Final Report

A review of the literature on biofuels and food security at a local level

Assessing the state of the evidence

Anna Locke and Giles Henley

Key messages

- People worry that using crop-based biofuels to increase the volume of low-carbon fuels could worsen hunger in poor countries by pushing up global food prices and endangering local food security in developing countries.
- ODI research finds that the published literature does not allow us to state categorically that biofuel projects in developing countries worsen local food security. There is little to suggest the opportunities and risks biofuel feedstock investments present differ from those investments in other commercial crops provide.
- However, activities associated with all agricultural projects bring risks that need to be acknowledged and managed. More important than the crop itself are the way land is made available for projects, the models of production used and the project design. The use of existing safeguards and best practice in project design and land acquisition is crucial to avoid negative outcomes.

Acknowledgements

We are grateful to Steve Wiggins, Senior Research Fellow at ODI, for his detailed comments on the conceptual framework, and to Ian Scoones and Lorenzo Cotula for their helpful reviews and suggestions.

Table of contents

Acknowledgements **ii**

Abbreviations **iii**

Executive summary **iv**

1 Introduction **1**
1.1 Background 1
1.2 Aim and focus of the study 2
1.3 Approach and methodology 2
1.4 Structure of the report 3

2 Conceptual framework for assessing biofuel and food security linkages **4**
2.1 The nature of biofuels projects 4
2.2 Concepts of food security 4
2.3 Measuring impacts and outcomes 6
2.4 Possible impacts of biofuel projects on food security 8

3 Evidence on the impact of biofuel projects on local food security 12
3.1 Nature of the evidence 12
3.2 Key findings 18

4 Parallels with the debate on cash crops and food security **27**
4.1 Nature of the evidence 27
4.2 Sugarcane in Sub-Saharan Africa 28
4.3 Projects in the oil palm sector in Southeast Asia 32

5 Conclusions and recommendations **35**
5.1 Conclusions 35
5.2 Recommendations 38

References **40**

Appendix **46**

Figures

Figure A1: Causal pathways connecting biofuel operations and household community level 46

Tables

Table 1: Biofuels and household food security – potential pathways vi

Table 2: Biofuels and household food security – potential pathways 9

Table 3: Studies of biofuel projects that contract outgrowers 14

Table 4: Studies of biofuel plantation projects 22

Boxes

Box 1: Changing concerns about food security and nutrition 6

Box 2: The sugarcane sector in Brazil 31

Abbreviations

BEFS	Bioenergy and Food Security (FAO)
CAO	Office of the Compliance Advisor/Ombudsman
CFS	Committee on World Food Security (UN)
CGE	Computable General Equilibrium
DEFRA	Department for Environment, Food and Rural Affairs (UK)
DFID	Department for International Development (UK)
EC	European Commission
EIA	Environmental Impact Assessment
EU	European Union
FAO	Food and Agriculture Organization (UN)
FANTA	Food and Nutrition Technical Assistance (USAID)
FCS	Food Consumption Score
FDP	Farmer Development Programme
FELDA	Federal Land Development Authority (Malaysia)
GBEP	Global Bioenergy Partnership
HLPE	High Level Panel of Experts on Food Security and Nutrition (FAO)
HFIAS	Household Food Insecurity Access Scale
KESREF	Kenya Sugar Research Foundation
LIC	Low-income Country
LSLA	Large-scale Land Acquisition
MAHFP	Months of Adequate Household Food Provisioning
NGO	Non-governmental Organisation
NTFP	Non-timber Forest Product
ODI	Overseas Development Institute
RED	Renewable Energy Directive (EU)
RSB	Roundtable on Sustainable Biomaterials
SLA	Sustainable Livelihood Approach
UK	United Kingdom
UNEP	UN Environment Programme
UN	United Nations
UN SCN	UN Standing Committee on Nutrition
US	United States
USAID	US Agency for International Development
VGGTs	Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security
WFP	World Food Programme (UN)

Executive summary

Aim and focus of report

This study examines recent documented experiences of biofuel projects to determine whether biofuel production in low-income countries (LICs) reduces food production and food security in the areas in which they are established. It is the second part of a two-stage analysis; the first stage of the analysis investigated the status of declared biofuel projects in five developing countries, analysing how much land had officially been acquired in those countries for biofuels and how much of that land was being cultivated for biofuel feedstocks according to original project plans (Locke and Henley, 2013).

Much of the analysis published to date and discussed in public fora focuses on the impact of biofuel policies in developed countries on global food prices or is based on studies that model the impacts of biofuels production on food security but do not triangulate these modelling outputs with findings on the ground. This study seeks to address that gap by reviewing studies based on case study or primary data that discuss impacts on local food security. It looks at two main models of biofuel feedstock production: small-scale outgrowers linked to nucleus estates producing the same feedstock or supplying commercial processing plants that do not produce their own feedstock; and large-scale commercial plantations, which use extensive areas of land, usually under a single crop, centrally manage decisions on land use and may or may not process their own output.

The study aims to inform policymaking and guide further research on biofuels.

Context

This study comes at a time when scrutiny of the possible impact of biofuel feedstock production on food security is centre stage, as the European Union (EU) reviews its policy on biofuels (the 2009 Renewable Energy Directive and the 1998 Fuel Quality Directive). In September 2013, the European Parliament voted by a small majority to cap the use of crop-based biofuels that can be used to meet renewable energy targets to 6% of fuel used in transport by 2020, reducing the original target of 10%, owing to fears that biofuels can push up grain prices or damage the climate.[1]

This comes on the back of the rapid expansion of the biofuel industry in the past five years and concerns over potential negative social and environmental impacts at local and global level (White and Dasgupta, 2010). Within this, the concern that there will be negative impacts on food production and food security has gone up the agenda, with worries that land, labour, water or other factors of production will be switched to biofuel production or that existing volumes of food crops will be switched from food to biofuel markets. However, others argue that increased demand for sustainable biofuels will encourage investment in agricultural production and that there could be synergies between biofuel and food production by bringing investment into relatively undeveloped areas with poor access to input and output markets.

[1] The new cap is 1 percentage point higher than the cap of 5% proposed by the European Commission (EC). Member states now need to seek a common position on their own. See http://www.europarl.europa.eu/news/en/news-room/content/20130906IPR18831/html/European-Parliament-backs-switchover-to-advanced-biofuels and http://www.euractiv.com/sustainability/food-price-fears-push-eu-lawmake-news-530400.

Approach and methodology

Defining food security

This report begins by clarifying the conceptual framework for assessing the impacts of local biofuel production on the food security of surrounding households. Its uses the definition of food security agreed by the 1996 World Food Summit, which establishes a framework for combining the multiple dimensions that the term covers, and builds on that definition, incorporating advances in the concept of food security that have been made since then.

The 1996 World Food Summit defined food security as a situation **'when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life'** (FAO 1996). The 2009 World Summit on Food Security extended this definition, describing the four pillars of food security as *availability*, *access*, *utilisation* and *stability*, and highlighted the centrality of nutrition in the concept of food security. Further discussions have emphasised the role of the health environment in food security, and this is also reflected in our analytical framework for food security.

Biofuels and food security – potential pathways of impact

Table 1 presents the different pathways through which the two main models of biofuel operations may affect the four dimensions of food security at local level.[2] We have left out potential effects on international prices, assuming that the LICs that are the main targets for biofuel operations are price takers on the world market.

As a biofuels operation is likely to generate a mixture of positive and negative impacts on different aspects of food security, the overall impact will depend on the **balance** of these impacts and how they are **distributed** among different parts of the population.

[2] Annex 1 presents the ways that biofuels production can influence access and availability in diagrammatic form.

Table 1: Biofuels and household food security – potential pathways

	Biofuel plantation	Biofuel outgrower scheme
Availability	A1. Land to food crops is reduced, which leads to less food grown locally; may lead to higher food prices if transport costs of imported food are high. A3. Plantation leads to better local access roads, more agro-dealers that make farm inputs cheaper and more available —> marketing of crops of all kinds becomes cheaper. A4. Plantation uses improved farm methods that can be imitated and applied to other local farms.	A1. Ditto. A2. Diversion of labour and capital from food crops —> less food produced locally, may lead to higher food prices if transport costs of imported food are high. A3, A4. Ditto, probably all the more so. A5. Expansion of land cultivated as plantation provides means for establishing more cultivated land (equipment and skills).
Access	B1. Loss of land to local farmers leads to loss in farm income – were they compensated? B2. Jobs on plantation, processing plant —> changes to local labour market. May raise wages, time worked and incomes (but may not if land loss increases pool of those seeking jobs).	B3. Gains to small farmer incomes – depends on relative returns to feedstock compared with previous crops. B2. Ditto.
Utilisation	C1. Time spent on farms or in refineries by women decreases time for child care, food preparation and feeding. C2. Loss of jobs for women, as most jobs on plantation and factory for men, reduces female income, status.	C1. Ditto. C3. Men signed as outgrowers; women lose land in household, income, status.
Stability	D1. Mono-cropping and specialisation of local economy increases exposure to effects of weather, pest and disease, and changes to biofuel markets —> less stable incomes. D2. Imported food may be subject to more or less variability and certainty of supply and price.	D1 & D2. Ditto.

Key findings

The nature of the evidence does not allow us to assess comprehensively the balance of impacts of biofuel (feedstock) production on local food security nor the distribution of those impacts …

While some broad findings can be pulled out of the review, the nature of the literature makes it difficult to compare results across different studies and evaluate the balance and distribution of such impacts, as different studies have a wide range of focus (geographical, crop and target population) and methodologies:

- Studies define food security in different ways, with very few adopting a holistic definition of food security that encompasses all four elements of availability, access, utilisation and stability; indicators used to measure food security reflect this.
- Quality of evidence across the studies is variable: few studies are based on primary evidence and the majority use qualitative approaches, relying on purposive sampling of participants and focus group discussions that explore some of the relationships in depth but are not necessarily representative of the population affected by projects.

- The focus of studies differs in terms of the countries, production models and crops studied:
  - The majority of recent studies on biofuels focus on jatropha production in Africa under contract farming models; the literature on plantations includes studies on other crops including oil palm and sugarcane as well as jatropha, all in African countries.[3]
  - The longer-standing literature on sugarcane and oil palm focuses mainly on outgrower schemes for sugarcane in Southern Africa and oil palm in Indonesia and Malaysia under both plantation and outgrower models.
- The studies reviewed also evaluate benefits and losses at different points of a project's lifetime, some looking only at the establishment phase, others analysing impacts of projects far beyond the establishment phase without factoring in initial results. Virtually no studies use longitudinal data to evaluate the before and after effects of a project being implemented over a substantial period of time.
- This is compounded by the fact that a relatively small number of biofuel projects have started and remain in production in developing countries.
- Counterfactuals are often not used as a starting point, and points of reference for comparisons vary significantly – in some cases, project participants are compared with non-participants in the same area, or with those who live outside the project area, or with national averages for different indicators.

… but there are some important common findings

Biofuels feedstocks may not be substantially different from other commercial crops …

Our main finding is that there does not appear to be anything substantially different between producing biofuel feedstock and any other commercial crop. It is not necessarily the fact that it is a biofuel feedstock that matters but the production model used; the timing of impact measurement; the profitability of production; and the terms and conditions under which entitlements to land, wages and prices are defined and productivity is raised.

… although biofuels have some particular characteristics

However, this observation must be tempered by two points:

- First, the scale and pace of interest in producing biofuels feedstocks have been greater than for many other crops, and projects have often encompassed large areas of greenfield sites (although actual implementation has been far below the level anticipated). The rate of expansion may depend on how well the biofuel industry is organised and how effectively it lobbies to secure subsidies and preferential access to land.
- Second, in the history of farming, large-scale agricultural investments have rarely gone for an untested and unproven crop such as jatropha. Most large-scale investments have focused on sugarcane (for sugar), oil palm, rubber etc. for which there was prior evidence of money to be made and better understanding of the agronomy involved, and hence resulted in fewer failures.

This was underpinned by the initial assumption that renewable energy policies in developed countries would create substantial markets for liquid biofuels, which created expectations of potentially high levels of profitability.

[3] While Brazil is a key reference point for sugarcane-based ethanol, there are limited parallels with many countries in Africa that have higher population densities in their cane production areas and more potential for land conflict. Lessons are drawn mainly from assessing benefits and risks from employment on sugarcane plantation.

Models of production matter …

The literature demonstrates that both plantations and outgrower schemes are being used to cultivate biofuels, despite earlier warnings that plantations would dominate.[4]

- The effects on food security of feedstock production or longer-standing sugarcane and oil palm production under outgrower schemes have been broadly positive. However, for some outgrower schemes, the effects of biofuels projects – whether positive or negative – are sometimes negligible, as biofuel feedstock cultivation is dwarfed by other activities in smallholders' livelihood portfolios, particularly in the case of jatropha.

- At the establishment phase, large-scale plantations present a high risk to the food security of local communities as access to land for those communities for foraging and food production is often reduced.

- Over time, benefits provided by plantations may improve the livelihoods of employees. However, as not all households are able to secure employment, benefits are not equally distributed, and some households affected by the project invariably lose out.

… and so do contractual terms in those models

In studies that highlight the terms of contracts between outgrowers and companies, the division of revenue between outgrowers and companies determines how much income farmers have earned from growing biofuel feedstocks (or sugarcane and oil palm for other ends). Because companies relying on outgrowers are regularly in a monopsonistic position (i.e. they are the only buyers that outgrowers can sell to and thus have strong market power), how much they charge for services and pay for goods is likely to determine how much outgrowers benefit from the relationship. Outgrowers with small landholdings may benefit less than large landholders if they have to pay the same price for goods and services despite having lower output.

Contractual terms may also determine the other crops outgrowers can produce and whether they can intercrop food crops with biofuel feedstocks. In the case of a longer-standing experience with oil palm in Indonesia, the company's original restrictions on intercropping food crops with young oil palm stands negatively affected farmers' food availability (production) and access as the immature palm stands did not produce sufficient income to buy in food.

Much depends on having a profitable business

When we look at sugarcane and oil palm – the only cases where we can see what has happened with sufficient time to see outcomes – the results are often positive for outgrowers and estate workers because returns to cane for sugar production and oil palm are high, compared with a crop such as jatropha, which has proved unprofitable. Whether these higher incomes are transformed into higher levels of food consumption and better nutrition is less clear.

An uncertain market environment for biofuels could undermine profitability and have a knock-on effect on local food security. Investment in sugar production in Africa has been done on the back of access to protected, high-priced markets, such as the EU (for Sugar Protocol signatories and least developed countries) or large (protected) domestic markets, such as Nigeria. Oil palm faces expanding demand in the vegetable oil market with the flexibility to switch between the edible oil and biodiesel markets. However, creating a stable and profitable market for biofuels may contribute to other negative impacts on food security.

The flexibility enjoyed by sugarcane, palm oil and soy producers (so-called 'flex crops') to supply biofuel, food and other markets diminishes the risk associated with a price slump in any one market. Whether earnings and outcomes from flex crops are better than for other crops depends on different factors and needs further analysis.

[4] It is possible that this is because outgrower models have been around longer (e.g. as early development projects promoting biofuels), or that plantations have not been subject to research efforts.

The way land is made available for projects is crucial

The experience of outgrowers in the studies reviewed here implied that there was not much of a shift of existing land to biofuels. Rather, several studies found farmers opened up new land for biofuels and companies sometimes played a part in this by making equipment available to prepare land that would otherwise not be possible to cultivate.

