
- 5** Expanding oil palm production on Imperata Grassland in Indonesia
- 6** Ethanol from wheat produced in the EU

The last case, ethanol from EU wheat, analyses a regional crop-specific case rather than a specific feedstock 'project-level' approach. This case was chosen for its relevance in the current debate on indirect effects in the UK and to gain a basic understanding of the fit between such a feedstock-regional-level approach with a project-level approach.

The other case studies were chosen to generate a representative mix in geographical origin and three different approaches to potentially prevent displacement, and thereby reduce the risk of indirect effects:

- 1** Expanding production without displacement of current production by expanding onto currently 'unused land';
- 2** Expanding production without displacement of current production by increasing the productivity of non-bioenergy systems;
- 3** Expanding production without displacement of current production by increasing the productivity of existing bioenergy systems (e.g. yield improvements).

For each case the following elements have been analysed:

- General characteristics and context of the project
- How does the project minimise indirect effects?
- Verifiability
- Barriers to wide scale implementation
- Economic viability
- Sustainability risks and impacts, including GHG impacts
- Potential for replication

The lessons learned from these case studies form the basis for the methodological framework.

1.3 How to read this document

The core of this document consists of the six case studies. Each of the case studies are analysed on the elements mentioned above.

- Chapter 2 presents a case study in which production is expanded by expanding onto 'unused' land.
- Chapters 3 and 4 present two case studies in which production is expanded by integrating bioenergy feedstock production with non-bioenergy systems (cattle) which leads to a higher overall land productivity.
- Chapters 5 and 6 present two case studies in which production is expanded by increasing the productivity of existing feedstock production systems that can be used for bioenergy.
- Chapter 7 finally present a feedstock-region-level case for ethanol from EU wheat.
- Based on the case studies a methodological framework is discussed in Chapter 8. The methodology is intended to enable companies to identify biofuels with a low risk of indirect effects.
- Finally, Chapter 9 discusses the next steps towards implementation of the methodology and the main barriers for such implementation.

An introduction to the mechanisms of indirect effects and some key characteristics of these indirect effects are included in Appendix A. Understanding these characteristics is important for defining effective mitigation options.

2 Case study of oil palm cultivation on Imperata grassland in Indonesia

Acknowledgements

This case study presents an example of oil palm cultivation on unused land in Indonesia. We gratefully acknowledge the help and inputs from David McLaughlin (WWF) and Laszlo Mathe (WWF).

2.1 General project description

In Ketapang district (West Kalimantan province, Indonesia) an oil palm mill and plantation were established on approximately 19,000 hectares of Imperata grassland (known as alang-alang in Indonesia). The project is certified against ISO 9001 and ISO 14001 quality and environmental management. It is a member of the RSPO and working towards RSPO certification. The organisation has a smallholders program that includes three Cooperatives and over 3,000 farmers in 6,400 hectares of palm oil plantation.



Figure 1 Location map Ketapang district.

2.2 Background

Many natural tropical forests in Indonesia have become fallow or wasteland after being cleared and burned and – as a result – have been overgrown by Imperata. This grass prevents the land from developing naturally into secondary forest and is therefore considered to be particularly problematic (Reinhardt et al., 2007). The total area of

Imperata grassland in Indonesia alone is estimated at 8.5 Mha (Garrity et al., 1997), compared to an area of 4.5 Mha planted with oil palm in 2007 (FAO, 2009).

Imperata is found widely distributed on the full range of soil orders. It occupies both fertile and infertile soils across a wide range of climates and elevations (Garrity et al., 1997). It has been suggested by several parties that oil palm expansion could expand more sustainably by focussing on such Imperata grasslands in stead of forested areas (Fairhurst and McLaughlin, 2009).

Box 1 Imperata grassland

Imperata cylindrica (L.) Raeuschel var *major* has been nominated as one of the world's 10 worst weeds (Holm and Herberger, 1969). Many natural tropical forests have become fallow or wasteland after being cleared and burned and – as a result – have been overgrown by Imperata (Rötheli, 2008). In general, Imperata areas are low in biodiversity (Fairhurst and McLaughlin, 2009). There is no doubt that the Imperata grassland ecosystem has much less to offer than the forest in terms of biodiversity, total biomass for the maintenance of soil fertility and carbon capture, and as a producer of useful materials for human populations (UNU, 1995).

Although propagated by seed, one of the main characteristics of Imperata is the formation of a dense mat of rhizomes just below the surface. Some buds of the rhizome will turn up to form new shoots, while other buds form rhizome branches (Ayeni, 1985). Rhizomes may remain for long periods in the soil without losing their germination capacity, and they may not be directly connected with above-ground shoots (Eussen and de Groot, 1974). They are constantly capable of sending up new shoots even after destruction of the above-ground biomass after fire - a characteristic that allows this plant to persist and spread at the expense of secondary forest species, which may be destroyed by fire. Competition for space, nutrients, and water in the root zone will allow the grass to crowd out crop plants, while at the same time the Imperata secretes substances that further inhibit the growth of competitors (Eussen, Slamet, and Soeroto, 1976; Eussen, 1977).

The main reason for this behaviour is that Imperata needs sunlight and will die if tree species are able to grow tall enough to shade it out. In primary forest, it may appear briefly in natural gaps but will quickly be shaded out by tree regrowth. Once established in larger gaps or following several years of continued shifting cultivation, it will still eventually be shaded out if the regrowth is protected from fire.

The establishment of what is known as "sheet alang-alang", in which the grass is dominant over wide areas, is often caused by human activity through regular burning, which favours the grass over other species, unless these are also fire-resistant and possess a deep root system.

Although known as a persistent weed on plantations, Imperata may fairly easily be controlled through the establishment of cover crops until shading out by the trees takes place. It is the sheet Imperata areas that provide the biggest problems when restoration of tree cover is desired. (Source: UNU, 1995)

Box 2 Scale related categories of Imperata

Imperata may exist in quite large contiguous areas or as small patches in a vegetation mosaic with secondary forest, shrubs or cropped fields. Most national estimates of Imperata area are not based on detailed map sources, due to data limitations. This leads to the exclusion of the smaller-sized Imperata areas in estimates. Garrity et al. (1997) distinguish four different scale related categories of Imperata: mega-grasslands, macro-grasslands, meso-grasslands and micro-grasslands.

The *mega-grasslands* are often referred to as 'sheet Imperata'. They are the large contiguous areas of Imperata that would appear on small-scale maps (e.g. 1:1,000,000). These grasslands are large enough to span municipality or district-level boundaries. This category is the one featured in discussions of the so-called vast Imperata 'wastelands'.

Macro-grasslands are also large contiguous areas that encompass individual village boundaries. However, these areas are confined within a sub-district or municipality. They exhibit many of the ecological characteristics of the mega-grasslands, but may not be large enough to appear on national land-use maps.

Meso-grasslands are *Imperata* areas more-or-less confined within villages. They are not large enough to be estimated except with quite large-scale maps (say 1:50,000). They are often of major local importance. Fire control is much more feasible in the meso-grasslands through regulations and monitoring at the village level.

The *micro-level grasslands* correspond to grass patches within individual fields. These patches can be managed by the individual farmer or land manager. Because they are 'privately' controlled, and are isolated by surrounding cropland or secondary vegetation, the grass can be managed as a problem of weed control. A major issue at this scale is how the invasion of *Imperata* can be prevented or alleviated in established agricultural or forestry enterprises. Failure to be able to control the grass often ruins the farmer's investment in crops or trees.

(Source: Garrity et al., 1997)

2.3 Suggested solution to prevent displacement

In this case 'the production on unused land' model was used, which prevents displacement and thereby potential unwanted displacement⁷. By establishing a palm oil plantation on unused land direct LUC takes place (land is converted to a palm oil plantation), but since there are no displacement effects, there's no risk of displacement.

Agricultural and economic feasibility of the system seem promising. Land clearing in Imperata areas is essentially limited to rolling the grass flat and the removal of remnant trees followed by chemical control of the Imperata until another crop shades out the Imperata (Fairhurst and McLaughlin, 2009) (see also the table below and the

⁷ Preventing iLUC was not a motivation at the time of establishment, since the issue was not considered at that time.

textbox 'Converting Imperata grasslands'). Palm oil yields found in this case study for the plantations established on Imperata grasslands are higher than the industry average.

Table 1 Pictures showing how Imperata grassland can be converted to oil palm (Source: Fairhurst and McLaughlin, 2009).

	<p>Typical alang-alang landscape in Kalimantan.</p>
	<p>'Rolling' the alang-alang is the first step in the conversion process. After the roller has pressed the alang-alang flat, chemical control using glyphosate is much easier and cost effective. The roller was manufactured by a local workshop.</p>
	<p>A tractor mounted boom sprayer fitted with single nozzle lines is very effective for spraying out alang-alang in flat areas.</p>

	<p>After two applications of glyphosate have been applied, legume cover plants (LCP) are planted but a large application of rock phosphate (1 t ha⁻¹ over three split applications) is required so that the LCP outcompetes the alang- alang.</p>
	<p>After three months LCP completely dominate the ground cover vegetation. Periodic maintenance is required to prevent the LCP from smothering the young palms and to ensure a two meter circle of bare ground is maintained around the base of each palm.</p>

Box 3 Converting Imperata grasslands

Why is Imperata viewed as a difficult weed to control? Part of the problem lies with attempts to promote *either* mechanical, *or* chemical *or* biological methods of control (Friday *et al.*, 1999; Indonesian Rubber Research Institute and Natural Resources Institute, 1996) rather than developing strategies that *integrate* the different techniques. Some oil palm plantation companies have become expert at Imperata control in new oil palm developments and the key components are:

- Control fire in the area to be developed (Friday *et al.*, 1999);
- Slash or roll and then spray several times with glyphosate to kill the Imperata (Terry *et al.*, 1997; Zaini and Lamid, 1993);
- Recapitalize soil phosphorus with 1 t ha⁻¹ RRP (Sri Adiningsih and Fairhurst, 1996);
- Plant legume cover plants (LCP) (Rankine and Fairhurst, 1999).

When supplied with adequate P, LCP can out-compete the Imperata but it is important to time each step correctly. LCP must be sown as soon as the second round of spraying has been completed and P fertilizer must be applied on time so that the LCP can grow rapidly and compete effectively with any residual Imperata that has not been controlled by spraying. Rapid palm canopy development also contributes to eradication since Imperata is not shade tolerant. In reality, then, it is much easier and certainly less costly to clear Imperata vegetation compared with secondary forest, provided the correct procedure is followed.

The first step is to flatten the Imperata vegetation using a tractor drawn roller. After 15 days the vegetation is sprayed with glyphosate² (2 L / ha) using a tractor-mounted boom sprayer or knapsack sprayers. A second application of glyphosate (1 L / ha) is applied using knapsack sprayers 15 days after the first round. LCP are sown immediately after the second application of glyphosate to maximize the period for cover plant establishment whilst Imperata growth is suppressed by glyphosate. A third spot spray application of glyphosate (0.5 L ha⁻¹) is made 3-4 weeks after LCP planting and a final spot spray round (0.25 L ha⁻¹) is applied to eradicate remaining patches of Imperata after a further 3-4 weeks. By 70-90 days after rolling, Imperata should be completely eradicated with LCP dominating the vegetation.

(Source: Fairhurst and McLaughlin, 2009).

2.4 Effectiveness & verifiability

In order to verify whether the model is effective in preventing displacement it needs to be determined what provisioning services (e.g. food, building material) the land supplied before and after the project was implemented. If at least the same provisioning services remain after the project, the risk for displacement is considered minimal.

2.4.1 Increasing CPO production by expanding on “unused” land

Although it was not formally established whether in the project area in the Ketapang district displacement occurred, it was suggested that in terms of food production it is likely that there was no displacement, since the area is very remote and there’s no evidence to suggest displacement. Some smallholders might have moved since the project was implemented, but no data is available on this (Personal communication David McLaughlin, 8 October 2009).

In general, there are different views on the use and value of Imperata grasslands. Some state that Imperata grasslands are ‘wastelands’ or form a vast underutilized natural resource (Garrity et al., 1997). However, others argue that these grasslands might be used and claimed by local people, e.g. for grazing and fallow-rotation cropping in shifting agriculture (Rötheli, 2008). Traditional shifting cultivation implies mainly subsistence crops grown in a rotational system that includes a long fallow period. Land is used for only 1-3 years, and then abandoned for up to 20 years (FWI/GFW, 2002).

In summary, the reviewed case study is unlikely to have caused serious displacement although no formal evidence is available for this. In general, some areas of Imperata will be used by local communities and for each potential conversion of Imperata to oil palm a local assessment should be made to prevent displacement effects and land right conflicts.

2.4.2 Additionality

In Indonesia Imperata grassland rehabilitation receives attention by government at all levels. The grasslands have been considered a prime target for transmigration schemes that attempt to resettle rural people to these areas from the over-populated island of Java. There's interest in investigating how to develop sustainable smallholder farming systems on these lands (Röthelli, 2008). It is unclear whether this has been effective.

Also other nations with large areas of Imperata grasslands (see also section 'Potential'), have looked at possibilities toward making better use of their Imperata grasslands, but the efforts have not paid off satisfactorily (Garrity et al., 1997).

The level of certainty that can be given on the effectiveness of this model to prevent displacement - today and up to 2020 - depends on the assurance that can be given on whether or not the land is in use today or will be tomorrow. If the land is not in use today and barriers for local communities are high (see also section 'Barriers to wide scale implementation of the displacement measure') it is plausible that the model is effective and displacement is not probable to take place now or in the period up to 2020.

2.4.3 Verifiability

In order to prove whether there is no or at least a low risk of displacement it should be established whether the land is used or not and the provisioning services of the area should be determined. Determining the use of the land should be done by a combination of analysing available land use data and consultation with local communities. Since areas of Imperata grassland can be remote and difficult to access, and villages are often dispersed, collecting data on the current land use will incur some costs.

2.5 Barriers to the wide scale implementation of the displacement measure

The main barriers to the wide scale implementation of cultivation on Imperata grassland have to do with social and cultural aspects, rather than technical issues. With the right equipment and adequate sequencing, clearing the Imperata is not a technological issue. Costs are neither likely to be an issue for large plantations (see also section 'economic viability').

1 Preference for (degraded) secondary forest over Imperata: In many cases oil palm planters choose to use lands with (degraded) secondary forest. This has several reasons:

- a. Perceived soil fertility.** Many in the industry choose to use secondary forest land because of perceived better soil fertility in these areas. However, research shows that soil fertility of Imperata grasslands are not structurally worse than those of secondary forests (Fairhurst and McLaughlin, 2009). In addition, research shows that the main

determinant of oil palm yields are agricultural practices, rather than soil fertility (Fairhurst and McLaughlin, 2009). The project in Ketapang district demonstrated the potential to increase yield where oil yields have been increased to 8 tonne / ha in plantings established on soils with a yield potential of 6 tonne / ha (Class III soils) under the Indonesian oil palm yield potential classification system. This demonstrates that there is a stronger relationship between yield and field management than between yield and previous land use;

b. Local perceptions: Local players in the industry and local communities often do not attach value to the forest. The opposite is often true. Developing forest into palm oil plantation is considered as a positive development by many local people (Personal communication David McLaughlin, 8 October 2009);

c. Timber revenues: Timber revenues are often mentioned as motivation for clearing forest to establish plantation. However, this contradicts with what Fairhurst and McLaughlin (2009) found in their study. They assessed four different land types in terms of yield potential and economic returns on investment. The seven estates visited all reported that timber revenues were not part of the financial equation.

2 Use by local people and land tenure conflicts: Although Imperata is agriculturally not a valuable plant, it might have a value for local people (e.g. for thatching) or indicate the presence of a rotational cropping system (subsistence farming). Since it is not always clear who has land (use) rights in these areas, the potential conflicts over land tenure this creates prevent companies from establishing estates on Imperata grasslands. Delays in plantation establishment due to lengthy negotiations for land acquisition induce additional expenditures. To avoid conflicts with local people and delays in plantation establishment, the oil palm plantation companies continue to use forestland instead of Imperata (Rötheli, 2008).

3 Barriers for smallholders: While costs appears to be a negligible factor for plantation companies, independent poor smallholder farmers may not be able to afford the conversion of Imperata grasslands to oil palm plantations on a medium scale: herbicides are too expensive. If they do not have animal draw, preparation is too labour-intensive, requiring about 200 days per hectare.

4 No policy incentives for oil palm development on Imperata grassland and current control mechanisms allow forested areas to be converted: In Indonesia, regulations are reported to be inconsistent and policies seem to favour (oil palm) establishment on forestlands rather than on Imperata grassland. In 2005, the government passed a moratorium on forest conversion for estate crops. However, at the same time, the Ministry of Forests released two contradictory circulars to the local governments. One stated that the moratorium was still effective, while the other stated that in order to optimize the use of forestland for estate crops, the Ministry would evaluate proposals for conversion on their own

merits (Rötheli, 2008). Moreover, there are still governmental offices that tend to issue permits to clear forests and to sell the wood before planting crops, rather than developing previously cleared land into plantations. In a number of such cases the concession owners have never established plantations. Rather, they harvested the timber and left the land abandoned. Although this is in contradiction to the obligation formulated in the concession, few cases, if any, have been persecuted (Rötheli, 2008). Even if a project developer wants to develop such degraded lands where a concession has already been given, this is difficult since original concessions are rarely revoked (Hardiono et al., 2003). On the other hand, some Imperata grasslands are classified as 'forest land' and are under the control of the Ministry of Forestry. During the classification, it might have been forest but it is now degraded. Since it is classified as 'conservation forest' or 'productive forest' only forestry activities can be developed and the land cannot be used for agricultural purposes unless permission has been granted by the Ministry of Forestry.

Conclusion barriers

Given the access to proper technology and knowledge, oil palm plantations on Imperata grassland seem economically and agriculturally feasible. Rather, the barriers have to do more with land right issues, cultural perception on knowledge on how to properly establish oil palm on Imperata grasslands.

2.6 Economic viability

Fairhurst and McLaughlin (2009) assessed four land types in terms of yield potential and economic returns on investment. They found oil yields on former Imperata lands that are certainly not inferior to those on other land types. The cost of plantation development and financial returns were greatest from palms developed on Imperata due to lower overall land clearing costs, despite more costly weed control. At present prices oil palm development on secondary forest on hilly land and on heathland provides a very poor economic return, due respectively to the cost of terracing steep slopes in secondary forest land and draining and breaking the hard pan in heathland soils. The largest returns were obtained from planting on Imperata grassland and secondary forest on flat land. Return on investment increased in the order heathland < 2nd forest (hilly) < 2nd forest (flat) < Imperata.

The total costs of establishing and operating oil palm development on Imperata lands and three other types of land are estimated by Fairhurst and McLaughlin (2009) (see Table 2).

Table 2 Planting costs and operating costs for oil palm development on four contrasting land types (Source: Fairhurst and McLaughlin, 2009).

Previous land use	Alang-alang	Flat 2 nd forest	Hilly 2 nd forest	Heathland
Total planting cost (€ / ha)	3,685	3,954	4,984	4,637
Operating costs (€ / ha)	669	669	755	1,006

Fairhurst and McLaughlin (2009) did not include revenues from timber after clearing of secondary forest lands. Revenues from timber could significantly lower establishment cost on secondary forest lands (and potentially even generate a positive cash flow). However, the estates visited in the study all reported that timber revenues were not part of the financial equation (Personal communication David McLaughlin, 8 October 2009). This is supported by Casson et al. (2007), who state that redirecting oil palm developments away from forested lands onto degraded lands is unlikely to result in significant revenue losses for oil palm companies. In the past, oil palm companies were able to generate substantial profits from clearing good quality forest to make way for oil palm plantations. However, it now seems that oil palm companies are finding it more difficult to acquire concessions located on suitable lands containing good quality forest that has economic value and are inclined to calculate the cost of clearing secondary forest as a cost.

In summary, the findings of this case study show that in terms of costs, oil palm cultivation on Imperata grasslands is competitive with oil palm plantation establishment on other land types. The main barriers to the wide scale implementation of cultivation on Imperata grassland have to do with social and cultural aspects, rather than technical or financial issues (see also section 2.5). It is unlikely that costs associated with implementing this type of model are an issue for large plantations.

2.7 Sustainability and GHG-performance

2.7.1 Sustainability risks and impacts

In terms of sustainability risks, palm oil production on Imperata grassland seems to be a sensible choice. Imperata is often considered degraded, with low carbon stocks and low biodiversity. Possible sustainability issues relate primarily to social matters, such as land rights and other uses of the grasslands.

- 1 Use of the land by local communities:** The main sustainability risk of this type of solution to prevent displacement is the (unofficial) use of the land by local communities. Imperata grasslands tend to be remote to roads and markets, and population density is much lower than in intensive agricultural areas. However,

villages – although scattered - often exist throughout these grasslands and although land use appears to be of low intensity, some suggest this is often misjudged (Potter, 1994; Dove, 1986). The land might be used by local people for thatching or rotational agricultural systems. Although it seems unlikely that given the enormous areas of grassland (especially in the mega Imperata grasslands) this constitutes a significant proportion of such an area, decision makers need to know what is really going on in the grasslands. Interventions to foster more intensive and productive use of the grasslands will rely heavily on a realistic understanding of the social and economic conditions on-the-ground in each specific area. Thus, all stakeholders (local people and communities, companies, government) need to be involved in negotiating land-use rights and - as a precondition – existing rights need to be respected, if Imperata grasslands are to be used for oil palm plantations.

- 2 Access to remote areas:** Improvements in road infrastructure will open up the area, also for other actors. This also makes nearby areas more accessible. Practices by other parties without good intentions (e.g. illegal logging) could have dramatic effects on, for example, neighbouring ecologically sensitive areas.
- 3 Use of pesticides to clear Imperata:** In order to establish an oil palm plantation on Imperata grassland, the Imperata needs to be treated with glyphosate in order to eradicate the Imperata (see also textbox 'converting Imperata grassland'). Although glyphosate might also be needed for clearing secondary forest (Fairhurst and McLaughlin, 2009), the application of chemicals could impact the local environment (e.g. water quality). It should be noted that this treatment is only required during the plantation establishment and that it is not structurally required to prevent the Imperata from coming back (once palm canopy is developed Imperata will not come back, since it is not shade tolerant).

2.7.2 Positive side-effects

Other positive effects of this model include the following.

- 1 Prevention of fires:** Because mega-grasslands are so large, the control of fire is often very hard⁸. Ecologically harmful fires in Indonesia are significantly correlated with the distribution of Imperata grassland. Large areas of Indonesia were burned in the 90s, which created large tracks of Imperata grassland. Therefore, the rehabilitation of Imperata by the establishment of oil palm plantations could help prevent fires in the long term.
- 2 Vulnerability of lands:** Heavy rainfalls and droughts affect Imperata grasslands strongly, resulting in floods and fires. The conversion to oil palm plantation could diminish the vulnerability of such areas (e.g. water regulation) (Rötheli, 2008).

⁸ This also poses a risk for establishing plantations on these grasslands, because of the ever present risk of fires. Settlement is most successful when it enters the grassland from the edge, although even there the risk of fire is still serious (Garitty et al. 1997).

- 3 Economic development:** Planting oil palm on Imperata grasslands provides job opportunities, as well as economic and infrastructural development of areas that were previously underutilised.
- 4 High productivity:** Oil palm is expected to make a significant contribution to the predicted two-fold increase in demand for vegetable oils over the next forty years (Fairhurst and McLaughlin, 2009). Oil palm has a high productivity per ha compared to other oil crops (e.g. rapeseed). If oil palm production does not expand to contribute to increased demand, this will likely result in more land used to grow less productive vegetable oil crops (that may displace important food crops and replace wilderness land).

2.7.3 Carbon and GHG performance

The establishment of oil palm plantations on degraded land can provide additional benefits such as carbon sequestration and soil protection via permanent groundcover. Perennials such as oil palm typically have no negative impacts on soil carbon due to no tillage. In addition, perennials store carbon in above-ground biomass. Ecofys (2007) shows that conversion from Imperata grassland to oil palm increases carbon stocks significantly. Carbon benefits are gained mainly through increased carbon stocks in above and below ground biomass. Research carried out in Sumatra and Kalimantan demonstrated that Imperata grasslands contain around 39 tonne C/ha while oil palm contains around 91 tonne C/ha (Murdiyarto et al., 2002). However, it should be noted that these data cannot automatically be assumed to apply in all situations since Imperata occurs in different areas with different soils.

2.8 Potential

The potential of this model to prevent displacement depends on the availability of the unused land. In the case of palm oil production on Imperata grassland there seems ample potential.

In 2007, the total harvested area of oil palm fruit in Indonesia amounted to 4.5 Mha. The total area in South-East was 8.7 Mha and global total harvested area amounted to 13.9 Mha in 2007 (FAO, 2009).

According to Garrity et al. (1997) the area of Imperata mega-grassland in Indonesia amounts to over 8.5 million hectares⁹ and in India to some 8.0 million ha. In Asia the area of Imperata is about 35 million ha¹⁰. It should be noted that this is an estimate of

⁹ Imperata grasslands are often associated with other vegetation types, in particular other grass species and secondary forest. According to Garrity et al. (1997), the total area of grasslands in Indonesia – mega, macro and meso – covers about 13.5 million ha. Garrity et al. used the most uniform and comprehensive data source for the estimation of Imperata areas – the Centre for Soils and Agroclimate Research (CSAR) in Bogor. CSAR developed a national map of Imperata distribution at a mega-grassland scale of 2’500’000. According to this Imperata distribution map, the largest Imperata areas are located in Sumatra and Kalimantan – about 2 million hectares on each island.

¹⁰ Garrity et al. (1997) developed three estimates: 1) a conservative estimate, 2) an estimate of the expected area of sheet *Imperata*, and 3) an estimate that assumed a larger figure to include macro and meso level

expected area of sheet Imperata, and does not include macro, meso or micro level Imperata.

The countries with the largest proportion of their surface area covered with *Imperata* are Sri Lanka (23%), the Philippines (17%), and Vietnam (9%). Laos, Thailand, Myanmar, and Bangladesh all have similar proportions of their land area infested with Imperata; all are in the range of 3 to 4%. Countries that have minor areas of Imperata as a proportion of their total land area are Malaysia (< 1%), Cambodia (1%), and the southern part of China (2%).

Not all Imperata grasslands will be suitable for oil palm, since suitability also depends on aspects such as climate, slopes, water availability and soil. Therefore, the realistic potential for oil palm on Imperata is likely to be smaller than the total Imperata area. However, other crops may be feasible in those areas. IIASA (2009) reports that in Indonesia, 3 Mha of unprotected grassland and woodland is (very) suitable for rain-fed oil palm. An additional 1 Mha is moderately suitable¹¹.

In Indonesia, some Imperata grasslands may be classified as 'forest land' under the control of the Ministry of Forestry. It may have been forest in the 1970s but is now degraded. Since it is classified as 'conservation forest' or 'productive forest', officially only forestry activities can be developed and the land cannot be used for agricultural purposes unless permission has been granted by the Ministry of Forestry. Imperata land classified as 'forest' limits the practically available potential, although it is unclear what size and which Imperata areas it concerns.

Nevertheless, Imperata grasslands represent a large potential towards satisfying the growing global demand for palm oil, and could considerably reduce the pressure on natural forests, if used for oil palm plantations. Fairhurst and McLaughlin (2009) suggest that the palm oil industry in Indonesia alone can meet the growing world demand for edible oils by focusing on improving yields in existing plantations and expanding the area planted on Imperata grasslands and degraded forest land provided this is carried out within a framework of good governance.

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Imperata areas that would not have been distinguishable at the mapping scales at which most of the work was done. These estimates are 20.8 Mha, 34.7 Mha and 57.2 Mha respectively. 35 M ha equals about 4 % of the land area in tropical Asia.

¹¹ In addition, Indonesia has 29 Mha non-protected forestland that is very- and suitable and 6 Mha that is moderately suitable for rain-fed oil palm (IIASA, 2009).

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3 Case study of a sugarcane cattle integration model in Brazil

Acknowledgements

This case study presents two examples of the sugarcane integration model in Brazil. We gratefully acknowledge the valuable insights and inputs from Gerd Sparovek and Andrea Egeskog. This case study wouldn't have been possible without the research performed by Ricardo Burgi and Göran Berndes and others at the University of São Paulo and Chalmers University of Technology.

3.1 General project description

In Ribeirão Preto region (São Paulo State, Brazil) lays one of the pioneer mills to implement the sugarcane cattle integration model. Together with local land owners sugarcane plantations were established in the 1980s, whereby the traditional use of the land – beef cattle farming – was maintained. The key to this integration is the production of animal feed through hydrolysis of sugarcane residues.

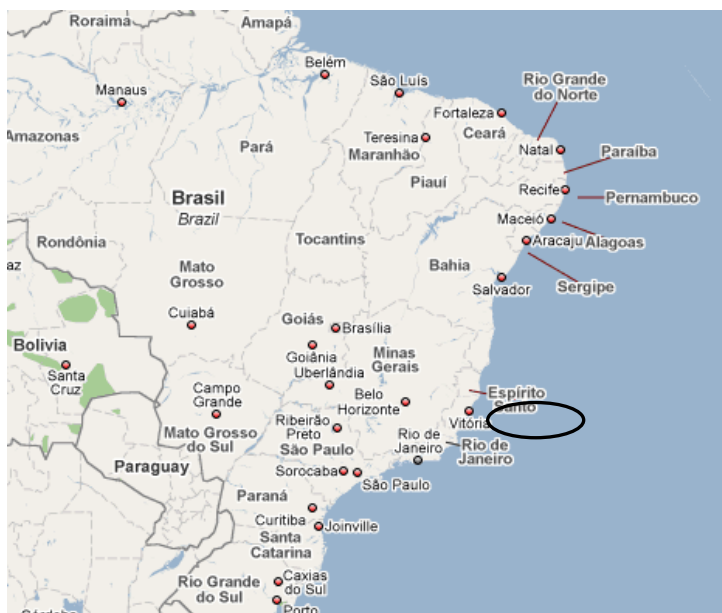


Figure 2 Location map of Ribeirão Preto region.

3.2 Background

The state of São Paulo (SP) in Brazil has most of the Brazilian sugarcane cropland areas and sugarcane is the largest crop in the state. Approximately 60% of Brazil's total sugarcane production comes from SP (Berndes et al., no date). Despite the

extensive sugarcane production in SP, there is still a significant expansion potential (Sparovek et al., 2008).

This case study presents two examples of the sugarcane integration model. The first example, the integration model in Ribeirão Preto, is based on research performed by Ricardo Burgi (1985). The other example describes a sugarcane expansion strategy developed by the University of São Paulo (USP), which is based inter alia on the project at Ribeirão Preto. These examples follow a similar approach, but have a slightly different focus. The following section describes the dynamics of sugarcane expansion and presents the starting points for the two examples.

Most sugarcane expansion takes place on pastures at the cost of cattle farming. São Paulo State has two types of farmers. *Settlers* have received land from the government in agrarian reforms and own properties of around 20 ha of land. *Ranchers* often own land areas larger than 1,000 ha. The ranchers' main income commonly comes from cattle farming (i.e. for meat production). The typical settler uses the land for milk production and the main income comes from selling milk and livestock. The prevailing low-productive and extensive milk production systems (low-productive cows and limited pasture management) restrict income growth for the settlers.

In Ribeirão Preto there are mainly large scale ranches that produce meat and sugarcane. The model developed by USP focuses on integration with settlers. USP's research was performed to investigate the possibilities to make the introduction of sugarcane more favourable for the settlers in the Pontal do Paranapanema region (Pontal) in São Paulo State by launching a combined production system with sugarcane and milk cattle. This model has been described and further worked out in several studies (Sparovek et al., 2007; Berndes et al., no date; Egeskog and Gustafsson, 2007; FEALQ, 2008) using input data and experiences from the project in Ribeirão Preto and other projects, covering a wide range of cattle (beef, milk and mixed production) in Brazil.

Both examples present an integrated sugarcane and cattle production model in which hydrolysed bagasse is used as animal feed. This additional feed allows more cows per hectare, freeing up part of the pasture land for sugarcane. This is further explained in the next section.

3.3 Suggested solution to prevent displacement

When back in the 1980s ethanol producers were looking for land to grow sugarcane in Ribeirão Preto, they found that most land was owned by ranchers, who used it for extensive cattle farming. In discussions with these ranchers it became apparent that they were open to growing sugarcane on the land only if they could keep their herds. In order to raise and sustain their herds they needed vast areas of land, especially in winter time, because of the low productivity of the land in that season.

In the 1970s the idea was developed at USP to use sugarcane residues to produce a "full feed ratio" for animals. Main driver for this was to get rid of excess bagasse and

other residues. This idea became quite popular in the 1980s and was widely adopted. In that time Brazil had approximately 180 sugarcane mills of which half produced feed (personal communication Gerd Sparovek, 3 September 2009).

Most sugarcane residues originate in the winter season when the cane stalks are harvested. It is particularly in this time that pasture productivity is at its lowest. By producing additional animal feed from sugarcane residues, less land is needed to sustain the same amount of cattle. Thus allowing more cows per hectare and effectively freeing up part of the former pasture land for sugarcane cultivation. In other words, by integrating cattle production with sugarcane production, the agricultural productivity in the area is increased.

As a result, the same land that used to support a certain number of cattle now supports the same amount (or more) of cattle while also producing ethanol from sugarcane. Sugarcane production is expanded on pasture areas without displacing the original cattle or milk production.

Example 1: Ribeirão Preto

At Ribeirão Preto a “full feed ratio” is produced at the ethanol plant from a mix with nutritious substances and sugarcane residues. Sugarcane residues that are used include inter alia hydrolysed bagasse¹², molasses, vinasse and filter cake. Other ingredients are also added¹³, such as cereals (e.g. corn or soy (residues)), urea, calcium and supplementary minerals and vitamins¹⁴. A small amount of residual bagasse is used to supply the required heat needed to hydrolyse the bagasse. The exact proportion and price of the feed ratio differs for the type of cattle (e.g. beef cattle or milk cattle). The average full feed ratio (the exact composition at Ribeirão Preto is not known) contains almost 90% (on a weight basis) of sugarcane residues and little over 10% of other ingredients. Of the latter, cereals (e.g. corn and soy) make up the largest part (approx. 85%) (Personal communication Gerd Sparovek, 3 September 2009).

Since only sugarcane *residues* are used, the production of the full ratio does not result in losses in production of ethanol. The full ratio is sold to the ranchers for a price close to the production cost which is roughly half the market price. The low price is motivated by the fact that the farmers grow sugarcane for the plant.

¹² The bagasse is heated up to 450 °C - 480 °C under high pressures.

¹³ Note that a feed ratio compiled solely out of sugarcane residues will be sufficient to sustain cattle, but is not nutritious enough to help milk cows produce a lot of milk or help beef cattle to grow (personal communication Gerd Sparovek, 3 September 2009).

¹⁴ In the integration model, there will be an increased demand for some external ingredients (e.g. corn, soy residues and minerals and vitamins) following the demand for full ratio feed.

Example 2: Expansion strategy

The integration model strategy developed at the University of Sao Paulo as sugarcane expansion strategy aims at avoiding political tension caused by a degraded socioeconomic situation in the settlements. The goal is to improve the situation for the settlers. Central in the strategy is an intensification of the milk production system, along with an expansion of sugarcane production. In addition, because of improved breeds of cattle, the expansion model of the USP not only maintains current milk production, but even increases the milk production by improving the breed of milk cows and the nutritional value of their feed.

The model developed by USP comes down to integrating sugarcane expansion with intensified milk production. Each settler will increase the milk productivity per cow through changing the breed from low- (4.5 litres of milk/day) to medium-producing (12 litres of milk/day) milk cattle. The area for milk cattle is reduced so that also sugarcane can be grown on the premises. Some 30% of the land will be used for sugarcane plantations. Before and after integration, some land is used for growing food in order for the settlers to stay self-sufficient (Berndes et al., no date).

In summary, both examples show that by increasing the agricultural productivity through integration, the pressure on land is reduced while growing demands for food/feed/fibre/fuel can be met.

3.4 Effectiveness & verifiability

With the increased attention for biofuel production models to prevent displacement, the integration model has gained renewed interest. If ethanol producers realise that by doing this they reduce the risk of displacement, this could create a new impulse for this model.

3.4.1 Expanding biofuel production without cattle displacement

Sparovek et al. (2008) found that sugarcane expansion primarily competes with pastures and cattle production in and around São Paulo State. Sugarcane expansion leads to discontinued cattle production on pastures where plantations are established, possibly leading to displacement¹⁵. Displacement of the current provisioning services of the land is likely to lead to migration of cattle production, which is associated with a traditional pattern of establishment in remote regions. For example, at the border of the Amazon. In such a case, indirect CO₂ emissions related to possible deforestation could occur. The integration model could reduce the migration of ranchers to remote areas in the Cerrado and the Amazon region.

The outputs (provisioning services) of the land before the project in Ribeirão Preto laid mainly in the production of milk, cattle and some food crops. No quantification is

² The discontinued cattle production can induce either (i) increased intensity in already established cattle production elsewhere; or (ii) conversion of additional land to pastures (i.e. indirect LUC) (Sparovek et al., 2008).

available, but the same provisioning services are still delivered by the land and have actually increased in the production of more milk (Personal communication Andrea Egeskog, 10 July 2009).

To illustrate the productivity of the model, consider the following example (Figure 3): In an extensive cattle raising scenario (for beef production), a rancher had 1000 cows on 1,000 ha (1 cow / ha). After implementation of the integration model, half of his land is used for sugarcane cultivation and the same amount of cattle is raised on the other half of his land (2 cows / ha). Since the animals are fed with a ratio that has a higher nutritional value compared to the situation before integration, the productivity per cow is also increased, which creates additional value for the farmer. In this example, the cattle productivity of the land has increased significantly (over 100%: from 1 cow / ha to 2 cows / ha). The total productivity of the land has increased through the additional sugarcane production and through the more nutritious feed (the total amount of cows remains the same in the example).

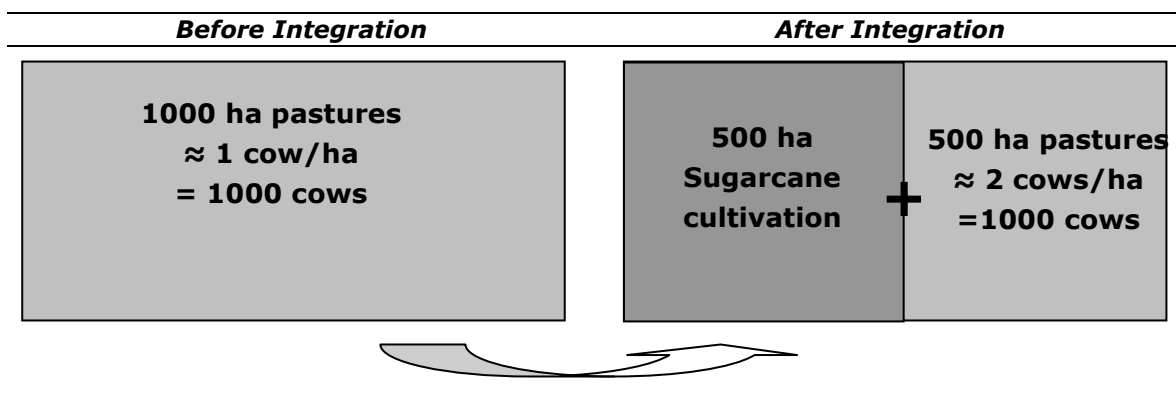


Figure 3 Example of increased productivity after integration

In the case where low-productive milk cows are replaced by medium-producing cows, the productivity increase is even larger (From 1 cow / ha producing 4l of milk per day = 4l / ha / day, to 2 cows / ha producing 12l per day = 24l / ha / day. This is a productivity increase of 600%).

3.4.2 Additionality

Whether the increased productivity can be attributed to the sugarcane integration depends on whether the same productivity increase would have happened without the project. An increase in land productivity might be possible without the project in the long run, but before that happens higher pasture productivity is needed and to increase the milk production another type of cattle would be required. Local inhabitants (e.g. settlers and ranchers) would need more knowledge and education for this. Most settlers haven't been farmers for very long, but only established farms from 2000 onwards. In conclusion, future displacement is possible, but not likely in the medium term (until 2020).

3.4.3 Verifiability

In order to verify that the integration model indeed ensures that no displacement takes place (by increasing the output of the region, while maintaining original production), it should be determined what the output of the project area before and after the implementation of the project is. Concrete data sources that can be used to provide the evidence are production figures in the project area (e.g. litres of milk and ethanol produced). It is not sure whether this information readily available. Some national databases in Brazil have productivity figures for different municipalities. Even in the case that such data is not yet available, the costs and efforts of collecting such data will be relatively small. It would be a matter of establishing the outputs of the project area before and after implementation of the project in order to assess whether displacement has actually occurred or not.

3.5 Barriers to the wide scale implementation of the displacement measure

For this model to work both settlers and ethanol producers need to be convinced of this model. Trust and good relations are essential. Also initial capital is needed for the investments in cattle and milk production. Below the main barriers and success factors are described.

Relationship between cattle farmers and mill owners

In order to overcome any of the barriers a dialogue is needed between farmers and ethanol producers. In the case of Ribeirão Preto, ethanol producers were interested in land belonging to several ranchers. The ranchers indicated that they were not interested in either leasing or selling their land or growing sugarcane themselves unless they could keep their cattle. This created a strong incentive to come up with solutions to integrate both systems. In some cases land is leased to ethanol producers / sugarcane growers. In such cases, the supply of animal feed to cattle farmers could be included in the lease-contracts.

An essential part of the model is the relationship between the ethanol producer and the cattle farmer. Since they are mutually dependent (the farmer for its animal feed at cost price and the ethanol producer for its sugarcane) trust is very important, as well as good and fair contracts.

Price of animal feed

The sensitivity of the net income of settlers to the cattle feed price (cf. section on economic viability) underlines the importance for settlers to create a beneficial relation with the sugarcane industry. In fact, the expansion of sugarcane production is crucial for the settlers in the USP expansion strategy, but not because of direct incomes from the sugarcane. It is the possibility to obtain cheap and nutritious feed – enabling the expansion of the milk production – that is of highest value. The industry might see the support to settlers in the form of cheap cattle feed as a well-motivated strategy to gain farmers acceptance and interest in producing sugarcane.

Preferably, the feed is used within 2-3 days. It is possible to store it over a longer period of time, but then larger and adapted silos are needed, which require additional investments. Also transport over long distances would significantly increase the cost of the feed. This means that feed is preferably not transported over long distances or stored for longer periods. In addition to point 1, this also emphasizes the dependency of regular deliveries to farmers.