This depended on additional land being available for cultivation. Where it was, outgrowers were able to cultivate new land and supply the nucleus estate (as happened in Indonesia after the establishment of an oil palm estate). However, the distribution of impacts can be very uneven: other villages in the project area with less surplus land suffered because they could not meet both the company's needs for feedstock and their own needs for food. Where incorporation into smallholder schemes includes transferring and reallocating land, poorer and disadvantaged groups can lose out if they give up more land than they are reallocated.

Longer-term efforts to safeguard food production were reviewed in some studies that looked at the experience with sugarcane, either through the company providing areas of land dedicated to food production or through households retaining a certain proportion of their own land for food production. These had mixed results.

However, when people lose their land for foraging and food production to plantations with no or insufficient compensation or poorly implemented land transfers, they suffered. Compensation, even when it could and should be paid, was not always paid to at least some of the losers.

Women are more vulnerable to the negative impacts on food security

Women can often be among the greatest losers when plantations are established, and there was evidence in some studies that the conversion of forest and swidden systems to oil palm or jatropha affected women's livelihoods particularly badly. While not analysed by the studies reviewed, longstanding literature shows women can also lose out under outgrower systems, particularly if only men are registered as the landholders or receive contracts.

Again, although the information was not a major part of the studies on food security reviewed here, where this was highlighted, the findings on wage income and employment conditions confirmed the wider literature that women received lower wages than men and were usually hired only on short-term contracts.

Yields can improve

While there was very little information on the impact of biofuel feedstock production on yields, one study showed yields had increased owing to better fertiliser access through the contract farming scheme. Longer-standing sugarcane outgrower schemes showed outgrowers could get more access to fertiliser through companies and applied more to food crops, boosting yields.

Recommendations

Strengthening the evidence base

Several recommendations emerge from this review in terms of improving the evidence base available to assess the impacts on food security of biofuel feedstock production:

- Analysis of impacts on food security would benefit from a more comprehensive and consistent analytical framework that would allow analysts to assess the balance and distribution of different impacts.
- Such analysis would also need a more consistent use of counterfactuals and selection of control groups or comparison points, for example villages in the project area and outside the project area.
- While case studies are useful to obtain more in-depth analysis of impacts, more data from baseline surveys and longitudinal studies would provide better information on before-and-after impacts of biofuel projects, as well as allowing for the analysis of different impacts that emerge over time and across target populations.

Improving project design

Drawing on the findings in the studies reviewed, some recommendations can be made on project design:

- In outgrower schemes, there is little to be lost and plenty to be gained from allowing growers to have as much control over their land as possible as far as this does not conflict with the overall business. Allowing outgrowers to intercrop the cash crop with food crops or allowing them to use inputs supplied for the cash crops on other crops – or simply deliberately supplying these inputs for other crops on credit – makes sense.

- There are clear things to bear in mind in designing outgrower schemes, such as making sure women do not lose land they might have used for a food crop or home garden. The wider literature on gender suggests it is important to compensate women for loss of gathering opportunities, making sure main crop incomes are not paid just to the men and are paid in regular payments rather than in a single annual payment.

- Given that tree crops take time to mature, some thought and attention need to be paid to what happens in the first few years before the crop is mature.

- Given the high risks of plantation establishment, policymakers need to ensure a high degree of vigilance when plantations are being considered. Where there are specific goals associated with plantation development, such as the generation of jobs or local benefits, the sequencing and provision of these needs specific attention to ensure there are no time lags between the time when a project convert fields and forests to feedstock production, and when people who are adversely affected by this receive compensation.

- In outgrower schemes, there may be a case for considering public regulation, at the very least to provide information to outgrowers about best practices on contracts in other countries to reinforce their negotiating power.

Increasing awareness and use of safeguards

Increasing awareness of potential impacts, and having information to assess those, is crucial. This needs to be reinforced with knowledge of safeguards and guiding principles to mitigate against potential negative impacts and boost positive impacts on food security.

Better information for stakeholders in host countries

The findings of the study indicated that, from the point of view of food security, national governments and other stakeholders in countries receiving investment for biofuel production need better information, and greater ability to process that information, before committing large areas of land to biofuel feedstocks and/or involving outgrowers who are less able to bear market risks. This includes information on:

- Markets for biofuels – the projected level and stability of prices and demand over the short, medium and longer term;

- The different crops for biofuel feedstocks – their track record on agricultural and industrial productivity in different contexts, and social and environmental impacts.

Local communities in areas of biofuel projects need greater information on their land tenure/use rights, and the implications of projects for access to land and the productivity of that land and longer-term impacts on income and access to markets.

Safeguards and guiding principles

Several points of reference exist that could be used to safeguard food security, or at least key elements that affect food security:

- Related to broader issues of how land is made available for biofuels projects, the most prominent set of guidelines for land governance are the Food and Agricultural Organization (FAO) *Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security* (VGGTs), endorsed by the UN Committee on World Food Security (CFS) in May 2012 (FAO, 2012). They aim to promote sustainable social and economic

development that can help eradicate poverty and food insecurity with a particular focus on smallholders (Clause 12.3). The VGGTs lay out the principles according to which governments should operate, advising on the laws, procedures and tools available to ensure land tenure reflects concerns over security and equitable distribution.

- Specific to biofuels, a number of organisations and institutions have developed guidance for different stakeholders involved in the biofuels sector, which provide practical guidance on the steps that need to be taken to safeguard the food security of local populations when developing biofuel projects. Guidance provided by the Roundtable on Sustainable Biomaterials and the FAO's BEFS project are useful in this respect. These should be used as a checklist for assessing the potential risks associated with individual projects.

1 Introduction

1.1 Background

Global demand for biofuels has grown substantially since 2007/08, following the rise in oil prices and the creation of mandates in the US. Demand is expected to continue to grow in the near future because of continued mandates in key consuming markets for renewable energy and blending biofuels with transport fuels, as well as rising oil prices. Although the US has so far relied on domestically produced maize to meet its renewable fuel needs, Europe, the second-largest consumer, is expected to rely more heavily on imported feedstock. At present, the main countries supplying European markets are Indonesia, Malaysia and Brazil. However, interest in increasing supplies from other areas, especially from African countries, is high because these countries benefit from a favourable trade status with the European Union (EU) (HLPE, 2013)[5] and are perceived to have relatively abundant supplies of land and water (Smeets et al., 2007).

The rapid expansion of the biofuel industry in the past few years has sparked concerns over potential negative social and environmental impacts at local and global level (White and Dasgupta, 2010). A concern that dominates the debate is that food production and food security will be negatively affected, either through switching land, labour, water or other factors of production to biofuel production or through the diversion of existing volumes of food crop from food to biofuel markets. However, others argue that increased demand for sustainable biofuels will encourage investment in agricultural production[6] and that there could be synergies between biofuel and food production by bringing investment into relatively undeveloped areas with poor access to input and output markets. While debates on the possible impacts of higher demand for ethanol from maize and sugarcane on changing land use and food production have been ongoing since the 1970s, technologies and policies to bring biodiesel into the energy mix have made this discussion one of global significance (Rathmann et al., 2010).

The level of concern over the impact of biofuel policies and production on people in developing countries is reflected in the attention given to the topic by researchers, advocacy non-governmental organisations (NGOs)[7] and the media. This concern has also been incorporated into regulations governing the use of biofuels; the EU requires social impact analysis for biofuels counted as contributing towards renewable fuel targets under the Renewable Energy Directive (RED) (e.g. EC, 2009).

However, several difficulties exist in assessing the extent to which these concerns of negative food security impacts are borne out on the ground, because of the nature of the evidence available:

Empirical analysis of the link between biofuels and food production has so far focused mainly on **developed countries**, such as the US and those in the EU, and impacts of the use of maize and wheat for ethanol production and the use of vegetable oil for biodiesel on **global food prices** (Babcock, 2011; DEFRA, 2012; de Gorter and Just, 2010; Helming et al., 2010).[8] Assessments of the global impacts of biofuel policies on social criteria point to small effects (e.g. Ecofys, 2013) but have met criticism because of their methodological approach (ActionAid, 2013b; Kropiwnicka, 2013).

[5] Although the introduction of stricter environmental and social criteria in European markets potentially restricts some of these countries from exporting to European markets, there is a keen interest in these countries for the European market to remain open.

[6] http://online.wsj.com/article/SB10001424052748704071704576277122793802138.html

[7] For instance, the IF campaign, which brought together leading international NGOs, included biofuel production as a major obstacle to ending hunger (IF Campaign, 2013).

[8] Because there has been a demand for analysis to consider the social impact of biofuel **policy** and not only **projects,** much of the analysis has focused on impacts on food prices.

- Where studies have been carried out in developing countries, they have mainly used modelling approaches to predict potential impacts on local food prices or broader livelihoods outcomes,[9] and have not triangulated findings with impacts observed on the ground. Relatively few studies look at experiences of local biofuel production on food security among communities near the production site (Hodbod and Tomei, 2013; Negash and Swinnen, 2012; Vanwey, 2008). This is partly because biofuel projects have started only recently in many countries; the new wave of interest in locating agricultural production in African countries has led to land acquisitions for the production of biofuels but there are few examples of projects underway that can be analysed (Locke and Henley, 2013).

- Analysis of biofuel–food security linkages is hampered because understanding and use of the term 'food security' differs between researchers (Havnevik et al., 2011). Not all researchers state clearly which outcome variables they are investigating when they discuss impacts on food security or justify this selection. Of those that do, some use narrow definitions that prioritise one particular outcome, such as self-sufficiency, whereas others include broader livelihood outcomes. The Roundtable on Sustainable Biomaterials[10] provides guidance on its definition of food security, but it is not clear that researchers and commentators have widely accepted this usage. For instance, Schut and Florin (forthcoming) argue that attempts to apply a common framework for food security across multiple contexts to make projects certifiable are too simplistic.

1.2 Aim and focus of the study

This study examines recent experiences to determine whether biofuel production in low-income countries (LICs) reduces food production and food security locally, in order to improve policymaking and guide further research on biofuels.[11]

The focus on food security in this study does not imply that environmental and other social impacts are not significant. These aspects have been investigated in detail in some of the studies reviewed here and elsewhere, and highlight that loss of biodiversity through the conversion of tropical forests and other biodiversity-rich biomes to biofuel plantations may be significant in many cases. Similarly, although this review briefly touches on the implications of expanding biofuel production for gender relations, where authors have investigated these, these will be important in most cases, particularly through the impact on land tenure and shifting intra-household dynamics as the composition of production changes.

1.3 Approach and methodology

This report is based on analysis of existing academic and grey literature on biofuels and food security. It also draws on published literature on longer-standing projects in sugarcane and oil palm – important feedstocks for biofuels – to examine what experiences and lessons can be drawn from these sectors. Reference is also made to the emerging literature on large-scale land acquisition (LSLA) that analyses impacts on food security (Oya, 2013; Tanner, 2013).

To identify relevant literature, we relied primarily on literature searches using Google Scholar and the Primo Central academic database search, backward searches through bibliographies of academic studies and reviews and hand searching websites of academic projects and conferences on biofuels. Finding relevant studies is challenging: many studies discuss targeted search terms like 'food production' as part of their context – resulting

[5] Studies that have looked at this include Arndt et al. (2009), Banse et al. (2008) and Wiggins et al. (2008). The BEFS study (BEFS, 2010) modelled potential impacts in Tanzania, Thailand, Peru and Cambodia using Computable General Equilibrium (CGE) models.

[10] Previously the Roundtable on Sustainable Biofuels.

[11] This report is the second part of a two-stage analysis looking at the impact of biofuels on food production and availability. The first stage of the analysis investigated the state of play of biofuel projects in five developing countries, analysing the relationship between biofuel production and land acquisitions in LICs. Although the original focus of this second stage of analysis was on how much biofuels had displaced food production, the authors felt this would provide only a partial view of the impact of biofuel projects and broadened the focus to food security in general.

in a high number of search hits – but do not analyse impacts on food production.[12] At least half of the studies identified were found through backward searches using bibliographies in review studies, and not through database searches, because the articles were not published in the journals or archived collections that search engines accessed.

We applied broad inclusion criteria to our search, including studies that discuss impacts on food security, even if they do not provide a precise definition of what they mean by the term. We excluded studies that do not investigate impacts experienced by households, but otherwise did not apply exclusion criteria based on study methodology. The analysis therefore includes a range of intermediate outcome measures associated with food security. We did not attempt to sort studies systematically on the basis of quality criteria but note where study designs and findings are potentially weak.

Exploring the impacts of biofuel projects on food security through a literature analysis has limitations because not all projects have been studied or are written up in in equal detail. The literature pool is small and analysis from recent years – when a rapid expansion in the number of biofuel projects has occurred – may still be at the publication process. Among projects that are analysed, there is a risk of bias towards longer-standing projects that have a higher chance of being studied (which may reflect better-than-average conditions for local participants) or alternatively those that have had a disastrous effect on local communities (which have come to the attention of the media and researchers). As has been observed within the contract farming literature (Barrett et al., 2012), the impacts of projects that fail before they are studied are unknown and are not recorded in the literature.

For all projects, analysis of impacts is necessarily specific to the time period covered and is likely to emphasise recent experiences over long-term ones. For projects that have operated over a short timeframe (normally below seven years), negative impacts may dominate if affected communities have still to receive forthcoming compensation that counteracts losses. By contrast, in the case of longer-running projects, early impacts may not be recorded if the situation has since reversed or if affected communities have moved out of the study area.

A counterfactual is required to understand what changes the activities related to a project have caused. Typically, a counterfactual can be established by looking at the conditions in a similar location not affected by the operation, and by comparing the situation before and after the start of an operation. This shows what may have happened in the absence of the project. Not all studies have done this effectively.

1.4 Structure of the report

This review begins by establishing the conceptual framework for analysing the impact of biofuels on local food security, outlining the different pathways through which biofuels projects can affect food security. The next chapter uses the framework to determine whether biofuel projects have undermined or contributed to local communities' food security. The third chapter focuses on recent experiences with biofuel feedstock production.

Section 4 focuses on longer-standing experiences with sugarcane and oil palm, two crops that are used for biofuels but that have a longer history of use as cash crops for the sugar and edible oil markets.

The conclusions summarise the evidence and identify gaps in current research.

[12] A Google Scholar search using search terms that included 'food production' and 'case study' returned 16,100 results. A similar search in Science Direct (only studies published as academic articles) returned 538 results. Almost none of these papers analyses impacts at the local level using field data.

2 Conceptual framework for assessing biofuel and food security linkages

This section discusses the nature of biofuel production, and the concept of food security used in the literature and its different dimensions. It draws out the theoretical or potential impacts of biofuel projects on food security at local level and the different factors that might influence these impacts.

2.1 The nature of biofuels projects

Biofuel projects have been set up using different models, ranging from NGO-supported smallholder projects to large plantation models,[13] but they can be categorised into four types (Gasparatos et al., 2012):

- **Type 1**: Local, small-scale biofuel projects for local use (e.g. rural electrification) where the feedstock is usually produced by local farmers and sold to a local generating plant;
- **Type 2:** Large industrial farms producing for their own use (e.g. commercial farms or mines);
- **Type 3:** Small-scale outgrowers linked to nucleus estates producing the same feedstock or supplying commercial processing plants that do not produce their own feedstock;
- **Type 4:** Large-scale commercial plantations, which may or may not process their own output. Large-scale plantations use extensive areas of land and decisions on land use are centrally managed (Smalley, 2013). Plantation establishment typically involves clearing a contiguous area of land of existing vegetation to plant a single crop.

Of these, Types 3 and 4 are most common (Gasparatos et al., 2012) and are the focus of this review.

2.2 Concepts of food security

While the term 'food security' appears straightforward, there are multiple understandings by different communities of practices working in public health, nutrition, food assistance and human rights. Some of these draw on a rights-based approach, prioritising the Right to Food as outlined in the International Covenant on Economic, Social and Cultural Rights; others lean towards approaches that prioritise nutritional outcomes.

As a starting point, this report uses the definition of food security agreed by the World Food Summit, which establishes a framework for combining the multiple dimensions the term covers; it also incorporates advances in the concept of food security that have been made since then.

The 1996 World Food Summit defined food security as a situation **'when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life'** (FAO, 1996). The 2009 World Summit on Food Security

[13] A comprehensive discussion on characteristics of different operation models can be found in Smalley (2013).

extended this definition, describing the four pillars of food security as **availability, access, utilisation** and **stability,** and highlighted the centrality of nutrition in the concept of food security:

- **Availability:** *The supply side of food security*, determined by the level of production, stock levels and imports of food in the local area. Availability of foraged foods may also be important in certain contexts. Weather, yields, soil conditions, planting decisions, transport and storage infrastructure and a change in the trade regime can all affect availability;

- **Access:** *Economic and physical access to available food,* mainly from the household perspective. This can be from purchases, gifts or transfers of food. Households' economic *access* to food is determined by overall household income, disposable income for food and food prices. Ease of *physical access* to markets to acquire food is influenced by the proximity of markets and other food sources (fields, forests etc.) and the existence and quality of infrastructure;

- **Utilisation:** *The way individuals are able to consume food,* which has a direct impact on nutritional status and is closely linked to feeding practices, preparation and distribution of food between household members;[14]

- **Stability:** *The maintenance of food security through time* – while an individual or household may temporarily be food-secure, outside shocks such as food price volatility, unemployment or harvest failures may undermine food security. Shifting demographics within a household, such as the birth or death of a child or other household member, may also affect the stability of food security over time.

Changes in understanding of food security across disciplines over time have built on this definition. Some of the advances in knowledge from these disciplines are relevant to the broader understanding of food security and have been used by authors of biofuel studies. From a nutritional perspective, recent years have seen a better understanding between the linkages to health that determine food security (CFS, 2012). There has been increasing acknowledgement of the importance of the quality of nutrition rather than purely the quantity of food available and accessible, and the role the health environment (public health, domestic hygiene, child care etc.) plays in determining a healthy nutritional status (CFS, 2012; Wiggins and Keats, 2013).

The World Food Programme (WFP) and other humanitarian practitioners have used the above pillars to construct measurements for assessing the severity of food insecurity in emergencies, to prevent famine situations. These typically differentiate between levels of quantity and quality of food, and particularly whether periods of food insecurity are short term ('transitory') or long term ('chronic').

Recognition of the diversity in rural households' livelihoods in sustainable livelihood approaches (SLAs)[15] highlights the different ways households access food in different contexts. While a reduction in a household's own food production may be devastating for one household's food security, its impact may be negligible for another that has chosen, or has the means, to engage in an alternative livelihood option.

[14] Although nutrition is recognised as an important dimension of food security, some of the links between feeding practices, food consumption and nutritional status remain unknown or debated in the nutritionist community (Wiggins, personal communication),

[15] Improved food security is one of five livelihood outcomes in the UK Department for International Development (DFID) Sustainable Livelihood Framework (DFID, 1999)

Box 1: Changing concerns about food security and nutrition

In the 1960s and 1970s, Malthusian fears that the rapid growth of the world's population would outstrip food production and lead to widespread famine meant food production and **availability,** rather than access, were the key concerns – with attention centred on national and world supplies of food. Matters came to a head during the world food crisis of 1973/74 when a combination of poor harvests and reduced food stocks led to a sharp spike in cereal prices, which more than doubled within a year. One consequence was a major boost to efforts to increase food production through application of the Green Revolution, above all in developing Asia.

The price spike proved short-lived. As food production rose ahead of population and prices fell in real terms, the focus on food supply gave way to **access** to food, determined economically and socially. Amartya Sen's 1981 work was highly influential. This shift of perspective transferred attention from aggregate levels to that of the livelihoods of households and individuals.

Subsequent analyses of food crises in Africa, and especially of famine mortality in Darfur in 1984/85 (de Waal, 1989), drew attention to the role of conflict, migration and disease in food security. Access thus came to be complemented by a wider range of concerns, some of which are meant to be captured in the **utilisation** and **stability** dimensions of the food security framework.

For nutrition, concerns have evolved from the 1960s, when lack of protein was seen as a prime problem in the developing world, to subsequent appreciation that this was usually manifested within diets deficient in energy. Hence protein-energy malnutrition became the focus. This macro-nutrition perspective has, in turn, given way to equal or greater attention to micro-nutrition, and the widespread harm from deficiencies in vitamins and minerals, especially of iron, iodine, vitamin A and zinc. Nutrition perspectives give weight to child care and the health environment as well as to food access in explaining malnutrition. In the past few years, there has been increasing awareness of these factors in food and nutrition security.

References: de Waal (1989); Rogers (2002); Sen (1981).

2.3 Measuring impacts and outcomes

Advances in understanding how food security differs by context have been matched by the development of tools and indicators to measure food security. For instance, WFP has developed at least eight types of assessment for measuring food insecurity in emergency, chronic or normal situations.[16] The US Agency for International Development (USAID) Food and Nutrition Technical Assistance Project (FANTA) project has developed guidelines for measuring whether development interventions aimed at improving food security are successful. These have tried to balance subjective measures of food security (self-defined by respondents) with objective measures that can be compared across groups.

2.3.1 Is food consumption the best measure of food security?

Measuring **changes in food consumption –** what a person actually eats – captures information on the quantity, quality and frequency of food consumed and on changes to diets at the household level. Ways to capture food consumption[17] include surveys of food items households have recently consumed, and how a household's meals change over time or in reaction to shocks. While these surveys can provide useful information on what individuals actually consume, they can be costly and intrusive, undermining the possibility of doing this on a regular basis.

[16] See UN World Food Programme website: www.wfp.org

[17] For instance, WFP uses a survey that enumerates what households have eaten over the previous seven days, which is analysed to produce food consumption score (FCS). The final score indicates whether households have poor, borderline or acceptable levels of food consumption . FANTA guides on Household Food Insecurity Access Scale, Household Diet Diversity Score and Months of Adequate Food Provisioning are examples (http://www.fantaproject.org/publications/home_title2indguides.shtml).

Given the difficulties of direct observation of food consumption, the Food and Agricultural Organization (FAO) tries to estimate this indirectly nationally and runs into many problems.

2.3.2 Measuring intermediate variables

Since measuring food security is so difficult, much of the time food security is measured by looking at intermediate variables that are known, in theory, to affect food security. Prices and unskilled wages, and especially the interaction of the two, are quite popular.

- Changes in the **price of important food items:** Prices normally reflect changes in availability of food items in local areas. Prices may be monitored directly, or by questioning households on price changes. Determining how vulnerable households are to food price rises can be carried out through assessing net welfare impacts with one of several methodologies.[18] If publicly available price data cover areas that are near biofuel production areas, these can be used.

- Changes in the **availability of food:** While collecting price data is likely to be easier, observation or perception-based surveys can be carried out to assess crop yields and marketed food availability, for example through interviews with farmers, traders and others involved in food markets. Conducting community resource assessments for both cultivated and foraged food products can provide insights into the types of food households typically rely on, and how these change over time.

- Changes in **incomes and spending:** Data on incomes and spending can be used to assess whether direct or indirect engagement with an activity such as biofuel production yields economic benefits to households. Incomes can be measured, with difficulty and with dangers of inaccuracy, through household surveys. Contextual information is needed to tease out non-biofuel-related factors.

- Although not a common indicator in food security analysis, changes in the **amount and type of land** local communities are able to access can be a proxy in the absence of other information, where it is known that households' livelihoods depend largely on agriculture or foraging. Clear descriptions of the areas and the types of land (e.g. agricultural, forest) local community members have gained or lost access to because of a project can provide useful indications of impact on access. Ideally, descriptions would provide information on the physical characteristics and the tenure status of land.

- Methods to assess and verify changes in the physical (as opposed to legal) status of land are useful because they provide a strong indication of reduced availability of land or land-based resources. These can include household questionnaires but the inclusion of other methods, such as transect walks[19] around plots or geographic surveys, can help improve accuracy.

- Changes in legal rights of access, as indicated by contractual terms, can also provide an indication of a potential change in access to food. However, greater or restricted access to land on paper may not reflect changes on the ground.

Overall, three main sets of outcomes can be taken as indicative of changes to food security:

- Changes in access to food as implied in food prices, local wages and incomes;

- Changes in access to home-grown food as and when farm households have less land and labour (and potentially water) to grow food crops; and

[18] For example, BEFS prescribes a method based on Deaton (1989) and adapted by Minot and Goletti (2000) (in Beall et al., 2012). WFP (2012) suggests a household terms of trade method that uses the relative prices of main goods bought and sold.

[19] A transect walk is a systematic walk around a landholding with community members to explore changes to boundaries or land conditions. Transect diagrams mapping these changes are produced from observation and information provided by community members.

- Self-reporting of food access and consumption by local people, especially those vulnerable to food insecurity (usually ordinal measures). We may also infer food security from the reactions of people who are food-insecure (Maxwell, 1996).

For all indicators, information on seasonal changes is useful for understanding changes in use or availability throughout the year. Indicators of stability, including frequency of meals, periods without food (e.g. food gap months) or periods when households have to adopt coping strategies, can provide information on how food security changes over time. Analysing how households' food availability and access change as a result of the calendar of biofuel cultivation (e.g. when biofuel cultivation competes for labour or provides an extra source of income during a slack season) can indicate changes in effects on food consumption across seasons. There are concerns that engagement in biofuel production may adversely affect women within households to a greater extent than men.[20] Household surveys that disaggregate analysis at the household level can measure different impacts on men and women.

2.4 Possible impacts of biofuel projects on food security

2.4.1 Points of reference for a conceptual framework

This section develops an analytical framework for assessing the impacts of biofuel projects on local food security. Several research initiatives working on this topic have developed conceptual frameworks for assessing the impact of biofuels on food security, including Beall et al. (2012), the Global Bioenergy Partnership Sustainability Indicators (GBEP, 2011) and the recent High Level Panel of Experts on Food Security and Nutrition review (HLPE, 2013). These include feedback effects from impacts of biofuel projects and policies at national level (e.g. national food availability) and international level (e.g. commodity prices). However, this approach to economy-wide analysis is difficult to use when researching impacts experienced 'on the ground' because it requires large datasets. Including broad casual links at the macro level risks sacrificing attention to causal linkages at the micro level.[21]

Since the impacts of biofuel production on communities near projects are emphasised in debates on the pros and cons of biofuels, this study looks only at the micro-level processes and ignores the effects of biofuel production elsewhere in the economy. Changes in access to resources and livelihood opportunities from a local biofuel project are the most immediate and obvious changes from the perspective of local communities. Interest in the local impacts of individual operators is high from the perspective of certification; according to RSB certification, all feedstock operations above 500 hectares need to do a food security assessment; if these show a negative impact, companies are required to implement and monitor measures to mitigate measures to improve food security (Schut and Florin, forthcoming).

In developing a conceptual framework to analyse the possible links between biofuel projects and food security at local level, we have drawn on existing theoretical and modelling literature that highlights both the positive and the negative impacts biofuel production might have on food security (ActionAid, 2012; Beall et al., 2012; Clancy, 2013; Diaz-Chavez et al., 2010; Elbehri et al., 2013; Hall and Paradza, 2012; IF Campaign, 2013; Wiggins et al., 2008; Rossi and Lambrou, 2008; UN Energy, 2007; Vanwey, 2008). A biofuels operation is likely to generate a mixture of positive and negative impacts on different elements of household food security. As such, **the important question is whether the gains offset the losses (German et al., 2011b) and how these gains and losses are distributed.**

2.4.2 Linkages and pathways

Table 2 presents the different pathways through which the two main models of biofuel operations may affect the four dimensions of food security at local level. We have left out potential effects on international prices,

[20] For instance, if land used for food production switches to biofuel production, increasing the burden on women to source food elsewhere, and reducing their control over land (Rossi and Lambrou, 2008).

[21] For example, the HLPE (2013) conceptual framework illustrates the overall effects of biofuel production from increased demand, including feedback loops from macroeconomic effects associated with greater exports and reduced fuel import bills, but does not explore the operator-level dynamics in detail. Annex 1 of the Roundtable on Sustainable Biofuels' component on food security lists some of the potential effects associated with project-level interventions but does not provide diagrams of the overall linkages.

assuming that the LICs that are the main targets for biofuel operations are price takers on the world market. Annex 1 presents in diagrammatic form the ways biofuels production can influence access and availability.

Table 2: Biofuels and household food security – potential pathways

	Biofuel plantation	Biofuel outgrower scheme
Availability	A1. Land to food crops is reduced, which leads to less food grown locally; may lead to higher food prices if transport costs of imported food are high. A3. Plantation leads to better local access roads, more agro-dealers that make farm inputs cheaper and more available —> marketing of crops of all kinds becomes cheaper. A4. Plantation uses improved farm methods that can be imitated and applied to other local farms.	A1. Ditto A2. Diversion of labour and capital from food crops —> less food produced locally, may lead to higher food prices if transport costs of imported food are high. A3, A4. Ditto, probably all the more so. A5. Expansion of land cultivated as plantation provides means for establishing more cultivated land (equipment and skills).
Access	B1. Loss of land to local farmers leads to loss in farm income – were they compensated? B2. Jobs on plantation, processing plant —> changes to local labour market. May raise wages, time worked and incomes (but may not if land loss increases pool of those seeking jobs).	B3. Gains to small farmer incomes – depends on relative returns to feedstock compared with previous crops. B2. Ditto.
Utilisation	C1. Time spent on farms or in refineries by women decreases time for child care, food preparation and feeding. C2. Loss of jobs for women, as most jobs on plantation and factory for men, reduces female income, status.	C1. Ditto. C3. Men signed as outgrowers; women lose land in household, income, status.
Stability	D1. Mono-cropping and specialisation of local economy increases exposure to effects of weather, pest and disease, and changes to biofuel markets —> less stable incomes. D2. Imported food may be subject to more or less variability and certainty of supply and price.	D1 & D2. Ditto.

The main paths identified in the literature to date are those grouped under A and B; C and D perhaps are either less likely or have less impact on food security. However, we check for them in the biofuels literature we survey. We discuss these pathways in more detail below. While we have addressed availability of and access to food separately, we recognise that there is not an absolute distinction, since the two interact.

Availability

The quantity and diversity of food produced or marketed in the region of a biofuel operation may be directly affected by a biofuel project.

Potential negative effects (A1 and A2)

As Table 2 highlights, both plantation and outgrower biofuel operations can potentially have negative effects on food security if they **increase competition between feedstocks and food production for land, water and labour.** Engaging in production of biofuels may mean outgrowers choose between growing food and biofuel crops. This could result in smaller areas cultivated, reduced yields and less food grown locally (Clancy, 2013;

Elbehri et al., 2013). Farming operations may also create **environmental externalities** like soil, water or air pollution **that reduce yields.**[22] Reduced availability of food may also lead to higher food prices if transport costs of imported food are high. However, farmers can typically decide how much to divert, provided they are not saddled with high debts to repay for services.

The early stages of plantation establishment, which involve the transfer and clearing of land, present high risks to food security, especially if agricultural land is cleared and alternative livelihoods and food sources are not available (Cotula et al., 2008).

Some also argue that the introduction of commercial biofuel production can, through processes of social differentiation, lead to **greater concentration of land, landlessness and decreased access to productive land by poorest** for growing food for own consumption or sale to the market (Hall and Parazda, 2012; Vanwey, 2008).