Management issues

The integration model does not require high investment costs related to total investments of establishing the plantation and ethanol plant, see section on economic viability. However, mill owners have to deal with several different ranchers (and even more settlers for the same area of land). It takes time and effort to manage and maintain these relations. For example, in Ribeirão Preto, feed is delivered to approximately 50 farmers.

Furthermore, mill owners will not earn significant amounts from the sales of feed ratios compared to the revenues from ethanol. In addition, for the establishment of a sugarcane plantation infrastructural improvements are often needed. These costs of such improvements are relatively high (in some cases similar to the land prices). Given the fact that mill owners need to make high investments, they might be reluctant to accept that they can only use a part of the land (since the other part is used for cattle grazing)¹⁶.

Finally, for mill owners it is easier to operate in a region that is more dependent on the sugarcane industry. In the case where there are no (significant) other industries in a region, people are often dependant on this industry, since it is one of the few possible sources of income. In such a case, labour and services are usually available at low prices.

Knowledge

Although the integration concept is not new in Brazil and ethanol producers know of the model, the exact requirements for successful application are not common knowledge. For this model to be successful knowledge is needed. On the side of ethanol producers, knowledge is needed about the benefits and how to overcome the management issues. On the side of settlers and ranchers, knowledge is needed about how to go from extensive to more intensive cattle production (e.g. pasture management changes slightly in the sense that cattle will need to graze in smaller areas).

¹⁶ This can be partly solved by using the areas that are least suited for sugarcane cultivation for the cattle farming (e.g. slopes).

Other uses of excess bagasse

The integration model was developed over 20 years ago. By that time the bagasse was seen mainly as waste. Making animal feed out of it meant a useful purpose could be given to the residues. Nowadays, it is common to use the bagasse to generate heat and power for the ethanol plant's own energy demands. For this some 85 % of the produced bagasse is used (Macedo et al. 2003). Excess power is usually supplied to the grid. With an average mill with a processing capacity of 1 Mton of sugarcane per year, the integration concept uses a very small part of the sugarcane residues, which does not have an effect on the domestic supply of heat and power¹⁷. The opportunity cost of producing feed from the residues are said to be comparable (personal communication Gerd Sparovek, 3 September 2009). However, the sales of animal feed are a relative small amount on total mill income. In addition, the other part of the excess bagasse will still have to be processed (since not all can be used to produce feed). This led to the fact that some mill owners consider the integration concept more as a favour to farmers.

3.6 Economic viability

Few additional costs for the mill owner

Based on experiences at Ribeirão Preto, the additional investment costs of the integration model are relatively small from both the mill owner's and the ranchers' perspective. Especially when compared with the total investment costs of a sugarcane plantation and mill. It could be suggested, however, that there is a loss of income from replacing a part of the excess electricity. Nevertheless, this is (partly) compensated since ethanol producers sell the animal feed from hydrolised bagasse at cost price (or with a small margin) and they have no additional costs (depreciation of the equipment is included in cost prices). Although we have not performed a detailed economic feasibility study, it appears that this is not likely to be an issue, especially considering the fact that it concerns only a part of the excess bagasse and that the sales of animal feed are a relative small amount on total mill income. In addition, it should be noted that the sugarcane project in Ribeirão Preto was only possible in this way since local farmers only wanted sugarcane production if they could keep their cattle.

Calculations show that the mill could sell 1 tonne of feed for approx. 120 reais (approx 45€) (including price of ingredients, maintenance, depreciation of the equipment, labour cost and transport (50km) and 25% margin for the mill) (FEALQ, 2008). The exact ratios and prices differ with the type of ratios (e.g. for beef cattle or milk cows).

¹⁷ 85% of the bagasse is needed for domestic supply of heat and power (Macedo et al., 2003). 15% of the excess bagasse is still too much to use all for animal feed (Personal communication Gerd Sparovek, 3 September 2009).

Higher income levels for cattle owners

The costs of the integration strategy from the cattle owner point of view are assessed by Berndes et al. (no date) (see Figure 4). Some costs are associated with the change of cattle, e.g. artificial inseminations, new pasture management and cattle feed. These costs were assumed to be financed with a special loan that the settlers are given by the Brazilian Federal Bank. All other costs were assumed to be covered by the incomes gained. The total costs and incomes were calculated for 25 years, assuming that today's prices prevail. An exception was made for the milk price, which was assumed to increase from 0.14 to 0.2 €/litre due to larger quantities and better care of the milk.

Based on the above analysis, Berndes et al. (no date) revealed that integration with sugarcane ethanol significantly improves income levels for the settlers. After 15 years, the typical settler will have a stable net annual income of 8,770 €, based on the milk production system, which is 7 times more than the net income from the milk production system in 2006. In addition, the sugarcane production on 30% of the land can further improve the income.

For the cattle owners, cattle feed is the largest expense in the integration model. After two years this cost stabilizes at a level corresponding to about 40% of the gross annual income (see figure below). Thus, the support to the settlers from the ethanol plants – in the form of cheap cattle feed – is crucial. If the feed price was raised to the market price level, much of the (additional) net income would disappear.

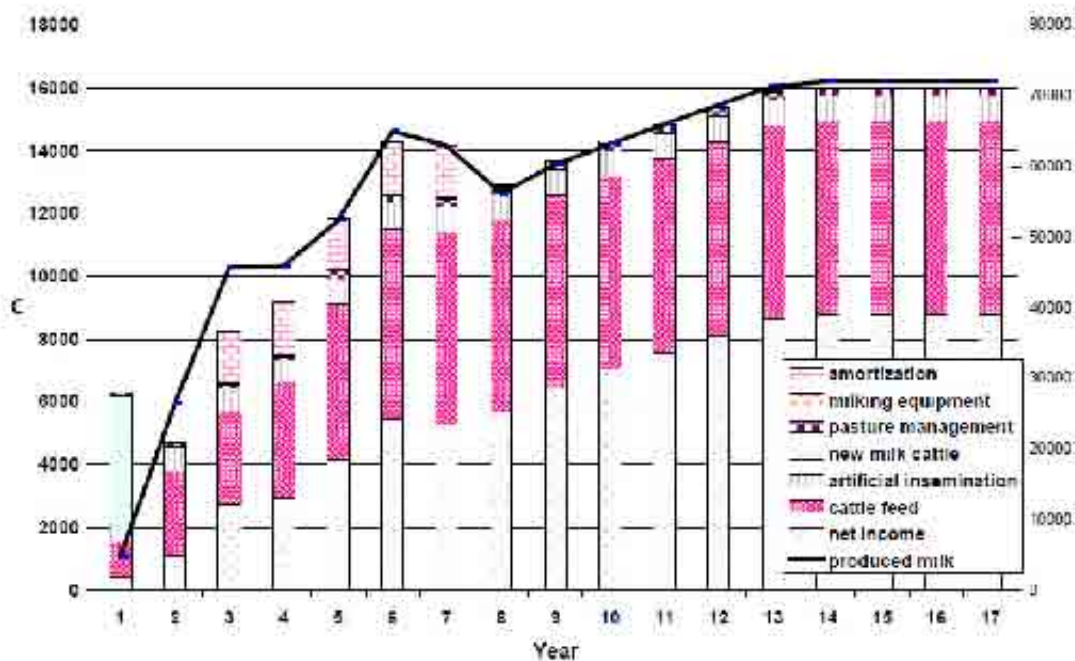


Figure 4 Net income and expenses following milk production in the expansion strategy (source: Berndes et al., no date).

Conclusion on economic viability

In summary, this case study found that costs associated with implementing and operating the integration model are not likely to be an issue. Integration with sugarcane ethanol can even significantly improve income levels for settlers. The motivation for mill owners to implement this model is likely to be more inspired by other aspects than financial motivations (e.g. access to suitable areas for sugarcane cultivation).

3.7 Sustainability and GHG performance

3.7.1 Sustainability risks and impacts

One of the possible sustainability risks of this model is the strong dependence of farmers and especially smallholders (settlers) on the sugarcane mill for their feed. The cattle feed price is crucial for the model to succeed, since this is a large part of the costs for the cattle owners as shown above.

The biodiversity of the pastures might also be affected when conversion to sugarcane plantations takes place. This should, however, be covered by existing sustainability regulations that prevent conversion of pasture lands with high biodiversity values (e.g. EIA regulations or EU RED requirements).

3.7.2 Positive side-effects

Other positive effects, besides prevention of displacement, of the sugarcane cattle integration model include:

- 1** Additional income for local smallholders. Sparovek et al. (2008) report that Municipal Gross Domestic Product (a variable for local economy) was greater and increased faster in municipalities in the central expansion areas (i.e. State of São Paulo and neighbouring States) that experienced sugarcane expansion between 1996-2006 than those municipalities without expansion. This could indicate that sugarcane expansion induces economic development and diversification from both increased cultivation and local industrialisation;
- 2** Improvements of infrastructure stimulated by the sugarcane expansion stimulates cultivation of other crops. Soybean, peanuts and cover crops are traditionally cultivated in areas where sugarcane is renewed. This area represents 15 – 20% of the area cultivated with sugarcane, implying that when the sugarcane expands, this cultivation opportunity also increases. (Sparovek et al., 2008);

3.7.3 Carbon and GHG performance

Excess bagasse is often used to generate electricity that is delivered to the local / national grid. This electricity from bagasse often replaces fossil fuel based electricity, which results in increased GHG benefits of sugarcane ethanol.

Using bagasse to produce animal feed instead of generating electricity that would otherwise be fed in the grid, could negatively effect the direct emissions associated to the ethanol. On the other hand, because the production of animal feed takes place, the productivity in the area is increased and the risk of displacement (and possible associated deforestation) reduced. Recent analysis on the size of emissions from iLUC shows these to be significantly larger than the emissions savings that could be achieved through the use of bagasse for electricity generation. In addition, as explained above, not all excess bagasse is used for animal feed such that part of it can still be used for excess electricity generation.

3.8 Potential

This solution is also applicable for other areas. It is unclear whether this model also works for other crops. This depends on the residues, their energy content and their digestibility. An assessment of potential crops was not part of this case study. In Ribeirão Preto the implementation of the integration model required small adjustments (e.g. installation of hydrolysis equipment). There are currently approximately 30 other mills in Brazil that apply the integration concept (Personal communication Gerd Sparovek, 3 September 2009).

Brazil saw an expansion of area under sugarcane cultivation from 4.8 Mha in 2000 to 7.1 Mha in 2007 (FAO, 2009). Sugarcane, however, is not the major land use in Brazil. Soybean and corn occupy approximately 3 and 2 times more land respectively than sugarcane in 2007 (FAO, 2009).

The total area of permanent meadow and pastures, both natural and cultivated, in South America amounts to over 450 million ha, with 200 million ha in Brazil (FAO 2009). IIASA (2009) reports a potentially suitable area for sugarcane (not protected grassland and woodland) in South America of 141 Mha (228 Mha worldwide). Total sugarcane area in South America equalled 8.3 million ha in 2007 (22.7 Mha worldwide) (FAO, 2009), suggesting a significant potential for the integration model.

Sparovek et al. (2008) conclude that peripheral expansion areas (i.e. expansion areas other than São Paulo and neighbouring States¹⁸) are not expected to become important sugarcane growing areas in a near future. Main reasons include that expansion in areas near the Amazon is limited due to infrastructure, logistics, distance to market and more restrictive environmental legislation. The areas in Northeast of Brazil can only expand with irrigation, which is not common practice for sugarcane production in Brazil.

¹⁸ More precisely: (i) the South Amazonian border region in Mato Grosso; (ii) the isolated initiative in the Municipality of Presidente Figueiredo in the State of Amazonas; (iii) the expansion at the East border of the Amazon (Pará and Maranhão); (iv) small expansion spots in the traditional Northeastern production region (Sergipe, Alagoas and Pernambuco) and the North part of Bahia; and (v) the North part of Espírito Santo (Atlantic Forest biome).

Moreover, expansion is most likely to occur around São Paulo State, because large areas are still available for expansion and can be expected to be the first choice for already established actors planning to expand their operations.

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4 Case study of integrated soy and cattle farming in Brazil

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4.1 General project description

This case study addresses increased land productivity through the integration of livestock and crops, specifically cattle and soy. The principle of crop and cattle integration with soy is particularly relevant in South America where soy and cattle production have increased substantially over the last 30 years and as soy oil may be increasingly used for biodiesel production. It should be noted that soy is primarily grown for soybean meal as animal feed rather than oil for biofuels.

Figure 5 illustrates the major grassland ecoregions in South America (left hand side) and major biomes of Brazil specifically (the right hand side). The Cerrado biome of Brazil where soy production has expanded rapidly is regarded as the most biologically diverse savannah in the world, with a high diversity of vegetation types (ranging from Campo Limpo short grasslands through a variety of shrub- and woodlands to Cerradão woodlands), and exceptional numbers of birds and plants (Dros, 2004). Valuable Grassland Areas and Important Bird Areas have been identified throughout the Rio de la Plata Grasslands (Minarro & Bilenca, _).

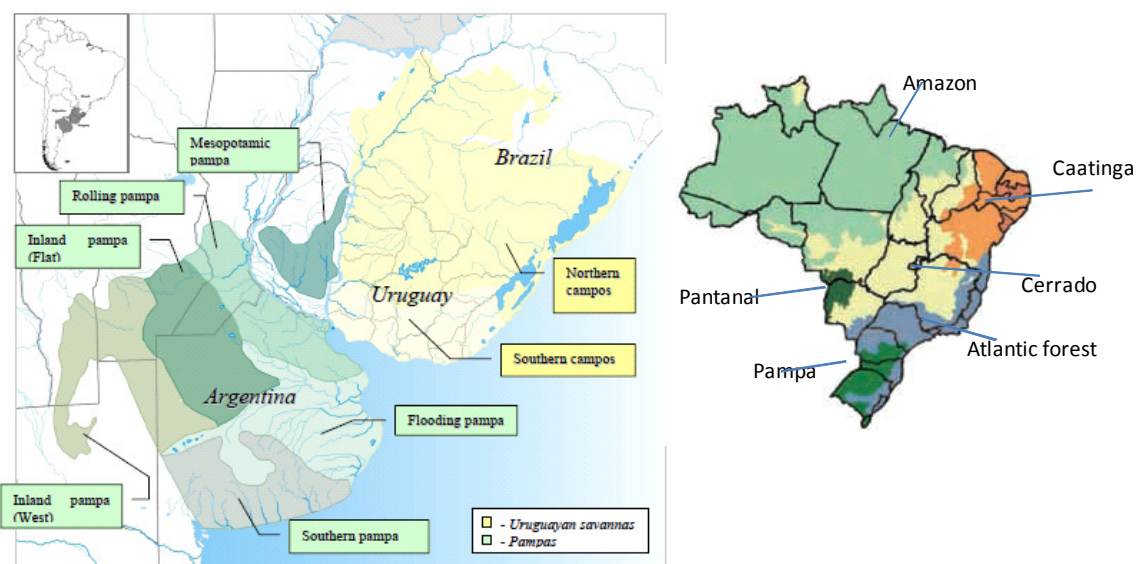


Figure 5 The Rio de la Plata Grasslands classified into eco-regions (left picture) and the location of the major biomes in Brazil (right picture). Source: Minarro & Bilenca () and Landers (2007).

4.2 Background

Figure 6 illustrates the significant role of South America, specifically Argentina and Brazil, in global soybean production.

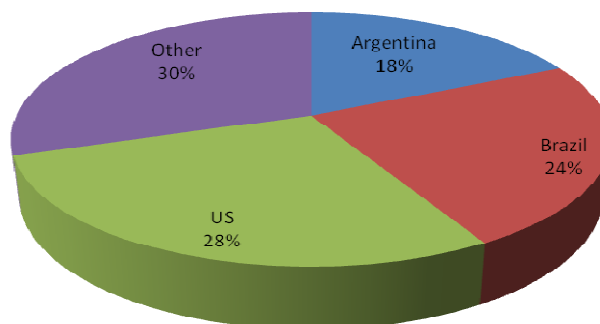


Figure 6 Percentage of harvested area in major soybean growing regions of the world (2007/8). Source: USDA statistics

In the 1970's soybean represented less than 3% of the sown area in Argentina and now represents around 40% (around 16Mha) (Minarro, F & Bilenca, D.). Brazil has a larger harvested area at around 21Mha but Table 1 illustrates pastureland, at 24.7% of the total land area, is around 4 times larger than that of annual crops. Soybeans are also the main biodiesel feedstock sourced from Brazil (and Argentina) for biodiesel production in other countries and regions (such as the EU), but the beans or oil are the product generally exported rather than the finished biodiesel itself.

- Brazil soy beans export in 2008: 24.5m tonnes (U\$ 10,952m)
- Brazil soy oil export in 2008: 2.31m tonnes (US\$ 2,671 million)
- Brazil Biodiesel production in 2008 = 1.16 billion liters

There are no official datasets on how much global biodiesel originates from soy in general or from the different producer countries.

Through the development of high-yielding tropical varieties and the availability of vast areas of Cerrado land, 60% of Brazilian production now comes from the tropical states, with Mato Grosso the single biggest producer (Dros, 2004). Currently, soy is expanding in the two largest biomes of Brazil, the Cerrado and the Amazon forests (a new, still relatively minor expansion area) (Dros, 2004).

Table 3 Land use in Brazil. Source: Goldemberg, 2008.

	Area	
	Million ha	%
Amazon Forest	360	42,3%
Pasture	172,3	24,7%
Yearly crops	57,9	5,8%
Perennial crops, except sugar cane	11	1%
Sugar cane	7,8	0,8%
Cultivated forests	6	0,7%
Non exploited	101	11,9%
Cities	20	2,4%
Protect areas	52	6,1%
Others	38	4,5%
Total	851	100%

Soybeans

Soybeans are rainfed and predominantly mono-cropped for several years during the low disease-weed-pest pressure period after land clearing in Brazil. When rotation is practiced, maize may be grown every following soybean harvest (Landers, 2007)

Zero tillage (ZT) is well-practiced in Brazil and is the preferred technology for conservation agriculture (but is not suitable in all cases e.g. it is not practical in the first year or two after clearing). From 1981 onwards, mechanized tropical ZT began to develop, with soybeans, maize and other crops in the Cerrado, reaching over 9 million ha in the tropical areas in 2004–05 (Landers, 2007) and currently estimated at over 13 million hectares in the Cerrado Biome according to APDC current estimates (Landers, *pers comm.*). Zero tillage is now the dominant production system for annual crops in Brazil and is increasing rapidly in importance for pasture renovation and establishment of perennial crops. Physical soil degradation has been hardly noticeable under ZT leading many farmers to dispense with or reduce other methods of conservation agriculture such as reducing contour banks or monocropping over pluri-annual rotations (Landers, *pers comm.*).

Pasture

Originally, the Cerrado was used for cattle-raising on natural pastures. In the 1970's and 80's, large areas of Cerrado vegetation were replaced by planted pastures, mostly in the Central and Southern Cerrado states. The Northern Cerrados have been generally undisturbed because of inaccessibility and their extremely acid, poor and degradation-prone soils (Dros, 2004). Most clearing for pasture in the last 20 years has been on infertile soils, subject to rapidly falling stocking rates as initial fertility declines and little or no fertilizer is used. This has led to even more clearing to compensate for loss of carrying capacity. (Landers, 2007). There are estimated to be 60 million ha of planted pastures in the Cerrado region, 70-80% of which are degraded (Landers, 2007).

Integrated crop–livestock zero tillage systems - ICLZT

Soybeans, and therefore biodiesel, could be rotated with cattle to intensify land use and mitigate or reduce indirect land use change. The introduction of nitrogen into the system (as a leguminous crop) enables greater productivity per unit of land area which is the principal approach to claiming a low risk of displacement in this case study.

The integration of cattle farming into annual crop systems began as a hedge against low soybean prices. The advent of tropical ICLZT technology in the mid 1990s enabled the sowing of grain crops directly into desiccated pastures (Landers, 2007).

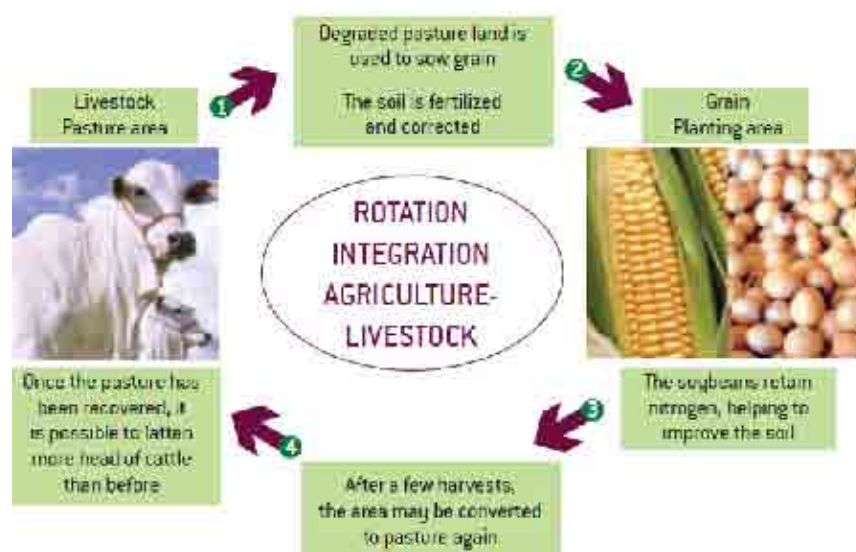


Figure 7 Illustrative diagram of integrating livestock and crops. Source: ABIOVE, 2007.