For food gathered from non-agricultural land (e.g. foraged foods), a biofuel operation that uses that land can conceivably only reduce availability.

Potential positive effects (A3, A4 and A5)

On the other hand, **production may expand** if a biofuel company supports the cultivation of more land for smallholder farmers (e.g. through draining, irrigating or levelling of smallholder farmers' land).

The introduction of a biofuel operation may also **boost yields from smallholder farm production:** technical knowledge introduced in biofuel plantations may spill over to farmers who either have contact with the operation or can imitate and apply similar techniques and innovations. Similarly, the introduction of a biofuel operation may increase the availability of inputs in the local area that farmers can apply to their food production (e.g. fertilisers, agrochemicals, seed varieties) that can raise yields (Govereh et al., 1999). Companies running nucleus estates may source farm inputs directly and make them available to outgrowers at prices below market rates.

Access

Changes in access to food divide between those related to economic access and those related to physical access.

Potential negative effects (B1)

The introduction of a biofuel project may affect economic access to food negatively by lowering local households' purchasing power and disposable income to spend on food: if biofuel companies displace land at the start of a biofuel project that local community members use to produce food or other items to be marketed, without adequate compensation or provision of alternative livelihoods, this can reduce incomes that communities receive.

Some have argued that, if a biofuel operation displaces local food production, this may raise local food prices *(A1)*, which increases spending on food, further reducing economic access to food for net food deficit households (ActionAid, 2012; IF Campaign, 2013).[23]

Conversion to biofuels of land that is not cultivated but important for gathering food to supplement diets (e.g. forests, grazing land) may also have negative effects on access to food as local households have to spend more time and energy accessing food.

In addition, displacement of farmland and relocation of the household further away from food sources or the erection of physical barriers around a biofuel company's operations may mean households need to travel longer distances to access cultivated land or food markets. This can result in higher time and energy expenditure.

[22] Other environmental externalities may occur if projects remove ecosystems that provide other important regulating services (e.g. habitats for pollinators, temperature controls, windbreaks).

[23] Even households that could be defined as net food producers over the whole year may experience periods of the year during which they have to purchase food, particularly in the hungry season leading up to the harvest.

Potential positive effects (B2 and B3)

Potential **positive** effects associated with new biofuel companies producing and/or processing feedstock establishing in rural locations include the possibility of additional incomes from employment on plantations or in factories, purchasing feedstock from rural households, stimulating the rural economy and spillover effects into local farming systems (e.g. BEFS, 2010, Clancy, 2013; Diaz-Chavez et al., 2010; Wiggins et al. 2008):

- Biofuel companies may directly contribute to higher incomes by providing jobs for local community members on plantations or in processing plants that exceed other income-generating opportunities. The presence of a new operator may raise wages, time worked and incomes, depending on the employment conditions the biofuel company provides; however, this may not happen if land loss increases the pool of those seeking jobs.

- When biofuel operations use outgrower models, farmers can sell feedstock for additional incomes; this will result in gains to small farmer incomes if the returns to feedstock are higher than previous crops and/or biofuel companies enable farmers to produce more of their existing crops. This will depend on prices for biofuel feedstocks and how the company shares benefits and risks with outgrowers; and the decisions on what crops to plant and how to plan land use.[24] In some circumstances, there may be some additional demand for food crops if biofuel operators purchase food for employees or to assist farmers with marketing of their food crops in other markets.

The presence of a biofuel operation may also reduce household spending on food and other goods: if a biofuel company directly improves local infrastructure, bringing in roads or electricity, or indirectly creates the critical mass for the government to invest in better infrastructure in the area of the biofuel production, this may bring down costs on imported production and consumable goods for community members. Better infrastructure may also reduce the distance locals travel and time spent collecting food from fields or from other sources, such as towns and markets. This may also make the marketing of crops of all kinds cheaper, boosting farmers' incomes further.

Utilisation

Potential impacts of a new biofuel operation on the way in which individuals within a household are able to consume food are particularly sensitive to gender. While the presence of a new plantation or processing plant may increase employment opportunities for both men and women, women tend to hold less skilled and less stable jobs, with lower wages. Additional time spent on farms or in refineries by women can also decrease the time available for child care, food preparation and feeding, negatively affecting the utilisation of food by different members of the family, particularly the nutritional status of children (*C1*).

Utilisation of food also depends on the status of different household members within the household. Women may lose status and income if biofuel outgrower schemes acknowledge men as landholders and the sole representative of the household (*C3*). Alternatively, if such schemes are established in such a way as to strengthen women's land tenure and acknowledge them as joint representatives of their household, this may boost their status and access to income, improving nutritional outcomes within the household.

Stability

If the introduction of biofuel feedstock production on plantations and by outgrowers results in mono-cropping and specialisation of the local economy, this increases farmers' exposure to the effects of weather, pest and disease as well to changes to biofuel markets (*D1*). This can lead to less stable incomes, which will negatively affect the maintenance of food security through time.

If local food production is reduced by diversion of factors of production from food to biofuels by farmers, making local households more dependent on imported food, such food may be subject to more or less variability, and certainty of supply and price, again affecting the stability aspect of food security (*D2*).

[24] For instance, whether the operator decides to dedicate land to food crop production.

3 Evidence on the impact of biofuel projects on local food security

This chapter analyses the nature of the evidence on the link between biofuel projects and local food security and identifies the key findings in the literature reviewed.

3.1 Nature of the evidence

Tables 3 and 4 present the type of studies we reviewed, distinguishing between studies on smallholder contracting/outgrower schemes and plantation projects.[25] We have also drawn on relevant conclusions from the recent review of literature on LSLA and food security (Tanner, 2013). Our analysis of these studies indicates that:

- There are few studies based on primary evidence: in their systematic search of the Scopus academic journal database, Hodbod and Tomei (2013) found only 17 studies that investigate the social and livelihood impacts of biofuel feedstock cultivation using primary data. The literature search (see Section 1.3) carried out for this study similarly produced 19 studies based on primary data that met our (loose) inclusion criteria.

- Although quantitative methods have been used to analyse biofuel project impacts, the majority use qualitative approaches. Oya (2013) notes many contributions are field reports rich in description but lacking both a conceptual and systematic approach. Most rely on purposive sampling of participants and focus group discussions that explore some relationships in depth but are not necessarily representative of the whole affected population. Although several authors attempt to sample a cross-section of households, few attempt to randomise sampling or control for biases using econometric techniques:

  a) With the exception of Negash and Swinnen (2012) and Loos (2008), who use randomisation in their sampling frames,[26] the studies on outgrowers all gather their information through targeted semi-structured interviews and focus group discussions.

  b) In the more restricted literature on biofuel plantation, information for the studies is gathered largely through targeted interviews and focus group discussions. It is difficult to assess how representative experiences are of all affected populations, although some studies claim to be representative based on their sampling strategy of affected and non-affected communities. Studies do not justify why they over-sample some respondents and under-sample others (Oya, 2013).

[25] The majority of studies look at projects that rely on outgrower models.

[26] While participants either opt in or are selected into outgrower schemes and are thus not randomly selected, researchers use randomised sampling procedures to select households into their study

- Studies use different definitions of food security. As no single outcome captures all dimensions of food security, studies use different outcomes as proxies. Some equate it with a decline in food production and self-sufficiency; others also look at wealth outcomes and others at consumption.[27] It is not always clear whether the definition chosen prioritises local reality – how households meet their food needs through livelihood strategies – or the authors' own understanding or preferences.

- As outcomes used to proximate food security differ between studies, so do the indicators chosen to measure these. These include change in land use, demands on labour, changes in food production and changes in food consumption. Some studies use single indicators whereas others use multiple indicators.

- Depending on the context and the population, authors exploring food availability focus on cultivated food, foraged food or both. Comparing or aggregating impacts on food production is therefore challenging.

- As well as literature published in journals, independent researchers and international NGOs have documented experiences of specific land deals in non-academic literature. While these provide descriptive analysis of the effects of deals, the quality of these studies varies because some do not explicitly describe their methodology.

- The majority of studies investigate jatropha. This is especially true for the contract farming literature, where nine of the ten studies included jatropha. The literature on plantations includes studies on other crops including oil palm and sugarcane as well as jatropha.

- Most of the studies focus on Africa (13). Two studies from Latin America and one from Asia were analysed.

- The smallholder studies analysed come from several African countries including Ethiopia (Negash and Swinnen, 2012; Teman, 2010); Kenya (Ehrensperger et al., 2013); Mali (Favretto et al., 2013); Tanzania (Grimsby et al., 2012; Loos, 2009); and Zambia (German et al., 2011a). Only one relevant study was found on Brazil (Finco and Doppler, 2010), and one on India (Ariza-Montobbio and Lele, 2010).

- Research analysed on biofuel plantations is from Liberia (Balachandaran et al., 2011); Ghana (Boamah, 2011; Schoneveld et al., 2010); Mozambique (Peters, 2009); Sierra Leone (Baxter and Schaefter, 2013); and Tanzania (Sulle and Nelson, 2012).

- The smallholder/outgrower projects researchers investigated were orientated towards production for domestic use, for either village-level electricity generation or larger rural electrification projects (e.g. in Mali and Zambia) rather than for export to supply overseas markets.

One of the main reasons for the low number of studies on biofuel projects and food security is that a relatively small number of projects have started and remained in production in developing countries. For instance, recent investigations into the jatropha sector in Africa did not find any projects that were producing only jatropha; all those that had started with a focus purely on jatropha had failed or changed plans and were producing other crops as well (Bioenergy in Africa, 2013; Muys et al., 2013). This echoes findings from the earlier scoping study carried out for this report on the status of biofuel projects in four African countries (Locke and Henley, 2013).

A counterfactual is required to understand what changes have been caused by the activities related to a project. Typically, a counterfactual can be established by looking at the conditions in a similar location that is not affected by the operation, and comparing the situation before and after the start of an operation. This shows what may have happened in the absence of the project. Not all studies have done this effectively.

[27] The Tanner (2013) review of the literature on LSLAs and their impact on food security encountered the same difficulty.

Table 3: Studies of biofuel projects that contract outgrowers

Study and crop	Company; location	Aspect of food security investigated	Short description of methodology	Findings
Negash and Swinnen (2012); castor beans	Not specified; Southern Region, Ethiopia	Food gap months.[28] Per capita food consumption (converting all food consumed into energy (kcal) equivalents.	Randomised surveys of 18-22 households in 24 villages, stratified by participants and non-participants in outgrowing (n=476).	Participating households have higher levels of food security on a food gap indicator. Food gap reduced by 23%. Participants also have higher consumption levels, although how much of this is because of households' castor bean production is not determined.
Favretto et al. (2013); jatropha	Mali Biocarburant; Mali	Change in land use.	Non-random, purposive sampling of growers. Surveys include Interviews with growers (n=120); in depth semi-structured interviews (n=36); transect walks[29] (n=30); wealth ranking and seasonal calendars[30] (n=30); and village focus group discussions (n=31).	Jatropha is planted on land previously used for food, but is intercropped with food crops (at early stages of production?)
Teman (2010); jatropha	Emami Biotech; Mieso, Ethiopia	Change in land use and effect on food prices.	Household surveys of 120 households based on random selection within purposively determined groups of 60 growers and 60 non-growers.	The growers planted jatropha on land planted to crops, but intercropped jatropha, which potentially resulted in higher yields (uncertain causal link).
German et al. (2011a); jatropha	Marli Investments; Zambia	Change in land use; changes in net food production; changes in quality of land allocated; loss of revenues and safety nets that non-timber	Focus group discussions with outgrowers in two or more villages per district; household surveys with 30 outgrower households in each district	19% of farmers have planted jatropha on land previously for food, but the majority of outgrowers expanded production through intercropping. If jatropha displaced food, respondents expanded land for food production. 63% of households reported no change in food production; 31% claimed

[28] Food gap months are defined as the number of months a household is without stocks of own food.

[29] Transect walks around fields with household members are used by the researcher to determine the area of land use change.

[30] Seasonal calendars are used to explore availability of foods at different times throughout the year with household members.

Study and crop	Company; location	Aspect of food security investigated	Short description of methodology	Findings
		forest products provide.	(male and female, based on interest).	an increase, but the authors found this was not related to jatropha production but independent factors (that the authors do not specify); 7% decreased their food production because of labour diversion to jatropha. Intercropping jatropha and food crops was possible without competition.
Ehrensperger et al. (2013); jatropha	Not specified; Bondo, Kibwezi and Kwale, Kenya	Change in land use.	Interviews with local experts of drivers of food insecurity, geospatial analysis of food displacement and household interviews (unspecified number).	No findings of displacement of food crops by jatropha. Only food-secure farmers were found to venture into production.
Loos (2009); jatropha	Prokon; Mpanda district, Tanzania	Change in land use. Availability of food.	Stratified, randomised sampling of participants and non-participants (n=248) for small group interviews.	The author found farmers integrated jatropha into their farms in one of three ways: 44% of farmers cultivated jatropha on new fields, 24% mixed jatropha into fields planted to food and cash crops; the remaining 31% replaced existing food and cash crops in fields (mainly maize and groundnuts) with jatropha. The author believes where farmers replaced food and cash crops in existing fields with jatropha, most expanded their farm area to grow food crops in new fields, but did not ask if they did. Farmers explained that they prioritised food production over jatropha production. High labour input required and low yields led the author to believe growing other crops would be more profitable.
Ariza-Montobbio and Lele (2010); jatropha	AGNI-NET Biofuels, D1 Mohan Biofuels and Shia distilleries; Tamil Nadu, India	Change in land use. Change in labour use.	Purposive (non-random) semi-structured Interviews of 45 farmers comparing jatropha cultivation under irrigation and rain-fed conditions. Agronomic surveys for potential yields.	Jatropha was adopted by larger farmers (>2 ha) because of access to irrigation. Because farmers expected increased loans, advice and inputs if they cultivated jatropha, 82% used land planted food (mainly groundnuts) to grow jatropha; only 18% used barren land or land for non-food crops. Jatopha production is no longer profitable for any farmers because of low yields. 70% have uprooted or abandoned their jatropha plants.
Finco and Doppler (2010); jatropha and castor bean	Not specified; Tocantins state, Brazil	Changes in land use.	Purposive sampling of 27 jatropha farmers and 25 castor bean farmers, representing 90% of oil-seed farmers in the region. Authors do not investigate	Half of the households had changed their land use from food crops to jatropha or castor beans. On aggregate, jatropha farmers planted 47% of their food crop land (1.37 of 2.87 hectares) to jatropha and castor bean farmers planted 27% of their food crop land to biofuels. (0.74 of 2.66

Study and crop	Company; location	Aspect of food security investigated	Short description of methodology	Findings
			change in incomes.	hectares.) They do not report impacts on food production.
Dyer et al. (2012); jatropha	Not specified; Malawi	Changes in land use	Interviews of households in 6 villages growing jatropha (sampling, household numbers not specified).	Farmers stated they did not divert land away from maize or other food production to jatropha. The author does not report whether jatropha was intercropped or planted on vacant land.
Hunsberger (2010); jatropha	Not specified; Nguruman and Mpeketoni Kenya	Food security not a core question, but the study looked at farmers' earnings from jatropha.	Purposive sampling for Interviews with 26 growers (Nguruman).	Farmers grew had grown jatropha for a long period but refused to sell owing to low prices, in contrast with expectations of high prices.
Grimsby et al. (2012); jatropha	Not specified; Monduli district, Arusha region, Tanzania	Food security not a core question of the study, which looked more closely at energy needs in the production system.	Purposive sampling and interviews with households and modelling of household energy requirements.	Farmers cultivated jatropha on land but did not harvest as it was not worth their time. The human energy input into harvesting was low (i.e. harvesting is light work); however, the energy output was also low: one day's harvest converts into 1 kg of oil. Although the income return of $1/day was low, it still attracted labourers.
Skutsch et al. (2011); jatropha	Proarbol (government programme); Chiapas, Yucatan and Michoacan, Mexico	Change in land use and food supply. They also looked for negative social effects including increases in land dispossession, indebtedness, socioeconomic disparity and women's workload, and positive impacts of incomes, employment and social infrastructure.	Purposive sampling of jatropha growers, non-growers and labourers in 5-6 villages in both Chiapas (34) and Michocan (38). Among growers, purposive selection of large and small farmers.	Jatropha growers owned more land than non-growers. Two-thirds of jatropha growers in Chiapas replaced maize with jatropha. In most cases, this was on land where maize yields were falling year-on-year. The remaining third used pasture land or cleared forestland. In Michoacan, over half of farmers integrated jatropha into their shifting cultivation farming system, using both cleared forestland and land planted to maize in the previous year. However, although jatropha production replaced maize production, jatropha growers still cultivated enough maize to meet their food requirements, and most still had a surplus to sell. As maize production is perceived to be unprofitable, jatropha growers preferred to take the risk of growing jatropha. This is because the Proarbol programme provided grants to plant jatropha for the first two years, and extensionists convinced farmers of high returns. Authors' calculations showed that jatropha production was unlikely to be profitable at current diesel costs and low yields of plants, and some farmers had already stopped

Study and crop	Company; location	Aspect of food security investigated	Short description of methodology	Findings
				cultivation, removing plants. However, the only negative social impact found was potential future increased workload for women if production was scaled up. Incomes to landless labourers increased because of more work on farms, as most jatropha farmers hired in labour.
Hought et al. (2012); cassava	Not specified Banteay Chhmar, Cambodia	Land use change. Food availability (households' own assessment).	Remote sensing of crop changes between 1990 and 2005, and field research to assess changes to 2009. Remote sensing data were supplemented with participatory land use mapping and village focus group discussions in two villages. Researchers conducted surveys with 32 households on impacts on livelihoods (stratified by size of rice plot), and in-depth interviews with farmers, traders and local leaders.	Farmers with the smallest size landholding had the highest proportion of land dedicated to cassava production (78.4% of land). Land for cassava production came from both expansion into forests and switching rice fields to cassava. Farmers with larger areas dedicated a higher proportion of land to rice. Farmers' exposure to cassava market had severe consequences during the 2008 price slump and closing of the Cambodian–Thai border. Farmers with the least land were most affected, as they had to sell off assets (particularly livestock). Small farmers cited lack of food as a major problem of the poor cassava market situation, but the authors do not quantify changes in production. The authors predict that poorer households that have higher debts and lower profits from cassava will lose access to land and food security because the current structure of the cassava market favours wealthier producers.

3.2 Key findings

This section discusses the recent evidence based on the primary research studies reviewed. We examine smallholder contracting/outgrower models and plantations separately, following the different pathways and impacts of biofuel production on food security laid out in Section 2. Because oil palm projects that target palm oil and biofuel markets are similar, these are analysed together in Section 4.3.

3.2.1 Smallholder contracting/outgrower models

Changes in food consumption

Only one study on outgrowers investigated the impact on consumption indicators. Negash and Swinnen (2012) found that Ethiopian participants in a castor bean outgrowers' scheme in an overall food-insecure region had better levels of food consumption than non-participants.[31] Their indicators included the seasonal food availability for households, and the energy content of food consumed. Participants scored better on both. Overall for non-participants, the level of food insecurity[32] (based on these measures) was 12% higher, and their level of chronic food insecurity was 6% higher. Participants in the programme gained an increase in food consumption of 27%, and their food gap period reduced by 23% on average. However, their findings also suggest that, given non-participants' endowments, their choice not to grow castor beans was correct; they would have lower levels of food consumption and longer food gaps if they had participated in the production programme.

Food production and factors of production

Land use and food production

The studies suggest there is support for complementarity between food and fuel feedstock production, meaning households could produce biofuel feedstocks without negatively affecting food production, or even engagement in biofuel production can raise food production levels. While some studies warn that future requirements for land may reduce availability of these factors for food production, most studies found farmers prioritised food production, and did not act against their best interests to grow biofuels:

- In most studies, researchers encountered **few farmers who had shifted much land from food crops to biofuel crops.** Negash and Swinnen's (2012) study of castor beans in Ethiopia found outgrowers had, on average, chosen to allocate only 15% of their land to castor bean production and the maximum proportion of land diverted did not exceed 25%. An exception was farmers growing cassava in Cambodia (Hought et al., 2012), where farmers with the smallest area of land changed their main crop from rice to cassava between 2000 and 2009 because of high prices.

- German et al. (2011a) found that, although 19% of farmers in Mungwi, Zambia, used land previously planted to food crops to plant jatropha, **overall the area of land under food cultivation expanded** as households intercropped jatropha with food crops on new land. Teman (2010) found that expansion of jatropha was mainly intercropped with existing crops, or planted on marginal land. An exception was Finco and Doppler's (2010) study in Brazil, which found that half of households had changed their land use from food crops to jatropha or castor beans. On aggregate, jatropha farmers switched 47% of land under food crops to jatropha and castor bean farmers switched 27% of their land.[33]

- **Opening of new land to plant biofuels was the most frequent strategy households followed** in Tanzania (Grimsby et al., 2012; Loos, 2009) and Mali (Favretto et al., 2013), and households that

[31] Only 49% of participants and 37% of non-participants were in food-secure households (consuming over 2,100 kcals per day).

[32] The authors define food insecurity as consuming on average less than 2,100 kcal per capita per day. Chronic food insecurity is defined as consuming on average less than 1,500 kcal per capita per day.

[33] The authors do not give more information on prices and incomes or discuss factors that might explain why farmers switch from food to biofuel production.

did replace land for food production with biofuels cultivated food on new pieces of land of a similar size and quality.

- In the Zambian case, a fifth of households felt jatropha cultivation had restored quality to the land because the crops' leaves assisted soil formation, and because intercropped plants (groundnuts) responded well (German et al., 2011a). Similarly, farmers interviewed by Teman (2010) in Ethiopia indicated that jatropha production had restored soil fertility, benefiting crops that grew alongside jatropha, such as khat.

Because in most cases there is relatively little switching of food crop land to biofuels, there was little adverse effect on food production. In cases where farmers switched land, they generally had large enough plots to switch land without compromising their ability to provide sufficient quantity of food. In Mexico, farmers used land previously planted to maize to grow jatropha, but their production was still sufficient to meet household demands and in many cases still generate a surplus (Skutsch et al., 2011). In the Zambian villages studied by German et al. (2011a), the majority of households (63%) noted no change in food production after having started to farm jatropha: many intercropped jatropha with food crops, which is possible in early years before the tree canopy becomes fully developed. A further 31% responded that food production had increased because they had decided to expand their acreage – a decision the authors claim was unrelated to jatropha production – and 6.5% noted that food production had decreased because they grew jatropha. This may reflect the type of farmer who opted, or was selected for, growing feedstock under contract. For instance, Ehrensprenger et al. (2011) and Negash and Swinnen (2012) found it was only the more food-secure farmers who chose to grow biofuel crops; those who were food-insecure, or would be as a result of production, chose not to.

Labour use and food production

German et al. (2011a) note that responses to questions on demands for labour in their case study in Zambia indicate that a small number of farmers felt jatropha cultivation competed for labour with food crops, especially during harvesting seasons. The authors also caution that labour demand may increase as jatropha plants mature; however, this competition for labour had not been observed yet. Grimsby et al.'s (2012) study of jatropha production in Tanzania also found households mainly harvested jatropha in their 'spare' time, as labour demands for this activity were low. Low labour demands were also noted by the majority of respondents of Teman's (2010) study in Ethiopia, who stated that the fencing function jatropha played meant farmers no longer spent time collecting bush and branches for this function.

Agrochemical use and food production

Only one study investigated the impact of biofuel production on agrochemical use. Negash and Swinnen (2012) found farmers in Ethiopia participating in castor bean production were applying higher amounts of fertilisers on their food crops because they had better fertiliser access through the contract scheme (around double the amount of non-participants), producing more food than non-participants as a result.

Changes in incomes and spending

The extent to which feedstock cultivation improved incomes and access to food varied according to household poverty levels and feedstocks cultivated. In general, studies on **jatropha** cultivated on farmers' plots found it **provided low opportunities for income generation**; in a review of studies on jatropha, Gasparatos et al. (2012) note that jatropha prices have been poor throughout Africa, and have not delivered high incomes for farmers. This owes to unstable demand because buyers have gone bankrupt or been faced with excess supply. Also, real yields in all sites are lower than the expected yields that project proponents use to calculate farm profits. Whether these incomes are attractive and able to boost farmers' purchasing power is very much dependent on existing levels of poverty and whether farmers have alternative livelihood opportunities.

The primary research reviewed here backs up this finding. In Tanzania, Grimsby et al. (2012) found that, although jatropha was cultivated on farm plots, it was collectors employed by companies, rather than households, that picked and processed the seeds, because households saw too little financial gain in these activities to merit their interest. In Mozambique, Loos (2009) found that low yields meant farmers were unable to recoup their costs of investment in a short time period. In villages engaged in jatropha production in Mali, most farmers derived some income from selling jatropha seeds for biofuel production (Favretto et al., 2013). However, incomes were lower than the value of sales for soap production that many households engaged in,

indicating low benefits from production. This was partly explained by farmers investing little into production because of previous experiences of low yields. Similarly, German et al. (2011a) found returns to labour for farmers were very low, at around $0.06 per day, partly because of low yields.

The extent to which households perceive jatropha production to yield income benefits depends in large measure on how poor households are, and what alternative livelihood options they have. For instance, despite the low incomes households could earn from jatropha production in German et al.'s (2011) study, households continued to perceive benefits from its production as the slim profits from seed and soap production allowed them to purchase basic, but highly valued, household goods. Similarly, households in Grimsby et al.'s (2012) case study in Tanzania continued to collect and sell jatropha despite earning less than $1 per day from such sales. Even where households derive higher incomes from other crops than jatropha, the additional income provided by jatropha may justify production: Teman's (2010) study found farmers who gained most of their incomes from cultivating other cash crops still cultivated jatropha.

Finally, the timing of income may be as important as the value. In Ethiopia, Negash and Swinnen (2012) found that the harvesting of castor beans meant households could buy food at times when cash was traditionally scarce; as castor beans can be harvested twice a year and do not spoil easily in the field, farmers could collect and sell these when they needed cash to purchase food.

While the studies reviewed showed some positive impacts on livelihoods, the relatively high level of risks associated with cultivating jatropha, including low yields and insecure markets, has led to outgrowers foregoing other livelihood strategies and losing out when buyers go bankrupt or projects are terminated. This presents a very real risk for jatropha projects: several of the projects researchers investigated (including in Tanzania and Zambia) subsequently went bankrupt.

Changes in food prices

Only one study (Teman, 2010) asked if food prices in the area had changed as a result of jatropha production. This was done by asking households in the area producing jatropha whether biofuel feedstock cultivation led to higher food prices; the overwhelming majority of respondents claimed it had not, or that they did not know.

Summary and conclusions

Based on the literature reviewed here, the evidence is too varied to make strong statements on whether production of biofuels feedstocks using contractual models is beneficial or detrimental to growers' food security.

However, two points emerge from the literature. First, there is little evidence to suggest households that grow biofuel feedstocks on contract do so by sacrificing their ability to feed themselves, either through their own production or through buying food. In most instances, it is the households that can bear the risk of reducing their food production that do so.

Second, low income gains from jatropha across experiences highlights real differences in benefits from different biofuel feedstocks, and the dangers of establishing supply of a feedstock in advance of both a sound understanding of agronomic and marketing potential.

As has been noted in other studies (Gasparatos et al., 2012; German et al., 2011b), the presence or absence of other factors is likely to be a more important determinant of food security than whether the crop produced is destined for biofuel production, for example the socioeconomic conditions of households and how the agreements they enter into with purchasers share benefits and risks.

3.2.2 Biofuel plantations

The literature on large-scale biofuel plantations is smaller than that on contract farming. Because plantations established for biofuel production are relatively new, the main impacts that can be observed so far relate to the displacement of land and livelihoods of local communities that used the land prior to conversion.

Research has been carried out on plantations in Kenya (; FIAN, 2010) and Mozambique (FIAN, 2010; Oakland Institute, 2010) that started land transfers and conversion but did not reach the production stage. These studies highlight potential risks associated with the land acquisition procedures for these biofuel projects, but, because

the research was conducted before any eviction or employment took place, they do not analyse impacts on changes in access to food or incomes, and are not included in Table 4

Table 4: Studies of biofuel plantation projects

Study and crop	Company; location	Aspect of food security investigated	Short description of methodology	Findings
Balachandran et al. (2012); oil palm	Sime Darby; Gbarpolu and Grand Cape Mount, Liberia	Food consumption (quantity and quality); access (incomes, spending) production (size and productivity of plots).	Comparison between households in affected and non-affected communities. Stratified sampling and random selection of 20 households in four communities for household surveys (n=80). Focus group discussions were used to understand local perceptions of household food security. Semi-structured interviews were also used with stakeholders.	Access to land to grow food decreased significantly in Grand Cape Mount, as did access to forests, which are important sources of food. Mixed employment benefits for communities with good road access, depending on household; no alternative employment for those without road access. Across indicators, food insecurity is unambiguously higher in the affected community.
Boamah (2010)	BioFuel Africa; Yendi and Central Gonja districts, Northern Ghana	Food consumption, income generation and transfers, education, health and nutrition indicators.	Purposive sampling of 50 household heads in three villages, and migrant workers. Semi-structured interviews and focus group discussions with 106 informants.	19 of 25 affected farmers were employed on the plantation. Income sources increased indirectly through stimulated demand from the biofuel project. Households also invested more in their own agriculture. Some incomes sources (e.g. Shea nut trees) were destroyed, possibly affecting women.
Baxter and Schaefter (2013); oil palm	Sierra Leone Agriculture, Socfin and Addax Bioenergy; Sierra Leone	Loss of agricultural land; loss of forest land and agro-biodiversity in forests that households indicated as important to their diets; analysis of ability to purchase food in the absence of subsistence cultivation.	Nine focus group discussions with 8-10 individuals in 10 affected, and soon-to-be-affected communities (n=84) and semi-structured interviews with community members (n=14). Resource inventories in 7 villages with a single informant (n=7). Before and after assessment of food availability. Cost-benefit analysis, based on imputed value of destroyed crops and trees.	Reduction in the amount of agricultural land available to local households; loss of half of the available resources important for diets and incomes (including loss of all surplus production in some cases). Community assessments of the Addax Farmer Development Programme were 'not positive' with participants complaining of the singular focus on rice and lack of appreciation of crop diversity by trainers who did not encourage intercropping rice with other foods. Respondents reported that yields of rice grown through the Farmer Development Programme (FDP) were low.
Schoneveld et al. (2011); jatropha	Not-specified; Pru district, Brong Ahafo, Ghana	Replacement of food crops by biofuel crops. Reliance on forest/ communal land and loss.	10 focus group discussions in 3 communities with groups employed at the plantation and those who lost land in 3 communities (disaggregated into native inhabitants, women and settlers). Household surveys were conducted with 31 employees (out of 120) and	Agriculture remained important to food security for all employees, including plantation workers. Access to good-quality land was reduced for all households as a result of company acquiring land. Few households were able to diversify their livelihood sources to overcome loss of agricultural incomes. Loss of access to important forest products, increased time collecting firewood and loss of income were also

			63 land-losing households (out of 69).	important impacts.
Peters (2009); jatropha	Emergen plantations (Chilengue and Nzeve), Bilene Macia district, Mozambique	Household food production, income from plantation wages and expenditure on food and changes in labour.	Analysis of before and after for (treatment) villages that supplied labour to the plantation, and comparison with a (control) village that did not. 84 households were surveyed.	Some 'treatment' households lost agricultural land. Some also reduced food production, but partly because of switching to other higher income opportunities in the tourism sector. Some compensation was given in one of the two areas. Households in 'treatment' villages spent more on food but higher incomes (that came mainly from the household's head plantation work) compensated this loss.[34]

[34] The author establishes that the main household occupations is plantation work but breaks down household income by source.