Main actors

- EMBRAPA (Brazilian National Research Enterprise) research institutes provide the technical capacity in Brazil for technology development and adoption. Embrapa Soja develops solutions for the sustainable development of soybean agribusiness.
- Zero Tillage Farmers’ Association for the Cerrado Region (APDC). Since 1992 the Zero Tillage Farmers’ Association for the Cerrado Region (APDC) has actively promoted ZT and now promotes the ICLZT technology (Landers, 2007).
- ABIOVE: (Brazilian Association of Vegetable Oil Industries): 12 member companies who are responsible for approximately 72 percent of Brazil's soybean processing volume. ABIOVE's objective is to represent the vegetable oil industries, cooperate with the Brazilian government as regards policies related to this sector, promote Brazilian products, support its members, generate statistics and prepare sectoral studies.
- Brazilian Federation for Zero-Till into Crop Residues (FEBRAPDP)

4.3 Suggested solution to prevent displacement

Rotating annual crops with Zero Tillage into degraded pastures allows intensification of land use and increased productivity per hectare. This rotation of pastures with field crops is one of the most effective ways of maintaining them in a state of high productivity, thereby reducing the need for clearing of additional land for pasture or arable land. The Integrated crop–livestock zero tillage systems (ICLZT) incorporates numerous models and systems to intensify land use through ICLZT (different crops, rotation patterns etc). Depending on the systems adopted, land use intensification through increased stocking and absorption of crop expansion in areas of degraded pasture has been calculated to mitigate land clearing (and therefore indirect land use change) on the scale of approximately 0.25 to 2.5 hectares for every hectare in ICLZT (Landers, 2007).

Models and approaches to ICZLT will differ but there are several main components identified (Landers, 2007):

- Crop establishment in degraded pastures;
- Pasture establishment in, or immediately following, an annual crop (for pasture). This could include dual use of a cover crop both for grazing and subsequent soil cover
- Use of crop areas for silage or green chop production as supplement for cattle;
- Enrichment of existing pastures with legumes. This is practically limited to sowing pigeon pea directly into existing pasture;
- Sowing annual crops into a permanent grass or legume sward. This technology has been tested in Mato Grosso and tests reported good soybean yields of over 3,000 kg/ha and obtained 90 days winter grazing for 1–1.5 animal units (AU)/ha with this system (Landers, 2007).

A common starting point for adoption of ICLZT would be a 10 to 20 year-old degraded pasture. The complexity of the ICLZT systems can vary substantially and could be dominated by land area under crops through the 8-year rotation period (Table 4) or cattle (Table 5).

Table 4 A general ICLZT system starting on a 10 to 20 year old degraded pasture (Landers, 2007)

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Summer	Soybeans	Soybeans	Soybeans	Maize undersown with grazing	Pasture	Pasture	Pasture	Pasture
Winter	Stubble grazing	Stubble grazing	Stubble grazing		Pasture	Pasture	Pasture	Pasture

Table 5 A complex ICLZT system starting on a 10 to 20 year old degraded pasture (Landers, 2007)

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Summer	Cotton	Soybean	Soybean	Ley*	Pasture	Pasture	Pasture	Pasture
Winter	Fallow	Maize	Maize undersown	Ley*	Pasture	Pasture	Pasture	Pasture

*This ley period maximises the stocking rate on the pasture up to 4–5 AU/ha from the customary 0.5AU/ha on cleared forestland (Landers, 2007) which allows a larger land area under crops in the 8 year rotation period than was otherwise the case.

One case study illustrated in Landers (2007) illustrates the potential indirect land use change mitigation potential (see same reference for detailed case studies):

In a 4-year rotation an ICLZT system¹⁹ on 4 hectares has been shown to:

- Produce 3 hectares of arable crops including soybean and
- Carry 5 AU.

To achieve the same production without integration of crops and livestock:

- 3 hectares would be needed to produce the same annual crops
- And an additional 10 hectares to maintain 0.5 AU per hectare in the customary grazing system on degraded pasture cleared from forest. Assuming a direct comparison is made with the 4ha rotation above, 1 ha remains in addition to that used for arable crops. This could support 0.5 AU therefore 9ha would be needed for the additional 4.5 AU.

The calculated deforestation mitigation potential illustrates four (4) hectares of this intensive integrated crop–livestock system ‘saves’ 9 hectares of forest from clearance and land degradation. Therefore, 2.25 hectares of forest is ‘saved’ per hectare of ICLZT which could be cited as displacement mitigation potential. In other words, the ICLZT leads to an improved land productivity of 225%. This implies that, compared to a normal system without integration, production can be more than doubled without increasing land requirements²⁰.

¹⁹ The total system was 800 ha with mechanized operation and beef cattle. Cropping pattern is a 1 year pasture ley in rotation with 3 years of annual cropping: soybeans-cotton-maize.

²⁰ Note that the climate will affect the carrying capacity of the land and therefore the land productivity. Dry season pasture production determines a farm’s year-round carrying capacity (animal stocking rate). Rainfall intensity increases to the northwest and this better winter rainfall in the Amazon region than in the Cerrado allows higher dry season stocking rates. Cattle enterprises give a higher average return per hectare in the Amazon region than in the degraded areas in the Cerrado. For example, the large cattle-growing area of South Pará has a dry season of only 2–3 months compared to 4–6 months in the Cerrado (Landers, 2007).

4.4 Effectiveness & verifiability

4.4.1 Increased feedstock production by increasing land productivity

The key to assessing displacement is to look at rotation systems rather than specific conclusions made at one point in time. For example, it could be concluded in a snapshot view of a project area that soybeans are 'displacing' maize or cattle which could be interpreted negatively from a displacement perspective. However, on a rotational basis of 4 to 8 years the productivity of the system as a whole would demonstrate that displacement has been minimised owing to greater outputs per unit of land.

4.4.2 Verifiability

Defining a baseline is key to demonstrate a low risk of displacement, and thereby a low risk of displacement. Minimum information that would be required in order to assess displacement risk for a baseline and following project implementation include:

- Project area (hectares) and location
- Animal stocking unit (head per hectare)
 - Farm data. Given that animal stocking units would decrease over time as pasture degrades a rolling average based on historical stocking rates, may provide a conservative displacement mitigation potential if the project is purely pasture (no existing rotation or pasture regeneration). In this situation it may be relevant to use the current animal stocking rate. The baseline context for the animal stocking rate may therefore depend on the specific context of the project.
- Total animal stocking units per rotation
- Yield of crops per ha (by crop type)
- Total production of crops per rotation (by crop type)

Farm records would be the main data sources required.

4.5 Barriers to the wide scale implementation of the displacement measure

Capital investment

Access to capital for investment is needed to integrate crops and livestock. For example:

- Investment in lime and phosphate etc. and removal of physical impediments (stumps, gullies etc.) is required to integrate crops and livestock in rotation and can be costly.
- Fencing costs could be high for a crop farmer adopting ICLZT as many annual crop areas do not use farm perimeter fences; the demand for watering facilities for

livestock on cropland is also highly variable (Landers, 2007) and can require relatively substantial investment.

Investment costs for systems differ and a 'no ICLZT' scenario could require greater investment per ha (Model #2 in Table 4). Table 4 illustrates that investment costs are most significant for ICLZT compared to a baseline of extensive cattle farming on a 10-year clearing cycle (Model #4).

Table 6 A comparison of investment costs for different ICLZT systems.

Case Study	System	Investmt. Yrs 1-4 (R\$/ha)
Model #2 Cerrado - cow/calf, annual rainfed maize & soybean, 400 ha expansion Bahia state.	ICLZT	1,000
Crops not rotated with pasture, Med.mgt.	No ICLZT	1,340
Model #3 - Cerrado - rainfed crops x beef rearing high.mgt - Goiás state. (irrigated crops)	ICLZT	2,598 (4,098)
Crops only without rotation w/pasture.	No ICLZT	2,432
Model #4 Amazon. South of Pará state. Beef and ICLZT with rice/soybeans med. high mgt.	ICLZT	698
Beef 10 yr clearing cycle med. low mgt.	Clearing*	-559

* Includes sale of land therefore negative investment cost. Source: Landers et al, 2006.

Business risk and perception

- For the crop producer there is the possibility of lower yields in the first year(s) from degraded pasture combined with zero till. Zero till practice is widely agreed to require several years in establishment before yields are as great as those from conventional tillage.
- A high risk perception for the livestock farmer exists. Many cattle rearers lack cropping skills and may be reluctant to either cropping and/or renting his land. An organized "Farm Rent Exchange" (which can facilitate a long term rental agreement with a livestock and crop farmer) has had some success in bringing cattlemen and crop producers together on rental agreements in Mato Grosso (Landers, 2007). It can guarantee for example that the livestock farmer will be able to use the crop stubble for winter grazing to keep his cattle well-fed during that time. If not, a large area of land may be needed for the grazing that should otherwise have been left fallow or with leguminous crops to increase soil organic matter.
- Access to sufficient technical information is also key when the 'new' concept of integrating livestock with crops is promoted. For example there is very little information on which grasses are suited to integrated crop-livestock rotations in

the Amazon region (Landers, 2007). Support for technology development and promotion through grants for farmer-led on-farm experimentation with farm-scale equipment and dissemination programs is required.

4.6 Economic viability

Just as there is a large variation in ICLZT models, there is a large variation in their economic viability or attractiveness. However, Figure 8 illustrates that in general crop integration with livestock is actually more profitable than beef cattle alone or crops alone. In other words, economic viability does not seem to be a barrier to this low-displacement risk production model.

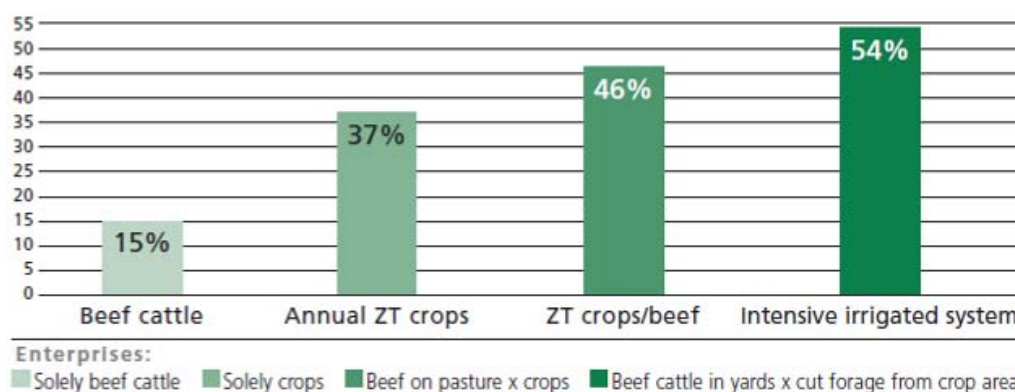


Figure 8 A comparison of gross margins at different levels of crop and livestock integration. Source: Landers (2007)

More detailed case studies from Landers et al (2006) identified in Table 7 illustrate that there is generally a considerable financial gain from switching to ICLZT, noted here as Internal Rate of Return (IRR) and net annual (undiscounted) profit/ha. However, financial rates of return range from very low for Model #5 to very high for Model #3. Forest clearance and subsequent land sale in Model #4 contribute to the higher IRR compared to long term management under ICLZT.

Overall, while there are large variations in absolute numbers between different production models, rotational ICLZT systems in general give higher returns than conventional systems that do not employ the livestock cattle integration of ICLZT. However, without the appropriate incentives, training, or equipment, many farmers (particularly smaller farmers) may see conversion to ICLZT as too risky an undertaking (Landers, 2007).

Table 7 Selection of case studies from Landers et al (X) that detail variations in economic gain from ICLZT models. Source: Landers et al. 2006* Includes purchase and sale of land which inflates the IRR calculation compared to the ICLZT situation.

Case Study	System	IRR (%)	Net Ret. R\$/ha/yr
Model #3 - Cerrado - rainfed crops x beef rearing high.mgt - Goiás state.	ICLZT	19.6-27.1	187-301
Crops only without rotation w/pasture.	No ICLZT	12.7	114
Model #4 Amazon. South of Pará state. Beef and ICLZT with rice/soybeans med. high mgt	ICLZT	6.5-11.7	173-310
Beef only - 10 yr clearing cycle med. low mgt.	No ICLZT (Land clearing*)	35.7*	37
Model #5 Atlantic - small farmer 261 ha, legumes - med. high mgt - São Paulo state.	ICLZT	6.4	138
Conventional tillage	No ICLZT	Neg.	16

4.7 Sustainability and GHG-performance

4.7.1 Sustainability Impacts and Risks

- **Intensification of land use may have negative biodiversity impacts:** Some species of birds for example require habitats with long grass and such intensification of land use may remove the long grass and therefore their habitat. However there are important exceptions. Some species of migratory birds prefer shorter grass and therefore the risk of overgrazing is less intense (Clay, pers comm.). The range of ecosystems that are covered by the term 'grassland' are diverse and it is impossible to make generalizations about the implications of intensification of cattle ranching. However, there is a lack of empirical data and research in this area that would assist, in the first order, risk assessments to determine where these risks may be greater than others.
- **Increasing productivity per unit land area will increase demand for water:** In some areas this may not be an issue but in others this may lead to increases in water stressed catchments.

4.7.2 Positive side-effects

- Direct effects of integrating crops and livestock with zero tillage include:
 - reducing erosion
 - increasing crop yields through improving soil biological activity and nutrient re-cycling
 - reducing the use of leachable herbicides used in conventional tillage

- By not repeating the same crop in the same season in successive years, the cycles of diseases, pests and weeds are broken, promoting biological controls and reducing agricultural chemical use and costs of production (Landers, 2007)
- Increased farmer income
- Not only increasing productivity of the land during a given period, but also preventing land abandonment and successive clearance of new (natural) areas for agricultural purposes (because the productivity of the system is maintained over the long term).

4.7.3 Carbon and GHG performance

Positive GHG impacts

- A well-managed pasture phase in a rotation is widely acknowledged to build-up soil organic matter that has been reduced through the process of degradation (Landers, 2007)
- The potential to reduce synthetic nitrogen fertilizer to regenerate pastures (and use legumes) is accompanied by a reduction in the potential N₂O emissions from the fertilizer application and associated leaching and volatilisation from rivers.

Negative GHG impacts

- Potential loss of trees in the pasture and associated carbon loss
- In some instances (such as in waterlogged soils) GHG emissions may be increased if zero till is practiced.
- Any additional liming requirements during rotations may negatively impact GHG emissions.

4.8 Potential

ICLZT has been developed principally in the Cerrado biome within Brazil. In principle, wider application is possible for the Amazon and the Caatinga biomes and there have been significant advances in implementation in the Amazon biome. Incentives to support these low displacement risk projects will be required either to compensate opportunity costs of higher returns to land clearance as opposed to expansion with ICLZT or encourage attempts to overcome barriers (Landers, *pers communication*). It should also be noted that as soybeans are grown primarily for meal, incentives for the oil only portion as it applies to biofuel may hold relatively small influence on producers. Broadly similar agro-ecological conditions to those in the Brazilian zero-tillage areas are widespread in parts of Africa and South and Southeast Asia (Landers, 2007) and may in-principle be relevant.

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5 Case study of sugarcane yield increases in the Philippines

The San Carlos Bioenergy Project in the Philippines illustrates large yield increases that could be considered to minimize the risk of displacement. Yields increased from an average of 70t/ha to 136t/ha in the trial area through installing drip-irrigation and improving management practice. The bioenergy project addressed existing barriers to such yield increases such as access to capital, technology support, existing agricultural practice and business models for cane supply. Regional data, GPS co-ordinates and site records would be required for verification.

Acknowledgements

This case study presents a specific project in the Philippines. We gratefully acknowledge the valuable insights and inputs from Bronzeoak Philippines, without which this case study would not have been possible.

5.1 General project description

San Carlos Bioenergy, Inc (SCBI) is a \$69.5m integrated ethanol distillery and power cogeneration plant located in Negros Occidental – the first in the Philippines and the Southeast Asian Region. The plant has the capacity to crush 450,000 tonnes of sugarcane over an 11-month period to produce 30-35M liters of ethanol annually (equivalent to 10% of the country’s total requirement for a 5% gasoline-ethanol blend by 2009) and approximately 8MW power, 2-4MW of which will be exported to the local grid. The fuel grade ethanol is sold to major local gasoline retailer, Petron, for use domestically to displace gasoline imports²¹. Approximately 400,000 tonnes of cane is needed per year for the plant, all of which comes from the 9,000 hectare San Carlos Sugar District.

Figure 9 Location map and photograph of San Carlos Bioenergy.

Source: SCBI



²¹ Project developers Bronzeoak were awarded prestigious Euromoney and Ernst and Young Global Renewable Energy Award in the category of Entrepreneurial Developer of the Year for this project.

The project has six main components²²:

- Cane mill with crushing capacity of 1,600 tonnes/day
- Fuel ethanol distillery producing 125,000 liters per day of ethanol (30m lpy)
- Cogeneration plant with a capacity of 8.2 MW
- Carbon dioxide recovery plant (50 tonnes per day)
- Anaerobic digestion plant (biogas used as additional boiler fuel).
- Integrated Waste Water Treatment Plant

While this project serves the local market and is not exported to the EU where displacement concerns are prevalent, however this model illustrates a concept that could be applied to reduce displacement risks in other projects.

Main actors

SCBI is a project company formed by the partnership of national and international groups: Bronzeoak Philippines Inc, Bronzeoak Clean Energy, National Development Company, San Julio Realty Inc, and Valmayor Ventures Inc.

Biomass Resources Inc, an affiliate of Bronzeoak Philippines, is a provider of services in applied research, development, and season extension work to sugarcane farmers to ultimately increase productivity levels and improve farmers' income as well as boosting the production of sustainable biomass feedstock for renewable energy.

5.2 Background

The area was the host of the first sugar mill in the Philippines (in 1907) and its soils have given some of the best yields of sugarcane on record in the country, with prime areas producing as much as 100t per hectare. The cane from this area has always been regarded as among the best in quality in the island. The international sugar market volatility and internal management issues caused the sugar mill in the San Carlos area to close forcing all the cane from the District's 9,000 hectares to be transported to mills up to 80 km away. However, sugarcane requires timely processing (ideally within 24 hours) following harvest before the sucrose degrades into other reducing sugars (which can't be crystallised to sugar). This longer transport difference results in a cost penalty to the farmers who are paid on the basis of sucrose content.

The Philippine sugar industry went through a relatively long and troubled period where many farmers and mills were facing long-term unprofitability due to oversupply and reform of sugar markets. The domestic sugar industry is not competitive internationally. It has a 30% tariff protection currently and Government interventions

²² Plans for the future include the construction of San Carlos Bio-Power, Inc (SCBP) a stand-alone 15 MW biomass-based power plant to utilize renewable indigenous fuel such as excess bagasse from SCBI and wood from dedicated tree plantations. The plant will be co-locating with SCBI in the San Carlos Ecozone.

try to manage the supply-demand balance year to year. In order to provide a boost to the industry and create local demand and at a price which may or may not exceed global sugar prices, a biofuel mandate was discussed. According to the December 2008 "Roadmap to Bio-ethanol through the Sugarcane Industry Route" prepared by the Sugar Regulatory Commission (SRA), the Philippine sugar industry is currently producing more than 10 percent of sugar that is surplus to domestic requirements and therefore is 'world market' sugar. This 10% could supply a percentage of the country's initial needs for bio-ethanol (but would not cover all requirements of say an E10 blend). The mandate was seen as a potential opportunity to remove the need for tariff protection as well as displacing oil imports.

The Biofuels Law was passed in 2006 and mandates the use of at least five percent fuel ethanol by volume in 2009 amounting to around 230 million litres. By 2010, the mandated volume is scheduled to increase to ten percent translating to 460 million liters of fuel ethanol to be blended with gasoline. The fuel retailers are the mandated parties.

The San Carlos agricultural landscape is unique in Negros as it is dominated by several large farms with a combined annual production of 200,000 MT per year that serves as an anchor of committed supply to the SCBI facility. Obtaining financing to build projects such as this often requires several large anchors of supply to reduce potential supply risks for investors. These larger farms may provide leadership in efforts to optimise varietal selection and agricultural practices.

SCBI delivered its first batch of fuel grade ethanol in March 2009. It took 2 years to construct and 3- 4 years in its pre-construction development.

5.3 Suggested solution to prevent displacement

The principle of indirect land use change asserts that if existing agricultural land is diverted to biofuel, and everything else remains unchanged, another piece of land will have to be brought into production to meet the demand for the diverted product. Yield increases have been cited as one of the solutions for avoiding displacement.

This project has subsidised implementation of sub-surface drip irrigation into some sugarcane fields to substantially increase land productivity and intends to expand the area under irrigation and encourage wider adoption of the practice.

The baseline in this case is:

- The Philippines has a biofuel mandate.
- The sugarcane for biofuel production in this project was being used for sugar production in the Philippines (which was surplus to market requirements and subsidised).

Yield increases within this project could be identified as displacement minimisation because less land will be needed to supply the mandate than would be the case without the project activities (e.g. sub-surface drip irrigation). If less land is needed

for the mandate the theoretical iLUC associated with international land use change (whether to produce sugarcane for ethanol or sugar demand) is minimised. If the yield was not increased, the additional feedstock material required to produce ethanol would have to come from somewhere else. This could be a new plantation (direct LUC), or by diverting some existing sugar production to fuel use and requiring additional land to be converted somewhere else (iLUC). In both cases there would have been a LUC. The SCBI project differs because it minimizes this LUC through the yield increase. Displacement is therefore minimized for the additional amount produced due to the additional yield increase, on top of the business as usual case. Displacement is not 'prevented' for the entire production of the plantation.

5.3.1 Details on the concrete measures that were taken to prevent displacement in this specific project.

Planting practices

A permanent raised bed system will ensure seed pieces are at a level higher than the inter rows to prevent submersion and water logging that prevents rotting during heavy rains. Since germination during wet season is normally low due to water logging, and lower temperatures, this cultural practice would ensure that germination will be higher. This system will also provide logistical advantages. The inter rows are designed to serve as roads where wheels of trucks and tractors pass, leaving the cropped rows untouched thus reducing compaction.

The modification of a mechanical cane planter was required to minimize gaps between plants.

Drip irrigation

Requirement for water is high during specific growth phases. Despite rainfall suitability on a year round basis, supply of water at the right time is critical to optimise yield and rainfall at the right time cannot be guaranteed. Drip irrigation (trickle irrigation) is the application of water directly to the root zone of the crop. The drip irrigation used is a surface drip system where the lateral lines are placed on top of the ground or sub-surface (below the root zone of the crop). Application of fertilizer with the irrigation water (fertigation) is spread over a 7-month period minimizing leaching and volatilization of the nutrients allowing more efficient utilization by the plants.

Drip irrigation with a raised bed system would be an ideal set up for both dry and wet season planting due to the fact that fertigation (fertilization and irrigation) improves fertilizer application efficiency thus increases yield and quality of canes. Fertilizer leaching which is common during wet season, would be eliminated due to the fact that fertilizer is applied in small amounts over a longer period of time.

In 2007, initial area for the trial was 12 hectares which produced 136 tonnes per hectare. The three year historical average of these fields using overhead irrigation was only 70 tonnes per hectare. Presently, 350 hectares of sub-surface drip irrigated are

installed among the core planters in San Carlos city. From this area, 100 hectares are with the improved sub-surface drip irrigation system while the remaining 250 hectares will be improved on the next planting cycle.

At 70t per hectare and an average 86 litres per tonne cane, the productivity per hectare is 6020 l/ha. At 136t/ha this increases to 11,696 l/ha. Yield improvements under the irrigation trials are not regarded as the limit of what can be achieved when combined with the other factors identified above.

Box 4 Other yield enhancing measures for sugarcane

Variety

The cane maturity period differs between cane varieties but is key to ensuring the best yields. SCBI is using a soil management programme to determine the most appropriate cane varieties in different areas to maximise yield.

Canes grown for crystallization to sugar require high sucrose content only as other fermentable sugars (glucose and fructose) in cane cannot be crystallized. Ethanol production can utilize the same varieties utilized for sugar production but also use the glucose and fructose in fermentation. Breeding programmes for the purpose of ethanol production would aim at high total fermentable sugars (not just sucrose) and are only just beginning – future variety improvements for ethanol yield can be foreseen. As a result, with appropriate varietal selection, more total fermentable sugars could be utilised from a given land area than would be the case in sugar production.

Increasing yields of other crops through introducing a legume fallow rotation system

During wet months of the year both at the start of milling season and approaching the end of milling season, a legume fallow system can be introduced. Legumes provide a direct economic benefit to sugarcane farmers by providing a source of nitrogen thus reducing cost of nitrogen fertilizer and other fertilizers. Legumes also provide a synergy with sugarcane production by breaking the monoculture cycle and improving soil health and cane ratooning ability. The growing cycle of the legume is around 2-3 months depending on species or varieties of legumes used.

5.4 Effectiveness & verifiability

5.4.1 Increasing biofuel production by increasing yields

A number of large scale local farms from the supply base for the SCBI project have been used to implement productivity increase measures that are expected to minimize displacement risks.

Using sub-surface drip-irrigation, yields (t/ha) have increased by 50% to 101% with an average of 63%. Original yields ranged from 54-75t/ha before drip-irrigation and reached a maximum of 136t/ha after installing drip irrigation. Stabilising and extending these gains is expected to be delivered by rolling out the system. In addition, yields may be enhanced further still by integrating the use of new high-yielding varieties, the use of compost for soil conditioning to improve nutrient uptake and introducing a legume rotation (Box 4).

If pre-system yield averaged 63t/ha then a 450,000tpy cane supply would require 7,143 hectares. With an increase in yields to 112t/ha average this area would be reduced to 4,018t/ha.

5.4.2 Additionality

In the Philippines as a whole, annual sugarcane yield has varied substantially and is directly related to Government programs/ legislation and profitability of the business. High yields follow periods of investment in business owing to good profitability. There is however no sub-surface drip irrigation technology in the Philippines.

Baseline yield estimation is key and could be established at 3 scales:

- National average
- Regional average
- Site-specific average

Site conditions have varied over time. A long-running average at a site-scale would likely be a more suitable baseline to avoid variations in yield according to unexpected weather events. Figure 10 illustrates the variations in national yield 1990-2007.

5.4.3 Verifiability

A baseline average yield would be required to compare to the 'new scenario'. In this project, a cane supply database at the plant provides detailed information on farm owner, cane varieties, date of planting and projected date for harvesting, estimated yield per hectare and actual volume of cane delivery to the bioethanol plant. A long-run average yield/ha would provide proof of baseline yields prior to project implementation however this may require resources to retrieve data from numerous farmers or sugar mills as the supply base previously supplied other areas or an ability to rely on data collected by national associations.

Data collection recorded throughout the duration of the project on yields would provide the verification of increased yields compared to the baseline. Confidence in the data collection methodology would have to be assessed on a project basis to ensure robustness of results.

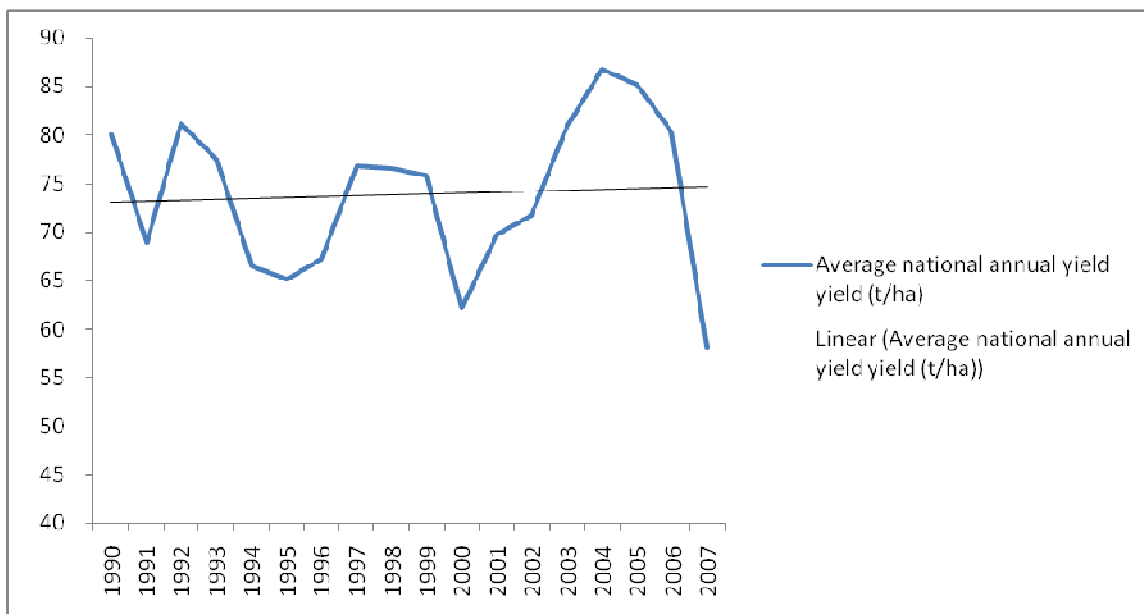


Figure 10 Average annual yields in the Philippines 1990-2007 (t/ha) with a linear trendline.
Source: FAO statistics

The Philippines has been over-producing sugar for a number of years prior to the implementation of the Biofuel Law (2006). There was no incentive to invest in order to produce even greater yields as the marginal product would be sold on the international market at prices at least 30% lower than supported domestic prices. With domestic tariff support projected to be reduced in the next few years, farmer profitability and therefore the likelihood of new investment in equipment and technology is much reduced. In the absence of the project it is not likely the improvement measure would have been implemented for sugarcane in general. Without US quota protection and domestic price support, Philippine farmers would not be able to earn a reasonable net income. This makes the Philippine farmers relatively more susceptible to global sugar price volatility on the downside and less inclined to invest in improvements for the longer term. Biofuels demand for feedstock can create the conditions to encourage all farmers to get back to investing in yields and planning for the long term. With respect to the SCBI project, the existence of long term cane supply contracts with the project creates the planning horizon required for investment to pay off.

5.5 Barriers to the wide scale implementation of the displacement measure

The size of the facility

The size of the facility was originally built to meet local supply. Increasing yields requires increased capacity which cannot be milled in the traditional season of 6 months. The cane has to be milled over a longer time period: extending the cane season is required to process the increased volume of cane.

The extension may have negative impacts on sugar content and yield level e.g. due to relatively low sugar content of canes harvested during wet months. In this case,

additional tonnage of canes would be required to be able to supply and extract the rated amount of fermentable sugars for the distillery. This effect can be minimized by selecting the appropriate varieties for example or effectively zoning the land so that well-drained soils and rolling areas are planted during wet months.

Tradition and willingness of farmers to extend the milling season

The area has long been a sugar producing region and therefore a long tradition of harvesting practice has been established. Modifying equipment and changing planting and harvesting techniques is not a simple activity that can be introduced – it requires the long-term commitment of the supply base. In addition, the introduction of a legume fallow period requires extra work and its successful implementation may depend on the willingness of the farmers to undertake extra work and/or pay for additional resources for its implementation.

Competitive supply base, business models and contractual barriers

In many circumstances, farmers supplying to mills may not be contracted to a specific mill and are therefore competing to supply. Long-term yield increases that would minimise the displacement risk for a biofuel producer require long-term investments and therefore long-term commitments from the supply base. A bioethanol producer investing in yield increases for a farmer that subsequently sells to a competitor would not make business sense. The business model and contractual relationships employed by the biofuel producer is therefore of substantial influence on the ability of the displacement measure to be realised.

Cost and access to capital

Planting, harvesting, and transporting of canes during the wet season will present operational challenges that have commercial implications which may be discouraging to farmers. An incentive might be required to partially compensate for these operational difficulties with their commercial implications.

Access to capital could be a substantial barrier for widespread implementation of such a technology especially among smaller farmers. SCBI is investing in 'truck and bin' infrastructure to assist loading from fields where traditional trucks may get stuck in the field or approach roads or damage the ratoon in-field.

Technology support

Typical non-corporate-owned sugarcane farms with individual land holdings of 50 hectares and below which are categorized as small farms are normally scattered. Technical assistance would have to be co-ordinated and farmers and farm workers trained to adapt to new and improved practices including modification of planting and harvesting equipment.

National R&D for technology and variety breeding programmes is required. Philsurin in the Philippines has traditionally developed the optimal varieties for sugar and a focused breeding program for ethanol optimization has not yet been established owing to the infancy of the biofuel program.

Regulatory barriers

In response to the food v. fuel debate the Philippines requires new ethanol plants to submit plans showing the land from which they will draw cane feedstock. If existing sugar mill supplies are protected in the cause of the food v. fuel debate this could have the unintended consequence of continuing the relative inefficiency in existing practice for sugarcane production and may undermine the effort to encourage investment in yield improvements.

Except for the regulatory barriers, all others identified above could be addressed by the biofuel project.

5.6 Economic viability

Should access to capital be available such a project would likely be economically viable as returns per hectare increase with increasing yields. A breakeven area (in hectares) below which the project is not financially viable would be likely. Smallholdings are therefore unlikely to adopt such technologies but could be incentivised as part of their participation in a larger project.

5.7 Sustainability and GHG-performance

5.7.1 Sustainability risks and impacts

Substantial investment costs require a guaranteed offtake to ensure these costs are recovered. Without a robust business model for investors such an investment is unlikely to be made.

Implementation of the irrigation technology alone will not deliver the yield increases. It has to be delivered as part of a package including better management practice implementation (e.g. to ensure the water and nutrient combinations are delivered at required times).

Irrigation that uses less water per unit area is not necessarily a water-saving measure as is often claimed. The interconnectedness of river basins usually means that water considered 'wasted' through run-off for example is another areas water supply e.g. river replenishment or groundwater supply. Watershed assessments (rather than site-scale) are more appropriate for water.

Small scale projects that could present good sustainability credentials may not see the purpose of participating in an approach to 'prove' displacement minimization for a number of reasons

- The market they sell to is domestic and verifying compliance with international sustainability requirements is not a top priority;
- The resources and costs of such verification compared to the benefits are burdensome.

5.7.2 Positive side-effects

The project has a number of potential positive effects:

- Demonstration of technology and management practices that increase yields speeds dissemination to other farms and areas;
- Farmers have longer-term business model rather than reliance on sugar markets;
- Philippines' balance of payments is improved owing to reduced gasoline imports;
- Introduction of renewable energy into the grid;
- Better management practices reduce soil erosion;
- Reduced fertiliser leakage due to fertigation.

5.7.3 Carbon and GHG performance

Positive GHG impacts

- Numerous well-to-wheel studies have illustrated that increasing yield is one of the single most effective ways of improving the GHG performance of biofuels. For example, Based on Macedo et al (2008) cane productivity increase of 20% improves the GHG balance by around 13%.
- Altered management practices reduce compaction of the soil and therefore a) reduce risk of waterlogging hotspots that cause methane emissions and b) improve soil quality which is understood to increase soil carbon sequestration.

Negative GHG impacts

- Introducing irrigation requires an energy source and would therefore influence the GHG balance. The amount of energy used would depend on topography, pumping distance, depth of water table etc and would therefore vary considerably. Most sugarcane GHG balances have been conducted on unirrigated Brazilian sugarcane and therefore the potential of irrigation to influence the GHG balance has not yet been explored widely. It is possible that the substantial increase in yield could offset such GHG penalties.

5.8 Potential

This proposed solution to address displacement is replicable in many areas of geophysical potential for sugarcane where water availability is not a limiting factor (see Figure 2).

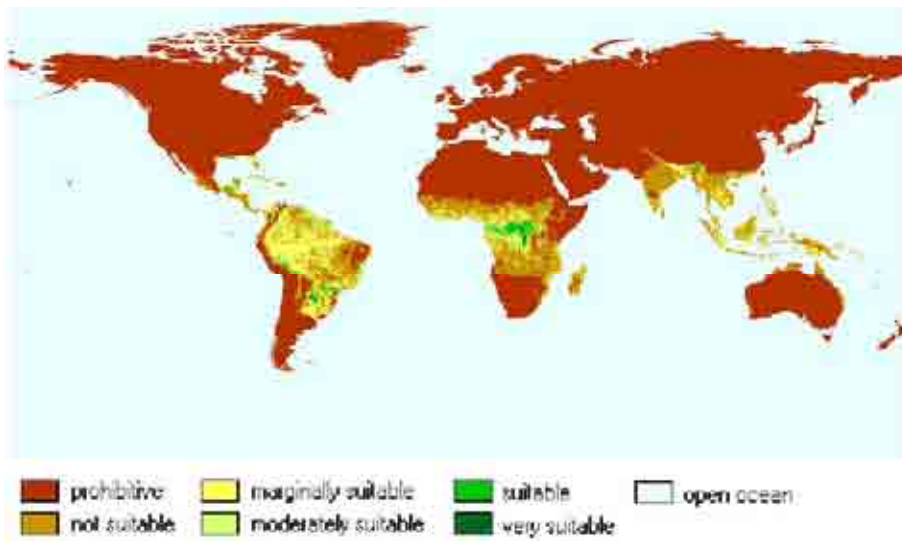


Figure 11 Suitability map for rain-fed sugarcane.

According to FAO statistics over 16% of sugarcane production was produced in countries with average yields of less than 70t/ha. Figure 3 illustrates countries have significantly different average yields.

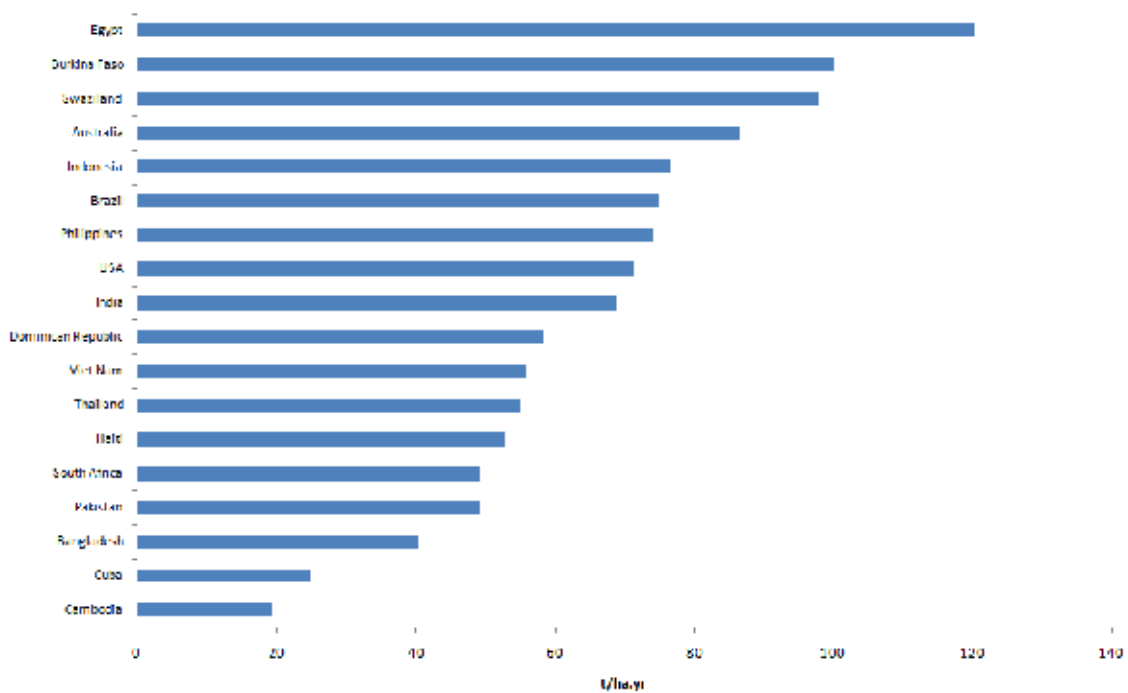


Figure 12 Average yield of sugarcane in different countries from 2005-2007 (t/ha).
Source: FAO statistics

6 Case Study of smallholder yield increases in Liberia

Acknowledgments

We gratefully acknowledge the valuable insights and inputs from Tate Munro (Winrock International).

6.1 General project description

The Liberia Smallholder Oil Palm Revitalisation project is focused on increasing smallholder yields of crude palm oil (CPO) through the introduction of mechanised processing. The project is located in several northern counties of Liberia. The project has introduced Caltech-type expellers, known locally as Freedom Mills, and uses local parts to ensure a sustainable supply chain of machines and spare parts. Participants include smallholders who harvest from wild palm in secondary forests and those who harvest from plantations. There are no mechanized processing facilities in Liberia (such as may be familiar from oil palm processing in SE Asia) and no outgrower schemes for smallholders.

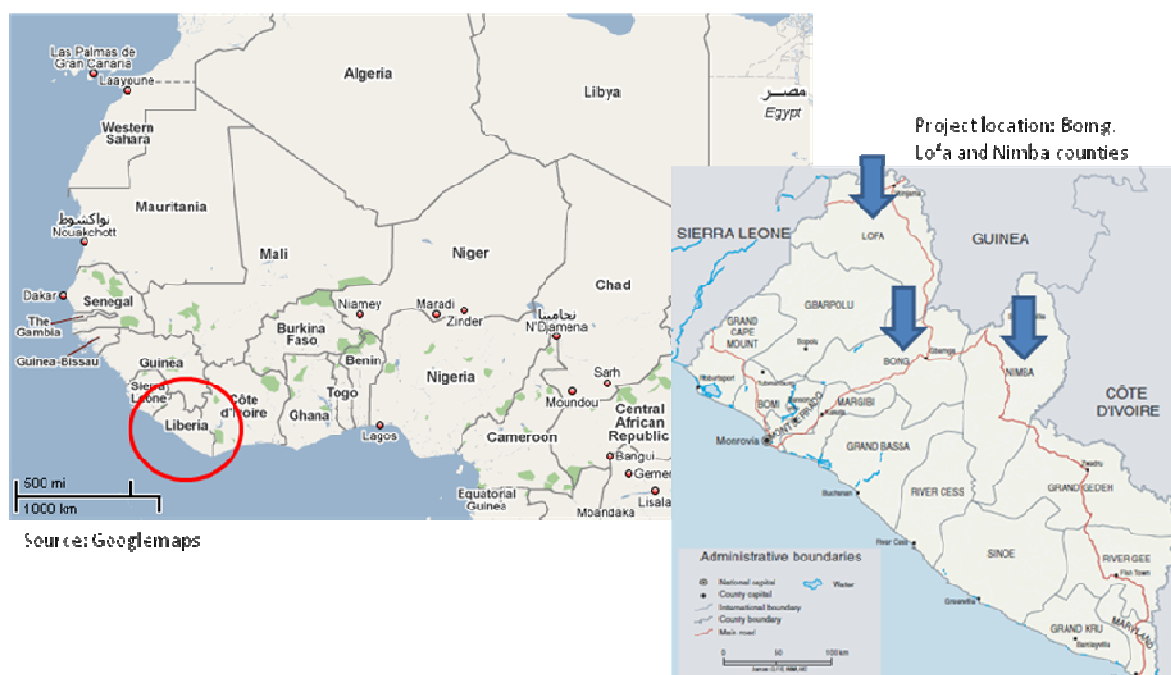


Figure 13 Project locations within Liberia

An estimated 35-40% of oil palm fruit goes un-harvested due to lack of time, labour, liquidity and appropriate harvesting and value adding technologies. Another 50% of palm oil is lost during oil extraction when processed by hand.