Changes in food consumption

Balachandran et al.'s (2012) study of the Sime Darby oil palm plantation in Liberia compared food consumption between communities affected by the project (because the project relies on land and water resources formerly used by the community) and non-affected communities, controlling for initial differences between communities. They found that **affected communities had significantly worse diets,** when other factors had been controlled for. Communities affected by the project experienced inadequate food[35] for four more months per year than non-affected households.

Access to land for food production and foraging

Looking at the pathways A1 and B1 outlined in Table 1, the evidence on plantations for biofuels points to **negative impacts on food security associated with displacement of land or communities.** With the exception of one project in Ghana, research on all the projects indicated that at least a portion of local communities experienced decreases in their food production, usually through loss of land for agriculture production or foraging. These impacts largely resulted from poorly implemented transfers of land and negotiation with local communities, which resulted in companies providing no or insufficient compensation in the form of alternative land, employment or payments for community members to sustain livelihoods. Where households rely on a wide variety of food from agricultural and foraging activities, displacement of these lands can reduce the quantity and diversity of diets. Although the evidence of this is sometimes insufficiently detailed, in the cases where researchers have compiled lists of natural resources that are important to community members for consumption and income generation, the extent of loss to access to food is significant (Baxter and Schaefter, 2013).

In villages surrounding the Sime Darby plantations in Liberia, the number of households without access to farmland increased fivefold after the project entered the local area (Balachandran et al., 2012). A survey measuring food insecurity access[36] indicated the environment communities were in was highly food-insecure, compared with a moderately insecure environment for the non-affected communities.

A study in Northern Ghana by Schoneveld et al. (2011) found that approximately 19% of land converted to a jatropha plantation was previously important for staple food production (e.g. yams) for households in the project area, while a further 24% of land converted to jatropha was land largely considered fallow by men in the community, but on which women grew subsistence crops mainly for household consumption. Because the 69 households affected were not consulted during land negotiations, they did not receive any compensation for their land from the company or local authority. Only 18% of households were able to gain access to alternative land in compensation.

In Peters' (2009) study site in Mozambique, land households cultivated food on prior to the plantation establishment was replaced elsewhere, but this was deemed too distant by some households to access, and was hardly used. Households also lost access to firewood because of clearance of woodland for the plantation.

There are also cases of biofuel plantations at early stages of establishment that negatively affected access to foraged food through forest clearance, which is not adequately compensated. Of these, Baxter and Schaefter's (2013) case studies of impacts on food security in three plantations in Sierra Leone that are currently planning to expand (Addax Bioenergy, Socfin and Sierra Leone Agriculture) are most comprehensive. Focus group discussions with affected communities indicated significant losses of all types of land (including productive agricultural and fallow/bush land). Crops lost included both food and medicinal plants. In the case of the Addax sugarcane plantation, the company has established an FDP to safeguard food production by preparing community lands for rice cultivation, raising productivity through providing inputs and training farmers. However, Baxter and Schaefter (2013) note differing assessments of the success of the FDP between the

[35] Food adequacy in Balachandaran et al. (2012) is measured using the Months of Adequate Household Food Provisioning (MAHFP) tool developed by USAID FANTA.

[36] The Household Food Insecurity Access Scale (HFIAS)developed by FANTA was used to assess the environment.

company and some community members in terms of whether rice production in the programme adequately compensated farmers, and whether the three-year length of the programme was sufficient.[37]

Case study research into local communities affected by the Sun Biofuels project in Kisaware, Tanzania, found households lost access to foraging land, as the company cleared bush land that was important for fuelwood, charcoal, wild fruits and meat (Oakland Institute, 2012). Although the company created jobs, the low remuneration provided was not sufficient to purchase goods households previously foraged, and all income was spent on food. Some plantation workers' household incomes were lower than when they had previously farmed their land, but they had taken on plantation work because communications from the company had convinced them of greater benefits.

Short case studies highlight where LSLAs for biofuels hold the potential to worsen households' food security by removing access to land and not providing adequate compensating households for this loss. ActionAid (2011) and FIAN (2010) give examples for Kenya, Mozambique and Tanzania. However, because these projects have halted, other longer-term (positive and negative) impacts have not been assessed.

Change in incomes and expenditure

Looking at the potential impact of plantation biofuel feedstock production identified in B1 and B2 in Table 1, Balachandran et al. (2012) note that some households in the biofuel project area in Liberia were able to get well-paid jobs with the plantation that increased their income. However, for some, rising costs and reductions in other household revenue streams offset the benefits of employment. Expenditure on food, schooling and charcoal rose for project-affected communities because of their displacement.[38] Affected households had higher debt levels, and many households borrowed to buy food and medicines.

Schoneveld et al.'s (2011) study of a jatropha plantation in Northern Ghana found community members incurred major economic losses because they no longer had the same surplus production or access to foraging resources. Women's incomes were particularly affected by the loss of access to trees and crops they relied on for incomes, which were destroyed during the plantation's establishment. The plantation provided well-paid jobs for 120 local people, and 67% of employees felt employment was overall positive, given the stability of income flows it provided. None of the employees felt it had contributed negatively. However, only 3 of the 69 individuals who had lost land were able to secure employment, and for others there was no compensation.

Peters' (2009) study of the Energem jatropha plantations in Mozambique found plantation workers received wages comparable with other opportunities in the local tourist or services sector. In general, households in communities with few opportunities prized the permanent jobs on the plantation, and hired in seasonal labour for their own farms during peak seasons. For households with other seasonal labour opportunities, absenteeism from plantations was high during these seasons, indicating workers could gain more income elsewhere. Overall, households working on the plantations were better off in terms of their economic positions (their disposable income) than households that did not work on the plantation, but, because households worked in multiple occupations, this is not wholly attributable to the presence of the plantation. Although work on plantations meant households produced less of their own food, many preferred this option, given the risks of shocks to food production in the area and preference for cash incomes among households.

Only two studies reported generally improved local benefits, including on food security; however, both projects subsequently collapsed. Boamah (2010) studied a jatropha plantation in Northern Ghana, where food production increased in project villages and employment on the plantation and in petty trading created more income opportunities on a more regular basis than alternatives. Because few households farmed during the dry season, the plantation provided local jobs as an alternative to travelling to cities for itinerant work. Villagers spent their increased income mainly on food. Although the project displaced some agricultural land, it secured alternative

[37] The success of the FDP in the Addax project remains contentious. A recent ActionAid report (2013a) criticises the programme on the basis of agricultural performance in the first two years of operation. Addax provided a response highlighting what it saw as flaws in both the research methods and data used in the ActionAid report..

[38] The local school villagers sent children to was removed because the company had acquired the land it was on. Sending children to a further-away school incurred higher costs.

land and established maize farms for the project villages. However, the project collapsed in 2011 as a consequence of financial problems stemming from negative local campaigning and the international financial crisis, resulting in a loss of employment for the local community. The Sun Biofuels project in Mozambique is also reported to have generated a high number of seasonal jobs prior to closing down owing to bankruptcy (Schut and Florin, forthcoming).[39]

Summary and conclusions

Where they have been measured, **impacts of large-scale biofuel plantations have largely been negative in the establishment phase.** In all instances, communities have lost land; in some cases, this has displaced agricultural production, which has not been compensated through alternative livelihoods.

Over time, benefits provided by plantations may improve the livelihoods of employees. However, as not all households are able to secure employment, **benefits are not equally distributed,** and some households affected by the project lose out. Although some jobs have been created, and respondents welcome employment opportunities, these do not always go to those who have borne the costs of land loss. Moreover, as several examples have demonstrated, if plantations face bankruptcy, this creates potential shocks to the livelihoods of employees.

[39] Sun Biofuels went bankrupt in 2011 and subsequently closed its operations in Mozambique.

4 Parallels with the debate on cash crops and food security

The debate over biofuel feedstocks and rural benefits shares aspects with the longstanding debate over cash crops, models of production and food security. It spans numerous issues, including nutritional outcomes for women and young children, effects on community members not engaged in cash cropping, effects across the rural sector and effects on national-level aggregate production.[40] Whether commercialisation competes with or complements food production has been central to the debate, which has focused mainly on land rather than on other factors of production (Govereh et al., 1999). A synthesis review of smallholder commercialisation in the mid-1990s found that, overall, there was qualified support for complementarities between food and cash crop production (von Braun, 1995). There are still questions about how this is best achieved, and whether models that involve large investors, including contract farming and plantations, provide development outcomes (Smalley, 2013).

Comparing findings from the biofuels review with longer-standing literature on the impacts of two of these cash crops – oil palm and sugarcane – provides an indication of whether the impacts of biofuel projects are unique. Also, as many sugarcane and oil palm projects have a longer history of operation, impacts over time from these projects can suggest what the impacts are of biofuel production over longer time horizons.[41]

This section looks at the literature on the impact of sugarcane and oil palm production – the two main biofuel feedstocks – on food security. Cases from Southern and Eastern African countries were selected for sugarcane production because five out of ten world-class sugar production facilities are in the region (Tyler, 2008). Cases from Indonesia and Malaysia were selected for oil palm because these countries represent over 95% of global production of palm oil. While lessons from these regions may have limited application for all countries where biofuel production is occurring, they can indicate the types and scale of benefits and risks biofuels may bring.

4.1 Nature of the evidence

Investigating the impacts of cash crop production faces similar methodological challenges to those indicated above for biofuels. A major review of the impacts of involvement in cash cropping among smallholders up to 1995 found that a number of earlier studies had conceptually flawed study designs (von Braun, 1995). A recent review of the literature (Barrett et al., 2012) notes that the quality of existing studies has not always been consistent, especially because they do not necessarily present credible counterfactuals for studied communities. This raises challenges for attributing welfare impacts to changes that cash crop operations create.

Similarly, while studies investigating social impacts of sugarcane and oil palm plantations exist, few can compare the situation of affected households before and after an intervention or attempt to control for bias in selection of their sample, particularly when an aim of the study is to draw attention to poor practices in plantation employment.

[40] http://www.unsystem.org/scn/archives/scnnews03/ch1.htm

[41] Nucleus and outgrower schemes have been popular in the sugarcane and oil palm industries because crops are labour-intensive and need to be transported for processing within a short time period.

As with the biofuel literature, few studies provide clear definitions of the term 'food security'. Where they use it, food security is measured using indicators of nutritional status, food production and land use, but studies do not consistently spell out how these measures affect food security.

4.2 Sugarcane in Sub-Saharan Africa

Sugarcane has long been grown in Southern and Eastern Africa. Most countries in Southern Africa have produced it, given good agro-climatic conditions (Richardson, 2010a). Because of good environmental conditions and cheap labour, African countries are generally among the lowest-cost sugar producers globally (Tyler, 2008). Relative to the largest global sugar producers, most African countries have never developed large sugar or ethanol export volumes (Richardson, 2010a). However, restructuring of the sugar sector, involving several large acquisitions in the late 1990s and 2000s, together with reforms in the European sugar regime and growth in domestic sugar consumption, has seen the expansion of sugarcane production (Tyler, 2008). Two countries in Southern Africa – Malawi and Zimbabwe – have histories of producing molasses-based bioethanol, since 1965 and 1982, respectively (Richardson, 2010a; Shumba et al., 2009).

Most sugar production in Southern African relies on large-scale estates owned by factories. Project owners or development organisations affiliated with the project have also set up outgrower schemes that supply additional feedstock to the factory. In general, factories rely on output from their nucleus estates, rather than outgrowers, to meet their minimum processing throughput (Tyler, 2008); however, the level of dependence has fluctuated and outgrowers are playing a more prominent role in areas that previously depended more on nucleus estates (Govereh et al., 1999).

Types of evidence

Despite the importance of plantation estates in Sub-Saharan sugarcane production (Tyler, 2008), much of the evidence has focused on the impacts of outgrower schemes (Smalley, 2013). This may be because of growing reliance on outgrowers for sugar production (Govereh et al., 1999), and because of expectations that involving farmers' outgrower models can raise living standards. The literature on working conditions on sugarcane plantations is small; only one study in recent years (Hermann et al., forthcoming) was found to provide a detailed investigation into conditions of plantation employees.

Key findings

Outgrowers

Only one study investigated food consumption, by looking at the relationship between sugarcane production and nutrition (Kennedy and Cogill, 1987). A small number of studies also considered changes in agricultural production and land. Otherwise, studies look at the effects on incomes, poverty or labour conditions. With the exception of one paper on Zimbabwe (Mutopo and Manase, 2012), all of the studies look at companies that have already been operating for a long period, and not at effects of the initial stage of land transfer and clearance.

Studies of the impacts of sugarcane production show **widely differing impacts on determinants of local communities' food security.** In nucleus-outgrower models in Western Kenya, sugarcane production has provided questionable income benefits over the long run, and there is some evidence of lower food production and loss of diversity where farmers have specialised in cane production (Wafula Netondo et al., 2010). On the other hand, sugarcane outgrowers in Zambia and Malawi have generally profited from production.

Food consumption

Kennedy and Cogill, 1987) is the only study that looks at food consumption and nutritional outcomes, discussing participants in a sugarcane outgrower scheme in Kenya. Using a longitudinal design that compared cane growers with non-growers, the authors found that households that grew sugarcane had higher incomes than non-growers and slightly better nutrition, measured in caloric intake. Pre-schoolers in sugarcane growing households also had slightly higher nutrition levels, although much of the nutritional status of household members – especially children – was explained by health and sanitation rather than differences in income.

Food production

Several studies look at how much food production is foregone as a result of sugarcane production, and how critical this is for household food security (pathways *A1-A5* in Table 1), with mixed results. In Kenya, Wegulo and Obulinji (1999) found sugarcane accounted for 15% of land use in the Mumias catchment area, and over 50% of land that outgrowers planted. More recently, Wafula Netondo et al. (2010) found growth in sugarcane planting in the same area had come at the expense of crop diversity as the quantity of traditionally grown crops, including staples, had declined.[42] Unfortunately, the authors do not provide information on households that have no involvement with sugarcane to serve as a comparison.

In terms of positive spillovers, Strasberg et al. 1998 (cited in Govereh et al., 1999) found households participating in sugarcane outgrower schemes (including the Mumias outgrower scheme) had access to more agricultural inputs than non-participants and applied more of these (especially fertilisers) to food crops than non-participants did (*A3* and *A4* in Table 1).

A recurrent feature of outgrower schemes in the literature has been the attempt to safeguard food production by providing dedicated areas of land for food production, or stipulating that households retain a percentage of land for food production. The success of these appears mixed: Jelsma et al. (2010) find that some Mozambican outgrowers wanted to plant their full acreage to sugarcane and refused to set aside land for food production. Tyler (2008) notes that outgrowers in Kaleya, Zambia, were not permitted to grow food crops on their irrigated land (which was reserved for cane production); however, the high incomes earned by outgrowers (see below) indicates this is unlikely to be a problem.