With the right planning and tools, extraction rates immediately increase allowing farmers to process more of their fruit, increase incomes from their existing production, dedicate more time to tending additional food crops and create much needed salaried employment in their local communities.

Improved extraction rates

Traditional milling extraction rates yield traditional milling extracts only 50%-67% of the available oil and mechanized processing extracts 90% to 92%. This accounts for up to 1.8 -fold increase in yields due to extraction improvements.

Increased throughput

4 people working for 4-8 hours will process around 0.25t FFB (a drum) into 12 gallons CPO. With mechanisation 4 people can process 0.25t FFB every 30 minutes. This can continue 24 hours a day as long as sufficient fruit is available. This accounts for an 8-fold to 16-fold increase in productivity. A larger number of hectares can therefore be processed (a limiting factor in traditional milling approaches).

Through a combination of the approaches above this Liberian project has increased the number of hectares harvested by 222% and the tonnes of oil palm produced in total by 682%.

Table 8 Impacts of the project

	2008 (baseline)	2009 (yr 1 impact)	% change
Oil palm trees harvested	43,199	106,731	247%
Hectares harvested*	324	720	222%
Tonnes palm oil produced	26	181	682%
Increased earnings from palm oil production (USD)	18,117	123,640	682%

* Existing plantation. Previously not harvested owing to lack of time.

6.2 Background

As an overall consequence of the civil conflict and economic decline, Liberia today is one of the world’s least developed countries and the country’s socio-economic indicators are among the worst. Poverty in Liberia is pervasive, with an estimated 80 percent of all households suffering from income poverty, with no access to basic health, education, and other social services. Around three-quarters of the population lives on less than US\$1 per day and approximately 90 percent of the population is considered vulnerable to food insecurity.

With a total production of about 35,000 tonnes of crude palm oil (CPO), Liberia is a minor producer of palm oil on the international and even regional market (Nigeria, Cote d’Ivoire are the largest producers in West Africa) but was a net exporter of palm

oil until the late 1980s. Liberia's agro-climatic conditions for oil palm are one of the best in West Africa however. It presently imports around 7,000t/yr of refined palm oil from Malaysia and Indonesia and demand is expected to grow.

Oil palm production in Liberia can be classified as follows:

- **Large plantations** (between 800 and 40,000 ha) produce export crops from perennials such as rubber & oil palm. Large commercial plantations that are owned and managed by the private sector (found particularly in the rubber and palm oil sectors) and the state-owned plantations run by the Liberian Palm Products Corporation (limited production).
- **Domestically owned, medium-sized commercial farms** (between 5 and 200 ha) produce industrial crops for export and the local market (although these farms are extremely small in number).
- **Small household farms** (average size of 1.2 ha), the livelihood of the rural population, **make up the majority of all farming area**. They use traditional production techniques with limited use of modern inputs.

Large industrial plantations have been largely abandoned during the war, some of them partly taken over by the local population for its own use. There has been no maintenance or replanting for about 20 years and the majority of trees (99%) are now past their peak productive years and bearing at diminished rates. Therefore, the current productivity of oil palm plantations, both large -scale and smallholder, is extremely low. Owing to the lack of maintenance and the aging of trees, average yields of the Tenera²³ plantations are probably less than 4 tonnes of FFB/ha and reported to average 2t FFB/ha. This compares with 12t/ha on average in Cote d'Ivoire (industrial plantations 15-20t/ha and 5-10 t/ha for smallholders) and 20-25t FFB/ha in Malaysia or Indonesia.

In addition, all processing/marketing infrastructures (crushers, press, storage tanks) have been destroyed during the civil conflict. Smallholders process (squeeze) palm fruit by stepping on the fruit with their feet and hands and then straining out the resulting fibers and liquids. This is extremely labour and time intensive and currently resulting in over 40% of the oil palm production in Liberia going un-harvested.

Owing to these circumstances, in 2007, the IFC reported Liberia produced only 35,000 tonnes of crude palm oil (CPO) over an estimated 100,000ha. 20,000t of CPO were produced on 25,000ha of plantation (of which 17,000ha is government owned) (national average yield of 0.8tCPO/ha). The remaining 15,000t of CPO were produced on an estimated 75,000ha of smallholder farms and harvested from wild trees/forests (national average yield 0.2tCPO/ha), see Figure 14.

²³ Tenera is a hybrid tree and has significantly higher yields than the other variety, Dura, but much a shorter lifespan (around 30 years).

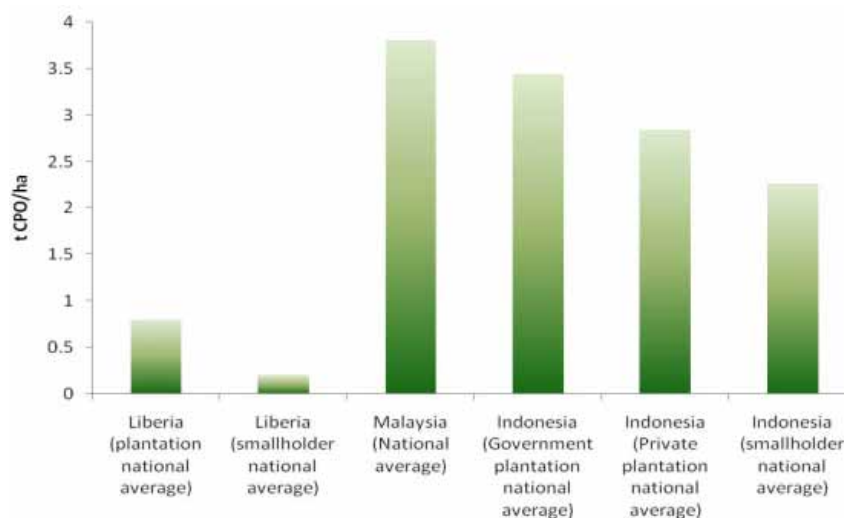


Figure 14 Yield comparison between Liberia and major oil palm producing countries (tCPO/ha) based on national average data

Relevant actors in the project

- Winrock International Institute for Agricultural Development
- Sustainable Tree Crops Programme/ International Institute for Tropical Agriculture
- US AID (funder)

6.3 Suggested solution to prevent displacement

This project focuses on increasing yields for smallholder through introducing small-scale mechanisation processes.

Improve processing yields through mechanization.

Small-scale Caltech-type expellers improve extraction rates from around 50-67% of the available palm oil to around 90%-92% of available palm oil – a yield improvement of more than 50%. Daily processing capacity is also increased from around 0.25t FFB to 4t FFB.

Additional measures to improve yields

As a further measure, improving planting materials would also substantially increase yields by replanting old oil palm with young, high-yielding oil palm trees.

Dura palm oil comes from the wild Dura tree. It generally isn't planted and is found mainly in secondary growth forests. It has a 200 year lifespan but with declining yields over time. Tenera is a hybrid tree and has significantly higher yields than the Dura variety but a shorter lifespan (around 30 years). Table 2 indicates that CPO production

from the Tenera variety is double that of the Dura variety in the project areas identified in Table 9 below.



Figure 15 Mechanical processing with 'Freedom Mill'. Source: USAID, Winrock, STCP

Table 9 Productivity differences based on oil palm variety

	Dura Variety	Tenera Variety
	Traditional	Traditional
FFBs processed (t)	0.2	0.2
CPO produced (t)	0.02	0.04

Tenera trees require heavier maintenance than Dura such as under-brushing etc so farm management is a large component of switching to this variety.

Plant breeding is required to support an improved planting program. Breeding is not difficult technically but there is no breeding programme established in Liberia.

Box 5 Rehabilitating large plantations to increase yields

The rehabilitation of existing oil palm plantations to increase yields in Liberia is another potential option. Recently, the government granted a management contract to Equatorial Biofuels Plc (EBF), a United Kingdom public company. Sime Darby, a Malaysian palm oil producer, is also reported to be investing 80% of an \$800 million in palm oil plantations in Liberia over 200,000 hectares (500,000 acres) in the West African country.

When re-planting and mechanization are both applied, from old Tenera farms yields can increase 600% per acre or more. When re-planting a wild oil palm tree (Dura variety) with a hybrid (Tenera variety), increases in yields of over 1,200% can be gained.

Equatorial Biofuels has taken over the Lebing plantation and is reported to be planning to invest about US\$60 million over the next ten years for rehabilitating/replanting. It is envisaged that total production at full development (2020) should reach 200,000 tonnes of palm fruit per year - or 40,000 tonnes of palm oil, essentially for export. Social issues related to success are key. US \$85,000 was paid to 522 former plantation employees to settle previous grievances dating back to 1980. In addition, many of the 80 percent unemployed in the country are former fighters with little education. According to the deal signed with the government at the end of last year, EBF will establish a school, spend at least \$25,000 a year on adult literacy, rebuild the old health clinic, and renovate the workers' roofless, moldering houses.

<http://www.csmonitor.com/2008/0508/p07s02-woaf.html>



Figure 16 Oil palm plantation locations in Liberia

6.4 Effectiveness and verifiability

6.4.1 Increasing CPO production through increased processing yields

Following project implementation, the area harvested under the baseline compared to year 1 increased by 222%. In total, with area increases and mechanisation introduced, the yield increase for the project area as a whole was 682%. Per hectare harvested the yield increase amounted to more than 300%.

Table 10 Productivity increase oil palm due to mechanised processing

	2008 (baseline)	2009 (yr 1 impact)	% change
Oil palm trees harvested	43,199	106,731	247%
Hectares harvested	324	720	222%
Tonnes palm oil produced	26	181	682%

Mechanised processing is not common practice in Liberia and indicates that this approach is additional to the current situation.

6.4.2 Additionality

Future yield increases across the sector that would impact future additionality are not guaranteed. The Government have signed agreements with several companies to rehabilitate large plantations but other than such agreements, the Government has little to do with the palm oil sector. There is poor institutional capacity to address agricultural improvements needed in all sectors and the capacity that does exist is geared toward production of rice: food security is a top priority. National policy treats oil palm as a cash crop rather than a food crop (despite its primary use as a food crop among smallholders) and is therefore not an investment priority for the Government. Government investment is therefore not expected to deliver future increases in yield. Other barriers to implementation of the measure that influence future additionality are addressed below.

6.4.3 Verifiability

Yield increase

Additional production stems from both additional area harvested (which was not previously harvested owing to lack of labour) and increased oil yield per FFB above the baseline. Baseline data is therefore needed on the following parameters to prove additionality.

- Area of project (ha) and area currently harvested
- Current yield

A long-run average yield would be more suitable than information from the current or previous year only. Historical records from smallholder farms are not necessarily kept and may present a limitation to obtaining this data. Owing to the war, migration and high illiteracy rates, records are not well kept. Most NGOs have found it necessary to walk the perimeter of farms to get true measures of surface area. However, quite a few smallholders are well organized. Therefore efforts to obtain the data will vary.

6.5 Barriers to the wide scale implementation of the displacement measure

Access to capital

Lack of access to capital has resulted in the absence of low-cost, appropriate and highly efficient processing mills.

Traditional Milling has a very low barrier to entry consisting of a hole in the ground (sometimes lined with a drum or rocks and cement) and wooden sticks or bare feet and hands for beating and squeezing the oil pulp.

Mechanical Milling recent domestic production of Caltech palm oil expellers have resulted in a manually operated unit costing US\$650 wholesale and US\$750+ retail.

A lack of improved planting material also has its roots in access to capital.

Private nursery entrepreneurs need to be encouraged to supply improved planting material. 1 year-old seedlings at US\$3/each have ready markets but therefore is no cash flow for the initial 9-12 month nursery period. Palm oil trading is a fast way to make small amounts of money that could kick-start the supply of improved seedlings. Loans could assist in the purchasing of mills, planting materials (seeds) for private nurseries so farmers and processors could produce oil.

Within the project, the first mechanical expeller is provided to vendors on credit. This allows the production and sale of palm oil for profit that can be used to reinvest and increase capacity.

Variety preference

Most plantations use the Tenera variety (though no new trees have been planted for around 25 years). However, palm oil is used for cooking and there is a clear taste preference for wild Dura palm. Therefore farmers consider Tenera only for making soap.

Farmers also need to ensure they have supply options for their own income insurance. If they need to sell on the local market a better insurance option is Dura palm oil owing to the taste preference.

Farmer confidence

During the years of civil strife, the main domestic consumption centers along the coast (in particular Monrovia) were often inaccessible and farm surpluses were either sold on

the immediate local markets or entered the cross-border trade to neighbouring countries (esp. Guinea and Cote d'Ivoire). The main urban markets became increasingly supplied by imported refined oil (mostly soy and palm oil). Proving the business case for farmers to increase production of palm oil and switch variety is essential – there has been turmoil in the country and confidence in markets needs to be rebuilt. Demonstration of the long-term economic viability of these projects can increase confidence and facilitate investment.

Project risk for biofuel companies

Commercial investment will be a critical link to bringing in renewed investment in the oil palm sector for planting material and fertilizer and to develop supply chains for domestic, regional and international markets. There is no biofuel production in Liberia currently from oil palm though several projects are planned (See Box 5). These projects are planning outgrower schemes with smallholders that directly border the larger plantations. Other smallholders that are not situated near plantations will not benefit directly from such investments, however anecdotal evidence suggests there is demand for CPO from West Africa including Liberia and investment in measures to increase CPO yields could be made by biofuel processors interested in procuring CPO for export. However investment risk in such improvements either through in-country production of biofuel or purchasing CPO for biofuel production is a substantial and is a barrier for wide-scale implementation of the measure.

6.6 Economic viability

The investment needed to deliver the improvements at a field scale is modest. Small amounts of credit – possibly around US\$800 – bundled into a 5 month repayment product would enable farmers and processing entrepreneurs to immediately double yields by purchasing a mechanical expeller.

Improvements demonstrated through this project increase earnings from US\$55.9/ha to US\$171.7/ha from CPO production both through increases in oil extraction and increases in harvested are due to the time saved oil expelling.

Table 11 Impacts of increased yield and area harvested on income

	Baseline 2008	2009 Year 1 impact
Hectares harvested	324	720
Increased earnings from palm oil production (USD)	18,117	123,640

While the major driver for economic viability lies in yield improvements, for CPO from Liberia to reach the international market in the future with a competitive price requires

investment in infrastructure. High transportation costs linked to a degraded transport infrastructure, in particular at the level of feeder/village access roads, is a key limitation. The Ministry of Public Works is responsible for the primary roads but secondary roads from plantations to primary roads may be lacking. The EU is currently assisting the Government in rehabilitating feeder roads and in introducing local maintenance capacity (IF, 2008). The state-owned National Port Authority (NPA) manages the four main ports in Liberia: Monrovia, Buchanan, Greenville and Harper. Monrovia is the largest and handles a wide range of cargo (National Investment Commission, 2007) but is a major problem for any investor either bringing in supplies, or attempting to export product (IF, 2008). It lacks sufficient infrastructure such as tanks but challenges arising from lack of robust management (paying port charges for example) also play a role in the viability of exports. One study (IF, 2008) estimates that to deal with the physical infrastructure on wharves alone would probably require US \$50m.

This case study illustrates that while substantial yield improvements for biofuel production to reduce the risk of displacement effects could be realised cost effectively, the infrastructure challenges associated with getting the product to the European market could be considerable. Challenges for economic competitiveness of Liberian palm oil with equivalent products remain but such yield improvements will assist: Cote d'Ivoire is West Africa's most efficient producer (average 12t FFB/ha) but is not yet at parity with palm oil from SE Asia (over 20t FFB/ha). Anecdotally, estimated production costs of Cote d'Ivoire are in the region of US\$450/t plus transport costs of about US\$100/t for landed cost in Europe compared to around US\$250-300/t plus transport costs of about US\$130/t to Europe.

6.7 Sustainability and GHG-performance

6.7.1 Sustainability risks impacts

Mechanized processing

- Less water is used per tonne of FFB in mechanical milling but since throughput is greatly increased the environmental risk from waste treatment can significantly increase if not mitigated.

Improving planting material

- Native vegetation has begun to reclaim many of the large scale plantations that now have many smallholder farmers as residents. Plans to revive low-yielding oil palm plantations could involve loss of biodiversity and loss of carbon stocks. This will require case by case evaluation whether revival of old plantations is acceptable from a biodiversity point of view – e.g. as is required for RSPO certification.
- The wild Dura variety of oil palm has been noted as the most significant non-timber forest product in Liberia (in terms of value) in recent studies undertaken by

ARD. Replacing these lower yielding trees with higher yielding varieties will increase risks of biodiversity loss.

- The Tenera higher yielding variety requires more substantial management than the wild Dura variety. Use of pesticides and herbicides could impact fauna and flora as well as create water quality issues if not managed correctly.
- The government has decided to privatize the existing state-owned oil palm plantations which will increase yields but some are heavily occupied by small farmers who have moved in following the plantations' abandonment during the war. Conflicts over informal land rights may result.

6.7.2 Positive side-effects

Improved income generation

Agriculture is the backbone of Liberia's economy, providing informal employment for more than 70% of the workforce (mostly in rural areas) and contributing an estimated 53% to the gross domestic product (GDP) in 2006. Improving yields could have positive socio-economic implications for the workforce.

Through decentralised crushing farmers add value to FFB through processing into CPO (a higher value product) and obtain a higher margin than selling FFBs (as long as they have equal access to the market). Alternative business models such as outgrower schemes are generally characterized by centralized processing facilities and outgrowers sell FFBs to the central mill. There is no experience of this model in Liberia yet.

Avoided deforestation

Biomass resources meet about 99.5% of the Liberian population's energy needs so they are vital to basic welfare and economic activity. Firewood and charcoal are the primary energy source used for domestic cooking and heating. At present, trees and branches are cut down and used for energy requirements (heating and clarification) for CPO processing. Oil palm residues generated during processing include fiber, shells, and empty fruit bunches (EFB) are discarded but could be used to displace charcoal and traditional firewood in the CPO processing stage and substantially reduce pressure on deforestation. Increasing the area that can be harvested per unit of time will increase residue availability.

The processes for measurement and monitoring of avoided deforestation are currently under discussion and development within the REDD process (Reducing Emissions from Deforestation and Degradation). Liberia is in the process of developing a REDD readiness plan but Liberia's DNA but is significantly under resourced. It is expected that Liberia is 1 to 3 years away being able to consider such projects for emission reduction claims.

Soil conditioning

There are other uses for these residues. For example, EFBs are rich in potassium can be used as soil conditioner: with increased processing capacity an increased capacity for soil conditioner becomes available. This could provide additional soil protection as well as other benefits such as nutrient supply and moisture retention that could improve nutrient uptake and therefore increase yield.

Facilitating rural electrification

While not a positive side effect of the project on its own, the benefits of the project could facilitate the growing emergence of decentralized electricity plants planned in Liberia. The productive life of the oil palm tree is about 25-30 years, and during replanting tree trunks and fronds become available. Increasing processing capacity also increases the volume of residues available. In addition, biogas to-electricity technology could be used to handle the industry's waste. GHG emissions from palm oil mill effluent (POME) are substantial if treated in open lagoons and the use of this waste as an energy source could produce further clean electric power generation. Economic feasibility of such projects is challenging but several are in the planning stages in Liberia at present in conjunction with the development of 'mini-grids' for rural electrification.

6.7.3 Carbon and GHG performance

Positive GHG impacts

- Numerous well-to-wheel studies have illustrated that increasing yield is one of the single most effective ways of improving the GHG performance of biofuels.
- Improving the management of oil palms improves their growth and therefore could have temporal carbon stock benefits

Negative GHG impacts

- Increasing oil palm processing increases volumes of waste (POME) which can substantially increase GHG emissions
- Increasing yields through replanting old Tenera varieties may require cutting back areas where natural vegetation has encroached into abandoned or poorly maintained plantations

6.8 Potential

The technology for mechanization is low-tech, low cost and high impact. It originated in the mid 1980s in Cameroon and is easy to replicate. Other countries in the region with good potential for oil palm cultivation but with low yields and a similar situation for smallholders to Liberia include the Democratic Republic of Congo, parts of Guinea, Cote d'Ivoire, Benin, Nigeria and Cameroon.

Note: Circumstances in Liberia differ and therefore these broad statements are indicative only to indicate theoretical potential.

- Current smallholder production of 15,000t could be doubled by the introduction of mechanization alone to 30,000t and increased further still through the ability to harvest a larger area of oil palm.
- There are approximately 100,000ha of oil palm in Liberia²⁴ none of which is mechanically processed. Through introducing mechanisation and high yielding varieties, an average of 2t CPO/ha over the entire area would produce 200,000t, far outweighing domestic consumption of oil palm.

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Winrock International/ IITA / USAID project documentation

²⁴ No official figures are available and verified but this represents a broadly acceptable consensus

7 Case study of a feedstock-region-level approach to EU wheat

This case study takes a different approach than the other case studies. It does not focus at an individual feedstock production unit but in stead analyses the possibility for identifying biofuels with a low risk of indirect effects on a feedstock-region level. The purpose of this is to gain a first understanding of the feasibility of identifying biofuels with a low risk of indirect effects at a higher level than the individual project level. This case is also relevant as it addresses recent ideas put forward by UK stakeholders on biofuels with a low risk of indirect effects.

The example used here is that of EU-grown wheat to ethanol. The two central questions that are discussed are:

- 1 Can a plausible case be made that ethanol from EU-grown wheat has a low risk of indirect effects?*
- 2 Does such a feedstock-region-level approach fit within the project-level approach to claim a low risk of indirect effects?*

7.1 Arguments for a low risk of indirect effects of EU-wheat-ethanol

The argumentation given here for a low risk of indirect effects of certain feedstocks grown in certain regions (referred to as “feedstock-region combination” here) is largely based on draft publications by and interviews with W Lywood (2009). The arguments do not necessarily reflect the opinions of the authors of this paper. The three main arguments are:

- 1 Ethanol from wheat has a low net land requirement because DDGS displaces a substantial area of soy bean;
- 2 The additional output of wheat in the EU will be primarily met by yield increases, while increased soy production will be met primarily by area increases;
- 3 The additional land needed to grow wheat in the EU will displace mainly low carbon stock idle land, while land used to grow additional soy beans is likely to replace land with higher carbon stocks.

The next sections analyse these three arguments and whether these arguments together provide a plausible case for a low risk of indirect effects for the relevant feedstock-region combination. Within the scope of this project, the detailed analysis required to draw firm conclusions on all these arguments was not possible. However, we will discuss to what extent these types of arguments at a feedstock-region level provide a promising approach to identifying biofuels with a low risk of indirect effects.

7.1.1 Low net land requirements due to useful co-products

The basis of this argument is that ethanol from wheat has a small net land requirement because a co-product in the form of DDGS is produced which can be used as animal feed. The use of DDGS as animal feed substitutes for other animal feeds, which, assuming no price effects, now don't have to be produced anymore. This results in a so-called land credit for the wheat to ethanol chain. This is common practice in LCAs that take a substitution approach²⁵.

In a draft paper (Lywood, 2009a) it is calculated that the gross land requirements (not taking into account co-products) of ethanol from EU wheat amount to 0.40 ha per tonne of ethanol. However, the paper then calculates that the net land requirements of ethanol from EU wheat amount to only 0.03 ha per tonne of ethanol: the difference of 0.37 ha per tonne of ethanol is explained by the wheat DDGS substituting both soy meal and wheat in animal feed. Especially the substitution of soy meal has a large effect due to the relatively low yield of soy. For details, see table below.

Table 12 Net land requirements for wheat to ethanol: numbers provided by Lywood (2009a).

Parameter	Value	Unit
INPUTS		
Feed wheat yield	7.75	t/ha/year
Feed wheat DDGS yield	2.56	t/ha/year
Ethanol yield from feed wheat	2.48	t ethanol/ha/year
Feed wheat displaced by DDGS	0.39	t feed wheat / t DDGS
Soy meal displaced by DDGS	0.59	t soy meal / t DDGS
Soy meal yield	1.84	t/ha/year
RESULTS		
Gross land requirements for ethanol from EU feed wheat	0.40	ha / t ethanol
Land saved by DDGS displacing feed wheat	0.05	ha / t ethanol
Land saved by DDGS displacing soy meal	0.33	ha / t ethanol
Additional land requirements to compensate for lower soy oil production	0.01	ha / t ethanol
Net land requirements for ethanol from EU feed wheat	0.03	ha / t ethanol

²⁵ The substitution approach for LCA is sometimes also referred to as the system expansion approach.

The above calculation finds a very low net land requirement for ethanol from EU wheat. It is not within the scope of this project to review the assumptions made by the paper on which this calculation is based (Lywood, 2009a). Nonetheless, what is relevant here is that the calculation is valid only for a specific region, the EU in this case, because the assumptions made on the substitution ratios of the DDGS are based on the feed market situation in the EU – more specifically, by the fact that the EU has a protein deficit for its animal feed and that it therefore imports soy meal. The same calculation for ethanol from wheat produced in the US would therefore result in a different outcome because the US has a different feed-market situation.

7.1.2 Additional EU wheat will be met primarily by yield increase

In another draft paper Lywood (2009b) argues, based on an analysis of historical data, that the majority of increased EU wheat output will be met by yield increase. The same paper also argues, again based on an analysis of historical data, that the majority of increased soy bean production in South America (the main exporter to the EU) will be met by area increase. Combined with the assumption that DDGS displaces a substantial amount of soy bean production, this would imply a significant reduction in soy bean land requirements in South America, combined with only a small increase in wheat land requirements in the EU.

It must be noted that this position on the relation between yields increases, area increases and output increases differs from the position of other parties on these parameters - see recent work by Ecofys (2009) for the Roundtable on Sustainable Biofuels that reviewed other initiatives such as those for the US Renewable Fuels Standard, the California Low Carbon Fuels Standard, the work by Searchinger, IISA, LEI, etc. Within the scope of this study we have not been able to test the validity of this position or that held by other parties.

7.1.3 Additional land for wheat in the EU will displace low carbon stocks idle land

The yield argument discussed above argues that very little additional land will be needed for additional EU wheat production for biofuels because most increase in output will be met by yield increase. It also argues that the displacement of soybeans by the DDGS would lead to a significant reduction in land requirements for soybeans in South America because most of the increase in soy beans production in that region would be met by increased area. The third argument, set out in another draft paper by Lywood (2009c) then goes on to argue that any land that is converted in the EU for additional wheat production will be land with low carbon stocks, leading to modest GHG-emissions from LUC. The same draft paper also argues that land converted to soy in South America will include more high carbon stock lands such as natural grasslands and forest land.

As with the position on yields, this position is not uniformly shared by others that have analysed the indirect effects of biofuel production - see recent work by Ecofys (2009)

for the Roundtable on Sustainable Biofuels. Especially the topic of land use change by agriculture is difficult due to limited reliable data availability. Within the scope of this study we have not been able to test the validity of this position by Lywood (2009c) or that held by other parties.

7.2 Feasibility of a feedstock-region-level approach to displacement mitigation

Do the above three arguments imply a low risk of indirect effects? This is a complex question. On the one hand, there are clearly several points in the argumentation that, if they hold true, imply a low net land requirement for ethanol from EU wheat:

- The displacement of soy meal by DDGS reduces the land needed for soy beans and since soy has a relatively low yields compared to wheat, this effect can be significant.
- If additional demand for EU wheat is indeed primarily met by additional yield increases, the additional pressure on land for ethanol from EU-wheat is small.

In addition, any additional land that would be needed for EU wheat is argued to be converted from low carbon stock lands, implying modest GHG emissions from LUC.

While the detailed assumptions made in each of the three arguments would need to be validated, the concept is interesting enough to merit such a more detailed analysis. However, the above argumentation is not sufficient to judge whether a certain feedstock-region combination has a low risk of indirect effects. The reason for this is that displacement of existing production, which lays at the basis of indirect effects, may still occur.

The crucial question for indirect effects is where the wheat (for the ethanol production) will come from? Will the wheat for ethanol production in the EU come from an equal increase in wheat production in the EU? In that case no displacement of existing production would occur. Or will the wheat for ethanol come from e.g. redirecting EU wheat exports to EU biofuel production? In the latter case there would be a displacement effect – the wheat that was produced for exports, is now no longer exported but is shifted to biofuel production. All other things equal, producers outside the EU will now have to increase their wheat production to make up for the reduced exports from the EU. Another possibility is where EU farmers increase wheat production but at the expense of other crops, because of which exports of these other crops decline or imports of these other crops, or their substitutes, increase.

With respect to the question where the additional wheat will come from, several observations can be made:

- An analysis by the European Commission on the land requirements of a 7% and 14% biofuel target, using the ESIM agro-economic model, estimates that 37% of all land used in the EU for biofuel feedstock production would be land diverted away from exports (EC 2006). In other words, without biofuel feedstock production in the EU, this land would have been used for exports.

- An impact assessment of a 10% biofuel target by DG-AGRI , also using the ESIM agro-economic model, estimates that:
 - 15% of biofuels from energy crops produced in the EU would come from EU arable land diverted away from exports; and
 - 27% of biofuels from energy crops produced in the EU would come from EU arable land diverted away from domestic production for non-fuel purposes (EC 2007).
- *Potential* studies such as those recently published by the UK Renewable Energy Association, on the EU's and UK's potential for sustainable biofuel feedstock production (REA 2009), do not provide an insight in where the additional wheat (or other biofuel feedstock) will actually come from. They show the potential exists to produce a certain amount of biofuel feedstock in the EU. However, where biofuel feedstocks will actually be produced is primarily determined by economics, not by the technical potential available in the EU and other countries.
- Arguments that the EU has a shrinking arable land area and/or significant areas of previously set-aside or fallow land available suffer from the same issue as the potential studies. The mere fact that these areas are or will become available does not mean that market forces will also dictate the additional production to occur on those lands. To assure that additional production for biofuels would occur on such, currently unused, lands would require market interventions in the EU agricultural sector. The feasibility of desirability of such market interventions is beyond the scope of this project.

The first two sources cited above suggest that around 40% of EU arable land that would be used for biofuel feedstock production would lead to a displacement of other production, with the accompanying risk of indirect effects²⁶. What the overall balance will be of this displacement of existing EU production on the one hand and the benefits of substitution of other animal feeds with DDGS is unclear.

In summary, the above described feedstock-region-level analysis may offer an interesting approach to analyse the risk of unwanted indirect effects, but additional analysis is needed on where this feedstock will come from to be able to draw firm conclusions on whether such biofuels indeed offer a low risk of indirect effects.

7.3 Does a region-feedstock approach fit with a project-level approach?

All other cases analysed in this project are cases where additional production can be attributed to specific measures taken by an individual feedstock producer. In the feedstock-region-level approach discussed in this chapter, this is not the case - individual producers are not required to demonstrate an additional increase in

²⁶ Other stakeholders have argued that this number is likely to be lower.

production²⁷. Therefore the feedstock-region-level approach cannot be fitted into the project-level methodology, which is discussed in the next chapter.

7.4 Conclusions

The feedstock-region-level analysis may offer an interesting approach to identify biofuels with a low risk of indirect effects at a higher level of aggregation than at the individual project level. However, additional analysis is needed on where this feedstock will come from to be able to draw firm conclusions on whether such biofuels indeed offer a low risk of indirect effects.

Because additional production cannot be demonstrated for individual producers in a feedstock-region-level approach, it does not fit into the project-level methodology discussed in this report. Of course, EU biofuel feedstock production can also be done in ways that can demonstrate additional production at the level of individual producers: e.g. by increasing yields or using (rotational) fallow land. Such production could still be recognised as having a low risk of indirect effects in the project-level approach.

A detailed analysis of the feasibility of a feedstock-region-level approach to identifying biofuels with a low risk of indirect effects is beyond the scope of this project. Further work is recommended to investigate the potential for such a higher-level approach, taking into account the issues identified here.

Note on consistency with RED

It should be noted that the potential low net land requirements for ethanol from EU wheat found in the draft paper by Lywood (2009a) are based on a substitution (or system expansion) approach. The RED GHG-methodology works with an energy allocation approach and will therefore not identify the substitution effects of co-products: or the differences in these substitution effects depending on the geographical region in which the co-products become available, e.g. due to differences in feedstock market circumstances. The choice for energy allocation in the RED is mainly based on practical reasons and because “it gives results that are generally comparable with the range of results given by the substitution method” (RED recital 81). However for iLUC effects, energy allocation of co-products gives entirely different results from the use of substitution effects and is therefore considered inappropriate.

²⁷ Individual producers could potentially demonstrate that their DDGS is used in the food industry. This could serve to prove that the DDGS displaced other animal feed, but it does not provide information on the crucial question whether the wheat for ethanol is produced additionally or whether it displaces other (wheat) production.

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8 Methodology

While the conclusions differ per case study, overall the case studies demonstrate that a significant potential exist to increase bioenergy feedstock production without displacing existing (and future) production for other purposes. The case studies also demonstrate that many of these opportunities are as economically viable as the dominant production models that put a higher pressure on land use change. The main barriers faced are often not of economic nature but typically find their origins in less quantifiable areas such as governance and contractual issues, land right issues and customary practices. Given the right incentives, the biofuel sector may be able to overcome these barriers – thereby fulfilling (a part of) their feedstock requirements in ways that have a low risk of unwanted indirect effects (and that may have other beneficial side effects as well).

This chapter sets out possibilities for a methodological framework to distinguish such biofuels from energy crops with a low risk of unwanted indirect effects. For the methodological concepts presented here, the authors have made use of concepts developed for the Responsible Cultivation Area methodology (Ecofys, WWF and Conservation International, forthcoming).

For the RFA, and other stakeholders, to be able to distinguish biofuels with a low risk of unwanted indirect effects, at least the following components of a methodology are needed:

- 1) Criteria that must be met by producers in order to qualify as a biofuel with low risk of indirect effects*
- 2) Guidance for producers on how compliance with the criteria can be demonstrated*
- 3) Verification rules*
- 4) Rules for the claims that can be made*

These components are dealt with below. It should be noted that this has been done at a level that allows discussion of the key concepts. For the methodology to be implemented in policy additional details are likely to be needed (see section on next steps). This section first clarifies the scope of the methodology and then discusses the various components of the methodology. This chapter also includes a comparison of the methodological framework made with the “degraded land” concept in the EU RED. Chapter 9 concludes this report with an overview of the main barriers to implementation of the methodology and a discussion on next steps.

8.1 Scope

Focus on indirect effects from energy crops

The scope of the methodology is limited to minimising the risk of unwanted indirect effects from biofuel production from energy crops. For biofuel production to be sustainable unwanted direct effects have to be prevented as well (e.g. loss of biodiversity) but this has been the focus of other work (e.g. the RTFO meta-standard). Mechanisms for direct effects are more easily assessed and monitored as they can be directly observed at the location of production; existing mechanisms such as certification schemes already exist for this purpose. Preventing unwanted direct effects will therefore always be necessary alongside minimising the risk of unwanted indirect effects. This methodology focuses on indirect effects only. Furthermore, this methodology focuses on biofuels from energy crops. The RFA is undertaking separate work on indirect effects from biofuels from residues and wastes.

Focus on three types of project-level approaches

In line with the case studies, the methodology focuses on three main approaches:

- 1 The use of land without current (and future) provisioning services²⁸.
 - a. E.g. oil palm on “unused”²⁹ Imperata grassland
- 2 Increasing land productivity through integration with non-bioenergy-feedstock systems
 - a. E.g. increasing cattle density through integration with sugarcane
- 3 Increasing the land productivity of existing bioenergy-feedstock systems
 - a. E.g. increasing the yields of existing sugarcane plantations

The methodology thereby takes a project-level approach, in which a low risk of indirect effects can be claimed by individual production units if certain requirements are met³⁰. As discussed in the case study on bioethanol from EU-wheat, methodologies to distinguish biofuels with a low risk of indirect effects could also be considered at a higher level, e.g. for a certain feedstock-region combination. However, the methodology discussed here takes a project-level approach.

²⁸ The Millennium Ecosystem Assessment distinguishes four categories of ecosystem services: provisioning services, regulation services, cultural services and supporting services. Provisioning services are defined as harvestable goods such as fish, timber, bush meat, genetic material, etc. (Commission for Environmental Assessment, 2006).

²⁹ The term ‘unused’ land is intended to signify land that is unused from an agricultural perspective but it is recognised that land is unlikely to ever be truly unused. Defining unused land is considered in the section on next steps.

³⁰ The term ‘project-level’ is used to refer to a specific activity or set of activities under the control of single party – it does not necessarily imply a biofuel only ‘project’ as some fuel chains such as soy or palm oil do not necessarily fit in such an easily identifiable and vertically integrated ‘biofuel’ project.

Focus on period up to 2020

The methodological proposals in this paper are primarily focussed on the obligation period of the EU RED. That is the period until 2020. This is relevant in discussions on the time period over which the proposed solutions must be effective in terms of minimising the risk of unwanted effects.

8.2 Mitigation criterion for unwanted indirect effects

Indirect effects of additional biofuel feedstock production are the result of a displacement of existing production on land that was already in use for other purposes. E.g. existing palm oil production that was previously used for the food sector is now used for biodiesel production³¹. Or land previously used for cattle is now used for sugarcane production for ethanol.

Displacement of existing production on land that is already in use for other purposes is therefore at the heart of the concept of indirect effects. Preventing displacement, by realising additional production instead of displacing existing production, is therefore at the heart of the solution to minimise the risk of indirect effects. The proposed criterion therefore is:

Additional production has been realised without displacing existing provisioning services of the land.

8.3 Demonstrating compliance: Baseline, additionality and registration

The above criterion states that additional production must be realised to prevent displacement effects. To be able to demonstrate compliance with this criterion the following is required:

- 1 Determine the baseline production levels of the project area. The increased production levels will be compared to this baseline after implementation of the project activity. The increase in production levels above the baseline is eligible for crediting.
- 2 Determine whether the project activity is additional, i.e. that in absence of the biofuel feedstock demand the project activity would not have been implemented during the crediting period³².
- 3 The project must be registered.

8.3.1 Setting the baseline

Two options exist for setting the baseline production levels:

- **Static baseline** in which the baseline production levels are set equal to the current production levels.

³¹ Note that different indirect effects may result from this. E.g. production is increased elsewhere potentially leading to a LUC, or consumption in other sectors may reduce (e.g. reduced food consumption).

³² For a definition of the crediting period, see section 8.5.2.

- **Dynamic baseline** in which the baseline production levels change over time, e.g. by taking into account business-as-usual yield changes.

The table below provides guidance on how the baseline can be set depending on the project type and the whether the baseline is set static or dynamic.

Table 13 Guidance on how to set the baseline. A difference is made for when the baseline is set static or dynamic.

Project type	Static baseline	Dynamic baseline
The use of land without provisioning services	Zero The land currently provides no provisioning services.	Zero The additionality test must demonstrate that the land would not be taken into production in the crediting period.
Increasing the land productivity of existing bioenergy-feedstock systems	-Current production levels of existing bioenergy feedstock system (yield) based on a multi-year average, OR; -Production levels that would be achieved with BAU practices. In case of rotational systems, the production levels are averaged to a per annum basis.	-Projected production levels of existing bioenergy feedstock system (yields) based on historic yield trendline, OR; -Production levels that would be achieved with BAU practices. In case of rotational systems, the production levels are averaged to a per annum basis.
Increasing land productivity through integration with non-bioenergy-feedstock systems	-Current production levels of existing non-bioenergy feedstock system (yield) based on a multi-year average, OR; -Production levels that would be achieved with BAU practices. In case of rotational systems, the production levels are averaged to a per annum basis.	Projected production levels of existing non-bioenergy feedstock system (yields) based on historic yield trendline, OR; -Production levels that would be achieved with BAU practices. In case of rotational systems, the production levels are averaged to a per annum basis.

8.3.2 Proving additionality

To prevent displacement effects, the project activity that increases production levels must be additional. To demonstrate such additionality for the three different types of solutions, the following would be needed:

- The use of land without provisioning services: demonstrate that in absence of the biofuel feedstock demand, land with certain characteristics would not have been used for the supply of other provisioning services (i.e. it would not have been taken into production)³³. E.g. for the oil palm case study in Indonesia, this could be land that lies outside the area destined for development by the Indonesian government because the land is classified as forest land by the government because of which it is very difficult to obtain a permit.
- Increasing the land productivity of existing bioenergy-feedstock systems: demonstrate that in absence of the biofuel feedstock demand, the yield increasing measure (e.g. drip irrigation) would not have been implemented.
- Increasing land productivity through integration with non-bioenergy-feedstock systems: demonstrate that in absence of the biofuel feedstock demand, the integration model (e.g. sugarcane-cattle) would not have been implemented.

The question is how such additionality can be demonstrated. Based on experience with carbon schemes, in which additionality is a common concept, several methods can be used to demonstrate additionality of the project activity. These include:

- Regulatory Surplus Analysis demonstrating that the project activity is not a requirement of existing law or regulation.
- Common Practice Analysis demonstrating that the new project activity is not common practice in the relevant sector in the relevant region.
- Barrier Analysis demonstrating that one or more barriers exist that prevent the implementation of the project activity in absence of the project.

Regulatory Surplus Analysis

The regulatory surplus analysis must demonstrate that the proposed activity is not already required by existing law or legislation. If the project activity is already required by existing law or legislation, it is not additional.

Common Practice Analysis

The common practice analysis analyses to what extent similar project activities have already been implemented or are currently underway in the same sector in the

³³ To gain a reliable insight in the actual provisioning services of an area, local stakeholder consultation will always be needed. One could not rely only on secondary data sources such as national land classifications. Also, the fact that the land is not used at a particular point in time does not need the land has no provisioning services. The land may be used in a rotational scheme with long fallow periods.

relevant geographical area. Other projects that are registered as having a low risk of indirect effects are not to be included in this analysis: i.e. these projects are not treated as common practice projects in the common practice analysis of later projects.

If similar activities are identified, then these must be compared with the proposed project in order to assess whether there are essential differences between the proposed activity and the existing activities. If essential differences exist it must be demonstrated that these differences explain why the existing activities did not face the barriers faced by the proposed project activity. If this can be demonstrated, the proposed project activity can still be considered additional.