Incomes and spending

How well households have fared economically through participation in outgrower schemes (*B3* in Table 1) varies widely by country, by prevailing wealth levels in communities and by the contractual conditions outgrowers are bound to. However, impacts appear to be broadly positive.

Even within a country, impacts of sugarcane growing have been varied. In a study conducted in the late 1990s of sugarcane production in the Mumias catchment, Wegulo and Obulinji (1999) noted that farmers earned 79% of their income from sugarcane. Kennedy and Cogill, 1987study in South Nyanza found that incomes for cane growers were higher than for non-growers; however, no other Kenyan studies compare conditions of participants with non-participants.

However, a series of other studies from Kenya (KESREF, 2006; Wafula Netondo et al., 2010; Waswa et al., 2009; 2012) highlight some concerns about the sharing of sugar revenue between factories and sugarcane outgrowers. Waswa et al. (2012) felt the sugar companies in the Nzoia and Mumias sugar belts deducted unjustifiably high amounts from cane growers' gross revenue. As such, while global sugar prices rose gradually over the years,[43] farmers' incomes did not grow at the same pace.[44] However, it is unclear that other livelihood opportunities available to households provide better incomes.

On the other side of the spectrum, Shumba et al. (2011) found that the 161 sugarcane producers in the Kaleya Smallholder Company (attached to the Nakambala estate in Zambia) earned high incomes from producing sugar cane. The average net income per outgrower was $11,700 per year, which was well above Zambia's minimum wage, and comparable with management positions in other sectors. High yields (110 tonnes per hectare) and incomes were ascribed to the high levels of skill among outgrowers, many of whom had participated in six-month training courses organised by the Kaleya Smallholder Company Limited prior to being allocated plots (Shumba et al., 2011).

[42] Staple and other food crops that have seen declines in production include maize, cassava, sorghum, sweet potatoes and bananas, finger millet, millet and Bambara groundnuts

[43] This price rise has recently been reversed, with global sugar prices falling since their peak in 2011.

[44] The authors have some concerns about the robustness of this study as the revenue-sharing agreement was not explained in detail, nor was the basis for the deductions, and the basis for strong conclusions did not always appear present. Yield data presented in the study indicated that cane yields were very low for some farmers, and this may have been more of an influence on net incomes than the revenue-sharing agreement.

Broadly positive findings were also found in outgrower schemes in Tanzania and Malawi. In the Mtibwa outgrower scheme in Tanzania, the proportion of outgrowers living under the minimum wage decreased almost threefold between 1998 and 2006 (Matango, 2006). How much sugarcane production alone is responsible for these gains is unclear. In Malawi, Hermann et al. (forthcoming) also found participants in sugarcane outgrower schemes prospered compared with non-participants. Their findings point to four-to-fivefold increases in per capita income among outgrowers, resulting in a 50% reduction in the poverty headcount. Very few outgrowers were below the nationally defined minimum food- and consumption-based poverty lines, whereas the majority of households who did not participate in outgrowing were. Asset ownership also indicated that participants in the outgrower scheme were better off than plantation workers. Comparisons with other villages indicate that participation in an outgrower scheme results in an increased income of 350%. However, there were some concerns associated with the schemes, as outgrowers feared social conflict over land associated with expansion of schemes.

Plantations

Three studies included in-depth investigations of conditions for workers on sugarcane plantations (Hermann et al., forthcoming; Jackson and Cheater, 1994; Mblinyi and Semakafu, 1995). The studies compared the situation of outgrowers with that of plantation workers.

Food consumption

No studies were found that systematically examined food consumption of plantation workers. However, Mbilinyi and Semakafu's (1995) review of women on Tanzanian sugar plantations notes that under-nutrition was common among plantation workers. The food provided by the plantation companies was not sufficient to sustain female workers' high levels of activity, and wages were too low to purchase supplementary food. According to the Mtibwa plantation doctor, heavy work and poor nutrition were believed to contribute to anaemia and fatigue among pregnant workers, possibly resulting in the observed high levels of involuntary abortions, low birth weight and infant deaths.

Incomes

A study of sugarcane production in the early 1990s in Zimbabwe by Jackson and Cheater (1994) indicated that the incomes and benefits for plantation workers were higher than for farmers who had been resettled in the area and contracted to supply sugarcane. Resettled farmers encountered difficulties in achieving the yields needed for their operations to be financially viable in the first few years because they lacked experience in cane growing. The minimum wages and benefits provided to workers on the plantations (including free housing, power, water, health care and primary schooling) were better than the conditions of nearby outgrowers with 10 hectares of land. Hermann et al. (forthcoming) found that, although sugarcane plantation workers in Malawi did not earn as much income from employment on the sugarcane plantation as outgrowers did from cane production, they nevertheless prospered economically compared with villages where large distances from the plantation meant jobs on the plantation or in outgrowing were not available.

Mbilinyi and Semakafu's (1995) study of female plantation workers in Tanzania since the 1950s found that wages and employment conditions had not improved women's livelihoods substantially. Women received lower wages than men and were hired only on short-term contracts. For the many unmarried female workers with families, incomes were insufficient for family needs.

Box 2: The sugarcane sector in Brazil

Brazil is the world's leading sugar producer and the world's second largest ethanol producer. Its sugarcane for ethanol programmes have been operating for 40 years, and can provide some interesting lessons on the development of the industry. The Brazilian ethanol industry has displayed a high level of organisation both in its ability to respond to challenges of labour issues and mechanisation and in its ability to effectively lobby and attract support from state governments, including gaining priority access to land identified for land distribution programmes (Wilkinson and Herero, 2010). However, because much Brazilian expansion occurred in areas with very low population densities with few conflicting claims to land, there are limited parallels with many countries in Africa that have higher population densities in their sugarcane-producing areas. Important lessons are therefore more likely to come from benefits and risks from employment on sugarcane farms.

Land use

Evidence from Sao Paulo state indicates that sugarcane expansion has displaced cattle pasture and, to a lesser extent, peanut, rice, vegetables and coffee. Beans, maize and poultry have not been displaced (Smeets et al., 2010, cited in Gasparatos et al., 2012; Wilkinson and Herero, 2010). Cattle grazing uses large areas of land in these areas and the evidence indicates that cattle are being stocked in smaller areas under a more intensive rearing system. Sugarcane production has displaced less profitable food crops in Parana state (Wantanabe, 2007, cited in Rathmann et al., 2010.

Employment

The question of whether the sugarcane industry has contributed to the creation of good jobs is contested. Although estimates of the number of people in the sugarcane and downstream industries rose from 680,000 in 2003 to 1.1 million in 2011,[45] growing mechanisation of sugarcane production has meant labour intensity has fallen to 8 workers per 100 hectares.[46] This is lower than the average for all of agriculture, but higher than cattle raising, a viable alternative in Brazil.

Poor employment conditions leading to health issues have been highlighted in studies (e.g. Martinelli and Filoso 2008). However, studies by Balsadi and Borin (2006) and Petti and Fredo (2009), cited in HLPE (2013), found that employment conditions had improved in recent years. Their studies from 1990 to 2005 indicated improvements in earnings and education and showed that the number of formal jobs had increased (in processing and downstream industries). This may owe in part to government incentives – in recent years, credit for sugarcane plantations has become dependent on employers respecting good labour conditions. Other factors include policies aimed at mechanising harvesting, closer monitoring of labour conditions and high-profile prosecutions for breaches of labour law (Wilkinson and Herero, 2010).

Overall rural development – the importance of local sugarcane processing

The contribution of sugarcane to overall rural development has been studied in Sao Paulo state. Martinelli et al. (2011) compare several economic and human development indicators in areas with a sugarcane-based economy with rural areas dominated by other economic activities (cattle rearing) and urban areas. The results of this study showed that areas where sugarcane was both grown and processed scored highly on these indicators, outranking other areas on most indicators, including urban areas.[47] The authors found that the siting of processing facilities close to the production of raw materials was responsible for this relatively high contribution to the economy.

[45] Figures for 2003 from Kojima and Johnson (2005), citing Macedo (2005) and for 2011 from www.Sugarcane.org, citing Ministry of Labour and Employment statistics.

[46] Figures from Sao Paulo state, cited in HLPE (2013).

[47] Wealth distribution was equal across study areas.

4.3 Projects in the oil palm sector in Southeast Asia

Types of evidence

Much of the literature in the oil palm sector focuses on experiences in Indonesia and Malaysia, the two largest producers of palm oil. In Indonesia, the dominant pattern of oil palm expansion since the late 1970s has been through conversion of forested areas on customary or state-owned lands. Although state-owned plantations dominated until the mid-1980s, since then corporation-owned plantations and smallholders have become the largest and second largest producers, respectively (Barlow et al., 2005; Jelsma et al., 2009).

Most expansion of palm oil was through nucleus-outgrower models, comprising large corporations and labourers from heavily populated islands who self-selected into government migration schemes (McCarthy and Cramb, 2009). In Malaysia, the main vehicle for supporting the smallholder sector – the Federal Land Development Authority (FELDA) – provided landless settlers with land, housing and credit in exchange for labour on a block of jointly held land (Vermeulen and Goade, 2006). Policies in both Indonesia and Malaysia support smallholders, with a specific aim that they meet 40% of total production (Sayer at al., 2012).

In general, there is a consensus that oil palm expansion that incorporates smallholders has been a positive driver of rural development because it has created jobs in rural areas as well as generating tax revenues for the government (Obidzinski, 2011; Sayer et al., 2012), but the differing benefit-sharing arrangements under different business models have led to different impacts. Some contractual arrangements between smallholders and companies have resulted in the loss of tenure and detrimental impacts on some gender and social relations (Cramb, 2012, cited in Sayer et al., 2012; McCarthy, 2010).

The more recent establishment of the oil palm industry provides more examples of early impacts on food security than the sugarcane literature does. However, the literature has focused largely on analysing projects that are up and running, and before and after comparisons are not available in many cases. As such, there is little literature that looks at the impacts of project developments in the early stages of implementation.[48] A World Bank Group report investigating impacts of lending in the sector notes that low civil society engagement and top-down processes for plantation establishment meant the contributions of existing natural resources to livelihoods (including food security) was overlooked (CAO, 2008). Recent analysis of environmental impact assessments (EIAs) carried out in advance of projects also found assessors frequently left out food security risks (Colchester and Chao., 2013). As a result, the full livelihood impacts of palm oil production systems in their early establishment phases are not documented in high detail (Bunidarsono et al., 2013; Rist et al., 2010). That said, several studies looked at the impacts of oil palm expansion on the human rights and rights to land of affected communities, especially indigenous communities, and found that unlawful dispossession and conversion of land under community cultivation was common (Colchester and Chaol., 2013; Orth, 2007).

Key findings

Food consumption

Given the focus of the studies, it is unsurprising that few of them investigated the effects on food consumption directly. Jelsma et al. (2009) note that nutritional surveys undertaken in the Ophir smallholder-managed plantation in West Sumatra identified that diets among farmers in the project were better than those in a nearby non-project village. One study of child stunting found this was lower in the project area than in surrounding areas, with the difference attributed to higher income levels and the cultivation of home gardens.

Access to agricultural and foraging land

Documented evidence of the conversion of forest and farming land to oil palm plantations in Indonesia and Malaysia has often highlighted that control over this land has transferred from local communities to companies. Clearance has involved the loss of forest area that is important for foraging food in many communities (Colchester et al., 2006).

[48] McCarthy and Cramb (2009) note that expansion following the 1988 policy shift towards providing credit to cooperatives led to some dispossession of village land from previous owners with inadequate compensation.

In their analysis of oil palm expansion in West Kalimantan, White and White (2012) note that conversion of forest and swidden (shifting cultivation) systems to oil palm has had particularly detrimental effects on women's livelihoods. Destruction of forests has resulted in lost access to an important income source from sales of raw and processed non-timber forest products (NTFPs), as well as access to nearby water sources. Andriani et al. (n.d. also note that deforestation for conversion to oil palm meant time spent collecting forest resources increased, and NTFPs became scarcer. Loss of access to land meant some households lost access to sources of protein from fish because fish stocks fell owing to pollution, and they became more dependent on purchased rice to meet dietary requirements.

In a recent study in Sandakan Malaysia, Nayang Dorwana et al. (2011) note that, although local outgrowers who used to forage food from the forests were unable to use this resource once the land was excised for agriculture, they were able to transition to supplying oil palm to the nucleus company, which compensated for this loss. In this case, sufficient land was available for continued agricultural production,[49] because population density in the study site area was relatively low. However, neighbouring villages that were unable to supply oil palm because of insufficient land experienced negative implications of losing land and water pollution, as households traditionally relied on hunting and fishing for subsistence and incomes.

The transfer of decision making from smallholders to companies over which crops to produce that follows the transfer of land tenure carried the risk that farmers would be unable to produce or buy sufficient food, especially if food prices were high. Barlow et al. (2005) found that restrictions by early Indonesian nucleus estates that prevented outgrowers intercropping food crops with young oil palm stands meant they had only 1 hectare to grow food on, which was not enough to meet household needs. As the immature palm stands did not provide a source of income, farmers were unable to buy in sufficient quantities of food. However, once these restrictions were lifted, and once oil palms had matured, many farmers chose to plant land set aside for food production to oil palm owing to higher income generation from oil palm (ibid.).

Incomes and expenditure

In Sumatra, Rist et al. (2009) found that palm oil contributed 63% of smallholder household incomes, and was an important factor in reducing poverty. Feintrenie et al. (2010) found similar results in Jambi province, Indonesia, where oil palm cultivation was slightly more profitable than the alternative cash crop (rubber) and five times more profitable than rice cultivation. A key determinant of whether smallholders were able to profit from cultivating oil palm came down to how much debt they incurred from the cost of establishing the plantation and ongoing management fees. In cooperatives where the leadership was able to negotiate favourable interest rates on loans and debt repayment conditions, smallholders were able to repay their initial debts quickly and benefited from high incomes.

Also in Jambi, McCarthy (2010) also found that the way that village institutions functioned partly determined outcomes of smallholder schemes. Where village leaders were aware of the increasingly high returns from growing palm oil, they could negotiate better terms with companies running smallholder schemes. As incorporating farmers into schemes involved a contested process of identifying existing claims to land, transferring these to a company and redistributing them once oil palms had been planted, there was scope for dispossession that disproportionately affected disadvantaged groups. Richer and better-connected early migrants gained substantially, as did later migrants who gained employment; poorer groups of existing local farmers fared less well as they were often not incorporated into schemes and could not gain employment on farms of successful oil palm growers.

Andriani et al. (n.d also found positive impacts on incomes in their three study sites, in Kalimantan, West Papua and Papua. They note that, although the majority of employees gave up their former livelihoods, respondents in two sites perceived a net improvement in their livelihoods because employment provided a more regular income flow.

[49] The study does not specify if agricultural production refers to food or non-food crops.

Jelsma et al.'s (2009) review of the Ohir project in West Sumatra[50] indicates that the 2,300 smallholders who jointly manage the project earned higher incomes from engagement in the project than farmers in surrounding areas who were not involved in the project. Many of the smallholders also hired labourers. They ascribe the positive benefits from the project over other nucleus-outgrower production models to various factors, including the sharing of responsibilities that came with establishing a farmers' organisation to manage the project. The self-help groups adopted to manage the project created responsibilities for all smallholders, and generated an incentive for farmers to pressure other farmers to maintain high production standards. This shared responsibility, along with the technical expertise of participants, resulted in higher incomes and kept the project going.