Barrier analysis

In most carbon schemes, a barrier analysis is performed to demonstrate additionality. The concept is that the project should demonstrate that barriers exist to the implementation of the project because of which the project is unlikely to be implemented in the baseline scenario. Barriers can be financial (e.g. the project is less economic than alternatives), technical (e.g. lack of availability of the technology in the region), but can also be of another nature (e.g. institutional, organisational or customary barriers – see the case studies for examples). Note the case studies of this project showed that barriers indeed exist for all reviewed cases. They also showed that often these barriers are not of economic nature.

Box 6 Simplified Methodology without additionality test

The methodology described here requires a demonstration of additionality, i.e. that in absence of the biofuel demand the project activity would not have been implemented during the crediting period. A simplified alternative of this methodology could only require that the project activity is not yet implemented at the time of registration and no additionality test is needed. This would allow the registration of projects that have not yet implemented a measure at that specific production unit, even though the same measure may already be implemented in most other production units in the same area.

The benefit of this simplified approach is that it is easier to implement as it does not require an additionality test. The disadvantage is that it will be less effective in preventing unwanted displacement effects because it credits measures that are likely to have been implemented anyways within in the crediting period.

Demonstrating additionality and transaction costs

A potential problem with the additionality tests is the potentially high transaction costs. There are at least two methodological choices that have a large impact on these transaction costs:

- 1** The required additionality tests. At least two options exist:
 - a. Regulatory Surplus Analysis + Common Practice Analysis
 - b. Regulatory Surplus Analysis + Common Practice Analysis + Barrier Analysis
- 2** The level at which the additionality tests has to be performed. Again, at least two options exist:
 - a. One barrier analysis required for each individual project: e.g. for each sugarcane-cattle integration project in Brazil.
 - b. One barrier analysis is required for a certain project type in a certain region: e.g. one barrier analysis would be performed for projects that integrate sugarcane with cattle in (a certain region of) Brazil. If this barrier analysis shows such a project to be additional, then all such project in (a certain region of) Brazil would be considered additional, without the need for each individual project to do its own barrier analysis. Of course, compliance with the displacement criterion (i.e. no displacement of provisioning services) must still be validated for each individual project. e.g. existing milk or beef production levels must be maintained. Also, compliance with any sustainability criteria on direct impacts (e.g. biodiversity or carbon stocks) will still have to be verified for each individual project.

In the choice between the above options a trade-off will have to be made between transaction costs and a potential erroneous conclusion on the additionality of an individual project.

8.3.3 Additionality and project “registration”

The use of the additionality concept normally requires the project to be “registered” before implementation. If the methodology acknowledges already implemented projects it would recognise good production practices but it would not ensure additionality. The implication of a strict approach to additionality is that existing production units, that already implemented measures that would normally qualify as low risk of indirect effects, are not rewarded by the methodology. A similar situation exists for most carbon markets such as CDM.

Potentially, one exception can be made to the rule of registration prior to implementation. If the project is already implemented but the driver can be shown to have been biofuel feedstock demand, one could argue this still complies with the additionality requirement that *in absence of the biofuel demand* the production increasing project activity would not have been implemented during the crediting

period. The final methodology will need to make a decision of such projects can be credited ex-post.

The concept of 'registration' implies the need for a 'body' and a governance process that does not currently exist for application of this methodology (See section 9.2 on next steps).

8.4 Verification

For companies to be able to make a credible claim on the low risk of indirect effects of their biofuels, some sort of verification will be required. What exactly would need to be verified to be able to make such claims, is described in this section. The next section describes the claims that could be made.

- Before the project is implemented: verification of additionality and the baseline. This happens only once.
- After the project is implemented: verification of continued compliance with the criterion that the original provisioning services of the land are not displaced (during the crediting period). This differs for the three solution types.
 - For the unused land option, all production is additional. This means only the actual production levels have to be monitored to ensure no more produce is claimed than is actually produced on the project site. Note that this is common practice for all certification schemes.
 - For the integration with non-bioenergy-feedstock systems, the provisioning services in the baseline scenario must be monitored to validate that they are maintained (e.g. milk production levels before project implementation, potentially increased by an annual percentage in the baseline scenario).
 - For the increased productivity of existing bioenergy-feedstock systems, the realised production levels must be monitored for validation. The "additional production without displacing the existing provisioning services of the land" then equals the realised production levels minus the production levels of the baseline scenario.

8.5 Claims

8.5.1 The quantity of product for which a claim can be made

What are the claims that can be made for projects of the three different approaches?

- 1 The use of land without current provisioning services: all production from the land could be claimed to have a low risk of indirect effects.
- 2 Integration with non-bioenergy-feedstock systems: all production of energy feedstock could be claimed to have a low risk of indirect effects (provided that baseline production levels of the non-bioenergy feedstock level are maintained).

- 3** Increasing the land productivity of existing bioenergy-feedstock systems: all production of bioenergy feedstock above the baseline can be claimed to have a low risk of indirect effects.

8.5.2 The crediting period

The crediting period is the finite length of time during which the project’s claim of low indirect risks is valid, e.g. 5 or 10 years. The crediting period can be renewed, but this requires a new assessment of additionality and the baseline.

Box 7 Comparison with the RED-bonus for degraded land

The RED contains a GHG-bonus of 29 gCO_{2eq}/MJ biofuel if biomass is obtained from restored degraded land. For this the land must meet the following conditions:

- Was not in use for agriculture or any other activity in January 2008: and
- Falls into one of the following categories:
 - Severely degraded land, including land that was formerly in agricultural use;
 - Heavily contaminated land.

These categories are defined further in the RED and further guidance still will be given by the EC following a Comitology process.

In comparison with the methodological framework discussed in this paper, the RED degraded land provision would be a subset of the first approach: “the use of land without current provisioning services”. Thereby the RED could be said to take “degraded soil conditions” as a proxy for additionality. The approach discussed here allows companies to show other barriers than soil-conditions of the land to demonstrate such additionality. In addition, the RED does not contain provisions that award increases in land productivity, analogous to the second and third approach discussed here.

8.6 Summary of the methodology

The table below summarise the methodology for the three different approaches. They summarise how additionality can be demonstrated, how the baseline can be established, what monitoring is required, and what claim can be made.

Table 14 Summary of the methodology.

	Land without provisioning services	Integration with non-bioenergy system	Increased productivity of existing bioenergy feedstock system
Displacement criterion	<u>Additional</u> production has been realised without displacing existing provisioning services of the land		
Demonstrating additionality	Demonstrate the project activity that increases feedstock production is additional: i.e. in absence of the bioenergy feedstock demand the measure would not have been implemented during the crediting period.		
	i.e. the land would not have been taken into production.	i.e. the integration model would not have been implemented.	i.e. the yield increasing measure would not have been implemented.
Setting the baseline	Zero (land previously unused)	Business as usual (BAU) production levels of non-bioenergy system (e.g. milk or beef)	BAU production levels of existing bioenergy system
Monitoring	Monitoring of realised bioenergy feedstock production levels	Monitoring that baseline production levels of non-bioenergy feedstock are maintained	Monitoring of realised bioenergy feedstock production levels
Claim that can be made	All realised production has a low risk of indirect effects	All realised bioenergy feedstock production has a low risk of indirect effects	The additional production ('realised production' minus 'baseline production') has a low risk of indirect effects

9 Towards implementation: barriers and next steps

This final chapter addresses the implementation of the methodology to distinguish and credit specific bioenergy feedstock production units that have a low risk of unwanted indirect effects. First, the main barriers to implementation are listed. This report concludes with a discussion on the next steps required for implementation.

9.1 Barriers to implementation

The table below lists the main potential barriers to the implementation of the displacement-mitigation methodology and gives comments on how to address these barriers.

Table 15 Barriers to the implementation of the displacement-mitigation methodology.

Barrier	Comments
<p>Exclusion of existing production. The methodology requires the production to be additional. This excludes current production – clearly a very large part of the potential supply base.</p>	<p>Additionality is fundamental to the effectiveness of preventing displacement that is needed to prevent unwanted iLUC until the bigger issue of global LUC is effectively tackled. Parting from this requirement would lead to a methodology that rewards good practice but that does not effectively prevent displacement and iLUC.</p>
<p>Lack of incentives. The case studies illustrate that the barrier to expansion of production with a low risk of indirect effects is not necessarily economic. The main barriers revolve around matter such as contractual relationships, land rights and customary practices. Whilst not insurmountable, these barriers are nevertheless sufficient that such opportunities appear unlikely to be realised in the absence of strong incentives.</p>	<p>Policy makers and/or voluntary standard initiatives will need to provide real incentives for bioenergy feedstock production with a low risk of indirect effects. The aim of both the RFA and the RCA initiative is to propose a methodology to these parties that can be used for this purpose.</p>
<p>Lack of protocols & guidance. The case studies have demonstrated that a large sustainable and economic potential exists for bioenergy feedstock production with a low risk of indirect effects. However, for the methodology to be implemented and applied consistently, protocols that provide additional detail and guidance would help a consistent implementation.</p>	<p>The next steps section of this chapter describes concrete steps to provide the required details and guidance for consistent and effective implementation of the methodology.</p>
<p>Meeting the requirement that existing provisioning services “must” be maintained. This is particularly relevant for projects that integrate with non-bioenergy systems (e.g. sugarcane-cattle). Maintaining current provisioning services requires that total production quantities do not decrease over time (e.g. milk or beef). However, market circumstances may cause producers of the non-bioenergy feedstock to stop producing the same products or to switch to products. In that case, would the bioenergy-feedstock producer then no longer be able to claim a low risk of indirect effects?</p>	<p>This specific issue needs to be explored in more detail. One option is that some flexibility is permitted without jeopardising the effectiveness of the methodology: e.g. that maintaining the existing provisioning services does not require the continued production of the exact same products. Other options can also be explored.</p>

9.2 Next steps

Several steps are still needed for methodological framework presented here to be implemented as a practical, effective and consistent methodology that enables market parties to claim their biofuels have a low risk of unwanted indirect effects. The next section first lists the elements ultimately needed to implement the methodology (several of these elements are already included in the methodological framework set out in the previous chapter). The following section provides additional information on the elements requiring additional work.

9.2.1 Elements required for an operational methodology

The following elements will be needed for an operational methodology that distinguished and credits biofuel feedstock produced with a low risk of indirect effects:

- 1** A criterion that must be met by producers in order to qualify as a biofuel with low risk of indirect effects
 - a. Proposed in this document
- 2** A final set of rules on how additionality can be demonstrated
 - a. Decision needed on what additionality tests are required
- 3** A final set of rules on how to set the baseline
 - a. Decision needed on whether baseline is based on historical production levels of the project site, or on a theoretical case using BAU practices.
- 4** A body with which the project can be registered
 - a. Additional work needed - see section below
- 5** A final set of rules for the claims that can be made, including the crediting period.
 - a. Decision needed on crediting period.
- 6** A set of eligibility criteria for projects to be considered: e.g. compliance with the RED sustainability criteria on direct impacts.
 - a. Additional work needed – see section below.
- 7** A final set of rules for the verification of claims made by producers including a description of the information to be submitted to the verifier by the party wishing to claim a low risk of indirect effects.
 - a. Additional work needed – see section below.
- 8** Guidelines for updating the methodology and dealing with questions and complaints.
 - a. Additional work needed – see section below.
- 9** Terms and definitions
 - a. Additional work needed – see section below.

In addition to the above, the methodology could greatly benefit from additional modules that provide additional guidance on critical aspects of the methodology. This

could include but is not limited to a module with guidance on how to set the baseline and a module on how to perform the additionality test or 'land without provisioning services'. The absence of such modules should not however form a reason not to implement the overall methodology yet. Many carbon schemes such as CDM were started without such detailed guidance documents, which have been added later based on actual project experience.

9.2.2 Information on elements requiring additional work

Central registration body

As indicated in the methodological framework, projects will need to be registered. This requires a central body with which such projects can be registered. For the RTFO, if adopted in the short term, it appears most practical to have the Renewable Fuels Agency perform this task. However, if the methodology is adopted by others, alternatives should be considered.

Eligibility criteria

Eligibility criteria describe the criteria that must be met by a project before it can be considered for registration. Eligibility criteria could include, but are not limited to:

- Provision of a project document with an explanation of how the project meets the criterion for a low risk of displacement and the following information:
- A positive additionality test
- A defined baseline
- Proof of a minimum level of sustainability (to address direct effects). For this purpose it is recommended to make use of existing concepts in the RTFO. The following options exist:
 - Projects must comply with the minimum sustainability criteria for direct impacts laid down in the EU RED.
 - Projects must meet the RTFO Environmental and/or Social Qualifying Standard level for the direct impacts.

Verification rules

This document already sets out the verification requirements at a high level, distinguishing between verification at the outset of the project and verification during the lifetime of the project. Additional details are needed on:

- What information needs to be submitted to the verifier by the party wishing to make a claim.
- Frequency of verification for monitoring purposes, i.e. after the initial verification at the outset of the project.
- Requirements for the verification party.

- Requirements for the verification process and the level of assurance that must be provided.

Guidelines for updating the methodology and dealing with questions and complaints

To provide clarity to stakeholders the RFA is recommended to communicate how it intends to update the methodology, especially in the first phase of the implementation when a lot of new experience will be gained. The same holds for how the RFA intends to deal with questions and complaints on the implementation of the displacement-mitigation methodology. An advisory group could fulfil the latter function.

Terms and definitions

A list of terms and definitions assist the consistent interpretation of the methodology and can help to reduce misunderstandings. An initial list is included in the textbox below.

Box 8 Initial list of Terms and Definitions

- **Crediting period:** the crediting period is the finite length of time during which the project’s claim of low indirect risks is valid.
- **System boundary:** the system boundary refers to the geographically explicit area that is directly influenced by the project. Provisioning services within the system boundary may normally not be displaced. The system boundary can stretch beyond the bioenergy feedstock production unit, e.g. it encompasses the cattle grazing area in the case of sugarcane – cattle integration.
- **Eligibility criteria:** set of criteria that must be met for a project to be considered for registration.
- **Verification:** Verification is the independent assessment of the Project Proponent claim by a qualified third party. The outcome is a verification statement that provides an opinion on the relevance, completeness, accuracy, reliability, and transparency of the quantification data and methods.
- **Tools:** A tool can be a component of a methodology (i.e., a stand-alone methodological module to perform a specific task) or a calculation tool (i.e., spreadsheets or software that perform calculation tasks).

Optional: modules to assist consistent implementation

The methodology would greatly benefit from a set of modules that aid parties through the various tasks that have to be fulfilled for the methodology. A list of the tasks that could benefit from such a module is included in the table below. The absence of such modules should not however form a reason not to implement the overall methodology

yet. Experience with the first projects can help define and refine these modules. This is also how CDM and its tools have developed over time. E.g. the first version of the “Combined tool to indentify the baseline scenario and demonstrate additionality” dates from November 2006 (several years after the first CDM project were implemented) and has been updated three times since its first adoption. The status and the hierarchy between various documents produced in support of the methodology should be clear to stakeholders.

Table 16 List of modules that could be developed to assist consistent implementation.

Module	Main purpose
How to assess the baseline	Detailed guidance on how to assess the provisioning services of the land that make up the baseline.
How to determine whether land classifies as having no provisioning services	Detailed guidance on the steps that must be taken to be able to claim the land has no provisioning services.
How to demonstrate additionality	Detailed guidance on how to demonstrate additionality.
Monitoring and reporting during the project lifetime	Detailed guidance on what information must be monitored and reported during the project life time.

Appendix A Introduction to indirect effects

This Appendix gives a brief overview of indirect effects and some of its key characteristics. It is an abstract of a recent publication for the Roundtable on Sustainable Biofuels (Ecofys 2009).

A 1 Indirect impacts of biofuel production

Sustainability is an important aspect of current biofuel production and use. At the start of the strong growth of biofuel production and use in the last decade, most attention was given to the direct impacts of biofuel production. These include for example: land use change³⁴ effects when starting a biofuel crop plantation; fertilizer, water and fuel use during feedstock production; fuel and chemical use during the processing of feedstock to fuel; and fuel use during the distribution of the fuel. The focus in studying these direct impacts is on their effect on the overall greenhouse gas (GHG) balance of the biofuel. In addition, the direct impacts of biofuel production on environmental aspects such as biodiversity, water, air and soil have been assessed, as well as the direct impacts on social aspects such as land use rights and labour conditions.

In more recent years, increasing attention is given to the indirect impacts³⁵ of biofuel production which are impacts of biofuel production that are the result of market mechanisms. The two main negative indirect impacts are indirect land use change (iLUC) and competition with food. These indirect impacts have become one of the key challenges to large scale sustainable biofuel production from energy crops.

iLUC occurs when the production of biomass feedstock displaces activities to other areas where they cause land use change and thus have potentially negative impacts on aspects such as carbon stocks and biodiversity. An example of this is when demand for palm oil for the biofuel market is supplied from existing plantations that used to supply to the food market as in Figure . As palm oil is now supplied to the energy sector, the food sector is confronted with a (temporary) shortage in supply. In the short run this will lead to higher prices as supply is slow to adapt to the new market circumstances. In time, the higher prices may lead to a production increase, which could require additional plantations, leading to land use change. The location of this indirect land use change is uncertain, and more importantly, is out of the control of the biofuel producer and consumer.

³⁴ Land use change means that the use of a certain area of land changes between different types. For example, a forest is cleared and taken into use as agricultural cropland, or currently unused grassland is turned into pasture for cattle grazing. Land use change can have an impact on the carbon stock (the amount of carbon stored in the vegetation and soil) and biodiversity of the land, which can be unwanted.

³⁵ Indirect impacts are sometimes also referred to as ‘indirect effects’, ‘displacement effects’, ‘indirect land use change’ or ‘macro effects’.

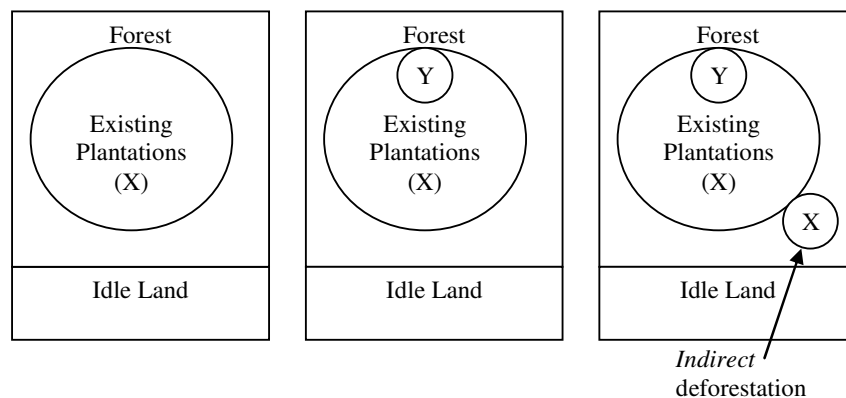


Figure A-1 Example of displacement mechanism causing indirect deforestation. Y is new demand from the bioenergy sector from existing plantations. X is expansion of existing plantations as a result of displacement effects. (Dehue, 2006)

The second main indirect impact of biofuel production, competition with food, starts with the same market mechanism as iLUC as described above: increasing demand for agricultural commodities for biofuel production leading to price increases. However, this time the increased demand in the biofuel sector is not met by increased production over time. Instead, there is reduced demand for the commodity in the food sector because not all consumers are able or willing to pay the increased prices.

In practice, it depends on a complex set of diffuse economic interactions which of the two indirect impacts described above occurs and to what extent. In most cases, it is likely that the increased demand for agricultural commodities for the biofuel sector results in both production increase and reduced consumption in the food sector.

The two main indirect impacts, iLUC and competition with food, are not by nature negative, but can very well cause unwanted effects. For example, the clearing of the forest as shown in Figure will release the carbon stocks stored in the forest vegetation and soil and will reduce biodiversity in the area. Competition with food can lead to decreased food consumption for groups of people who cannot afford the increased food prices. This effect is especially severe when it impacts the poorest groups of people that are already at risk of undernutrition.

A 2 Difficulties in assessing and mitigating indirect impacts

Indirect impacts of biofuel production are far more difficult to assess and mitigate than direct impacts. This is because they occur through market mechanisms that are generally beyond the control of the biofuel producer and consumer, whereas direct impacts are usually more obvious and easier to influence.

A few important notes on indirect impacts to further illustrate their difficult quantification and mitigation are:

- **Displacement effects act across national borders:** e.g. a shift in the oil palm produced in Malaysia from food to fuel could lead to an expansion of oil palm for food in Indonesia, with the accompanying risks of LUC.

- **Displacement effects act between substituting crops:** e.g. a shift in the rapeseed oil produced in the EU from food to fuel could lead to increased imports of a substituting vegetable oil, e.g. palm oil, for food. This puts additional pressure on oil palm expansion.
- **Competition for land connects also non-substituting crops:** e.g. high demand for maize may increase maize prices, leading to farmers planting more maize. This will mean less planting of another crop, e.g. soy. This could lead to an expansion of soy in other areas as a response to higher soy prices induced by the reduction in supply or additional pressures on soy-substituting crops.

The developments on mitigation of indirect impacts have suffered from the difficulty of assessing and influencing indirect impacts. Parties in favour of pursuing mitigation of indirect impacts claim that these impacts are so large they cannot be ignored in biofuel strategies and policies, while parties opposed to mitigation claim there is a lack of scientific consensus on indirect impacts that prevents development of accurate mitigation strategies and policies.