In Riau province, Indonesia, Bunidarsono et al. (2013) found villagers surrounding oil palm plantations received higher incomes than those further away. Of households cultivating oil palm, 18% had increased their incomes by 200-300% within five years of starting cultivation. High palm oil prices during the period of study (up to 2008) led to large profits for households that produced oil palm for longer periods: 35% of households saw income increases of 400-1,300% after 5-10 years, and 45% saw raises in income growth of over 2,200% after 10 years. They also note that the higher incomes from oil palm production were spent locally, with about 84% being spent in the local economy, with multiplier effects for other community members.

In Malaysia, Nayang Dorwana et al. (2011) note that incomes had increased for both plantation workers and smallholder outgrowers supplying the plantation. Although 17% of employees cited a decrease in food security,[51] all but one employee indicated that their livelihoods had improved. This may owe in part to the provision of housing and schooling by the company. For outgrowers, incomes were higher than the national average, driven by high international oil palm prices. Although this exposed them to shocks, no household had been affected in recent years. As in Jelsma et al.'s (2009) study in Indonesia, outgrowers were increasingly employing labourers to do farm work.

However, impacts are not shared evenly across communities: Obidzinski et al. (2011) notes that benefits of palm oil farming accrue to richer, experienced farmers and to migrants, rather than indigenous populations and customary land users. This is because these latter groups are less familiar with oil palm as a crop, and possess neither the technical knowledge nor the skills to secure employment on a plantation (ibid). Andriani et al. (n.d.) note that former landowners and customary groups report negative implications of oil palm production because of a reduction in land owned and changes in livelihoods. Positive impacts came from the facilities constructed for communities and compensation for land loss, but not all households received compensation for land.

[50] The smallholder control aspect of this project was established in the hope that farmers would see greater benefits from their own control of production.

[51] The study indicates that the definition of this is based on the respondents' own perception.

5 Conclusions and recommendations

5.1 Conclusions

The nature of the evidence does not allow us to assess the balance of impacts of biofuel (feedstock) production on local food security and the distribution of those impacts …

While some broad findings can be pulled out of the review, the nature of the literature makes it difficult to compare results across different studies and evaluate the balance and distribution of such impacts, as different studies have a wide range of focus (geographical, crop and target population) and methodologies:

- Not all studies tried to observe food security or observed isolated elements of food security.
- Studies define food security in different ways, with very few adopting a holistic definition of food security that encompasses all four elements of availability, access, utilisation and stability.
- Studies evaluate benefits and losses at different points of a project's lifetime, some looking only at the establishment phase, others analysing impacts of projects far beyond the establishment phase without factoring in initial results. Virtually no studies use longitudinal data to evaluate the before and after effects of a project being implemented over a substantial period of time.
- Counterfactuals are often not used as a starting point, and points of reference for comparisons vary significantly – in some cases, project participants are compared with non-participants in the same area, or with those that live outside the project area, or with national averages for different indicators.

… but there are some important common findings

Our main finding is that there does not appear to be anything substantially different between producing biofuel feedstock and any other commercial crop. It is not necessarily the fact that it is a biofuel feedstock that matters but the production model used; the timing of impact measurement; the profitability of production; and the terms and conditions under which entitlements to land, wages and prices are defined and productivity is raised.

However, this observation must be tempered by the point that the scale and pace of interest in producing biofuels feedstocks have been greater than for many other crops, and projects have often encompassed large areas of greenfield sites (although actual implementation has been far below the level anticipated). The rate of expansion may depend on how well the biofuel industry is organised and how effectively it lobbies to secure subsidies and preferential access to land. The support among national and regional governments enjoyed by the ethanol industry in Brazil and palm oil companies in Indonesia partly explains their rapid expansion. In addition, in the history of farming, large-scale agricultural investments have rarely gone for an untested and unproven crop such as jatropha. Most large-scale investments have focused on sugarcane (for sugar), oil palm, rubber etc., for which there was prior evidence of money to be made and better understanding of the agronomy involved, and hence resulted in fewer failures. This was underpinned by the initial assumption that renewable energy policies in developed countries would create substantial markets for liquid biofuels, which created expectations of potentially high levels of profitability.

Models of production matter …

The literature highlights that both plantations and outgrower schemes are being used to cultivate biofuels, despite earlier warnings that plantations would dominate.[52]

- The effects on food security of feedstock production or longer-standing sugarcane and oil palm production under outgrower scheme have been broadly positive. However, for some outgrower schemes, the effects of biofuels projects are sometimes negligible, as biofuel feedstock cultivation is dwarfed by other activities in smallholders' livelihood portfolios, particularly in the case of jatropha.

- At the establishment phase, large-scale plantations present a high risk to the food security of local communities, as access to land for those communities for foraging and food production is often reduced.

- Over time, benefits provided by plantations may improve livelihoods of employees. However, as not all households are able to secure employment, benefits are not equally distributed, and some households affected by the project invariably lose out.

… and so do contractual terms in those models

The structure of benefit-sharing arrangements between companies and outgrowers and the consequent division of revenue determine how much income farmers have earned from growing biofuel feedstocks (or sugarcane and oil palm for other ends) in the studies that highlight this. Because companies relying on outgrowers are regularly in a monopsonistic position (i.e. they are the only buyers that outgrowers can sell to and thus have strong market power), how much they charge for services and pay for goods is likely to determine how much outgrowers benefit from the relationship. Outgrowers with small landholdings may benefit less than large landholders if they have to pay the same price for goods and services despite having lower output.

Contractual terms may also determine the other crops outgrowers can produce and whether they can intercrop food crops with biofuel feedstocks. In the case of Indonesia's longer-standing experience with oil palm, the company's original restrictions on intercropping food crops with young oil palm stands negatively affected farmers' food availability (production) and access as the immature palm stands did not produce sufficient income to buy in food.

Much depends on having a profitable business

When we look at sugarcane and oil palm – the only cases where we can see what has happened with sufficient time to see outcomes – the results are often positive for outgrowers and estate workers, because returns to cane for sugar production and oil palm are high, compared with a crop such as jatropha, which has proved unprofitable. Whether these higher incomes are transformed into higher levels of food consumption and better nutrition is less clear.

Borras et al. (2012) note that the flexibility enjoyed by sugarcane, palm oil and soy producers (so-called 'flex crops') to supply biofuel, food and other markets diminishes the risk associated with a price slump in any one market, and suggest this has contributed to the rapid expansion of biofuel crops in Latin America. Whether better earnings and outcomes can be associated with flex crops as compared with other crops depends on different factors (such as the presence of local processing plants and location and size of different markets) and needs further analysis.

This has several implications for thinking about biofuel production:

- In the history of farming, large-scale agricultural investments have rarely gone for an untested and unproven crop such as jatropha. Most large-scale investments focus on sugarcane for sugar, oil

[52] It is possible that this is because outgrower models have been around longer (e.g. as early development projects promoting biofuels), or that plantations have not been subject to research efforts.

palm, rubber etc. for which there was prior evidence of money to be made, and some understanding of the agronomy involved.

- An uncertain market environment for biofuels could undermine profitability and have a knock-on effect on local food security. Investment in sugar production in Africa has been done on the back of access to protected, high priced markets, such as the EU (for Sugar Protocol signatories and least-developed countries) or large (protected) domestic markets, such as Nigeria. Oil palm faces expanding demand in the vegetable oil market with the flexibility to switch between the edible oil and biodiesel markets. However, creating a stable and profitable market for biofuels may contribute to other negative impacts on food security.

The way land is made available for projects is crucial

- The experience of outgrowers in the studies reviewed here implied there was not much of a shift of existing land to biofuels. Rather, the studies found that farmers opened up new land for biofuels and companies sometimes played a part in this by making equipment available to prepare land that would otherwise not be possible to cultivate.

- This depended on additional land being available for cultivation. Where it was, outgrowers were able to cultivate new land and supply the nucleus estate (as happened in Indonesia after the establishment of an oil palm estate). However, distribution of impacts can be very uneven: other villages in the project area with less land suffered because they could not meet both the company's needs for feedstock and their own needs for food.. Where incorporation into smallholder schemes includes transferring and reallocating land, poorer and disadvantaged groups can lose out by giving up more land than they are reallocated.

- Longer-term efforts to safeguard food production were reviewed in some studies that looked at the experience with sugarcane, either through the company providing areas of land dedicated to food production or through households retaining a certain proportion of their own land for food production. These had mixed results.

- However, when people lost land for foraging and food production to plantations with no or insufficient compensation or poorly implemented land transfers, they suffered. Compensation, even when it could and should be paid, was not always paid to at least some of the losers.

Women are more vulnerable to the negative impacts on food security

- Women are often among the greatest losers when plantations are established, and there was evidence in some studies that women's livelihoods were particularly badly affected by the conversion of forest and swidden systems to oil palm or jatropha. While not analysed by the studies reviewed, longstanding literature shows women can lose out even under outgrower systems if only men are registered as the landholders.

- Again, although the information was not a major part of the studies on food security reviewed here, where this was highlighted the findings on wage income and employment conditions confirmed the wider literature that women received lower wages than men and were usually hired only on short-term contracts.

Yields can improve

While there was very little information on the impact of biofuel feedstock production on yields, one study showed yields had increased owing to better fertiliser access through the contract farming scheme. Longer-standing sugarcane outgrower schemes showed outgrowers could obtain more access to fertiliser through companies and applied more to food crops, boosting yields.

5.2 Recommendations

Improving the evidence base

Several recommendations emerge from this review in terms of improving the evidence base that is available to assess the impacts on food security of biofuel feedstock production:

- Analysis of impacts on food security would benefit from a more comprehensive and consistent analytical framework that would allow analysts to assess the balance and distribution of different impacts.
- Such analysis would also need more consistent use of counterfactuals and selection of control groups or comparison points, for example villages in the project area and outside the project area.
- While case studies are useful in getting more in-depth analysis of impacts, more data from baseline surveys and longitudinal studies would provide better information on before-and-after impacts of biofuels projects, as well as allowing for the analysis of different impacts that emerge over time.

Improving project design

Drawing on the findings in the studies reviewed, some recommendations can be made on project design:

- In outgrower schemes, there is little to be lost and plenty to be gained from allowing growers to have as much control over their land as possible as far as this does not conflict with the overall business. Allowing outgrowers to intercrop the cash crop with food crops or allowing them to use inputs supplied for the cash crops on other crops – or simply deliberately supplying these inputs for other crops on credit – makes sense.
- There are clear things to bear in mind in designing outgrower schemes, such as making sure women do not lose land they might have used for a food crop or home garden. The wider literature on gender suggests it is important to compensate women for the loss of gathering opportunities, making sure main crop incomes are not paid just to the men and are paid in regular payments rather than in a single annual payment.
- Given that tree crops take time to mature, some thought and attention need to be paid to what happens in the first few years before the crop is mature.
- Given high risks of plantation establishment, policymakers need to ensure a high degree of vigilance when plantations are being considered. Where there are specific goals associated with plantation development, such as the generation of jobs or local benefits, the sequencing and provision of these needs specific attention to ensure there are no time lags between the point that projects convert fields and forests, and when affected people receive compensation. .
- In outgrower schemes, there may be a case for considering public regulation, at the very least to provide information to outgrowers about best practices on contracts in other countries to reinforce their negotiating power.

Increasing awareness and use of safeguards

Increasing awareness of potential impacts, and having information to assess these, is crucial. This needs to be reinforced with knowledge of safeguards and guiding principles to mitigate against potential negative impacts and boost positive impacts on food security.

Better information for stakeholders in host countries

The findings of the study indicate that, from the point of view of food security, national governments and other stakeholders in countries receiving investment for biofuel production need better information, and greater ability to process that information, before committing large areas of land to biofuel feedstocks and/or involving outgrowers who are less able to bear market risks. This includes information on:

- Markets for biofuels – the projected level and stability of prices and demand over the short, medium and longer term;

- The different crops for biofuel feedstocks – their track record on agricultural and industrial productivity in different contexts, and their social and environmental impacts.

Local communities in areas of biofuel projects need greater information on their land tenure/use rights, and the implications of project for access to land and productivity of that land and longer-term impacts on income and access to markets.

Safeguards and guiding principles

Several points of reference exist that could be used to safeguard food security, or at least key elements that affect food security:

- Related to broader issues of how land is made available for biofuels projects, the most prominent set of guidelines for land governance are the FAO *Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security* (VGGTs), endorsed by the UN Committee on World Food Security (CFS) in May 2012 (FAO, 2012). These aim to promote sustainable social and economic development that can help eradicate poverty and food insecurity with a particular focus on smallholders (Clause 12.3). The VGGTs lay out the principles according to which governments should operate, advising on the laws, procedures and tools available to ensure land tenure reflects concerns over security and equitable distribution.

  Specific to biofuels, a number of organisations and institutions have developed guidance for different stakeholders involved in the biofuels sector, which provide practical guidance on the steps that need to be taken to safeguard the food security of local populations when developing biofuel projects. Guidance provided by the Roundtable on Sustainable Biomaterials and the FAO's BEFS project are useful in this respect. These should be used as a checklist for assessing the potential risks associated with individual projects.

References

ActionAid (2011) 'Fuelling Evictions. Community Costs of the EU Biofuels Boom. Dakatcha Woodlands, Kenya'. London: ActionAid.

ActionAid (2012) 'Biofuelling the Global Food Crisis: Why the EU Must Act at the G20'. London: ActionAid.

ActionAid (2013a) 'Broken Promises. The Impacts of Addax Bioenergy in Sierra Leone on Hunger and Livelihoods'. London: ActionAid.

ActionAid (2013b) 'Actionaid Expose: European Commission Fails to Respect Lisbon Treaty'. London: ActionAid.

Addax Bioenergy (2013) 'Open Letter to ActionAid'. 2 September 2013, www.pangealink.or g/addax-bioenergy-open-letter-to-action-aid/

Andriani, R., Andrianto, A., Komarudin, H. and Obidzinski, K. (n.d.) 'Environmental and Social Impacts from Palm-based Biofuel Development in Indonesia'.

Ariza-Montobbio, P and Lele, S. (2010) 'Jatropha Plantations for Biodiesel in Tamil Nadu, India: Viability, Livelihood Trade-offs, and Latent Conflict'. *Ecological Economics* 70(2): 189-195.

Arndt, C., R. Benfica, F. Tarp, J. Thurlow, and R. Uaiene (2009) 'Biofuels, poverty, and growth: A computable general equilibrium analysis of Mozambique'. Environmental and Development Economics 15: 81–105. Cambridge University Press.

Babcock, B. (2011) 'The Impact of US Biofuels Policies of Agricultural Price Levels and Volatility'. Geneva: ICTSD.

Banse, M., H. van Meijl, A. Tabeau, and G. Woltjer (2008). 'Will EU biofuel policies affect global agricultural markets?' European Review of Agricultural Economics 35:117–141.

Balachandaran, L., Herb, E., Shahbano, T. and O'Reilly, E. (2012) 'Everyone Must Eat? Liberia, Food Security and Palm Oil'. International Conference on Global Land Grabbing II, Ithaca, NY, 17-19 October.

Barlow, C., Zen, Z. and Gondowarsito, R. (2005) 'Estates and Smallholdings in Indonesian Palm Oil Production: Performance and Prospects'. Canberra: International Oil Palm Study Group.

Barrett, C., Bachke, M.E., Bellemare, M.F., Michelson, H.C., Narayanan S. and Walker, T.F. (2012) 'Smallholder Participation in Contract Farming: Comparative Evidence from Five Countries'. *World Development* 40(4): 715-730.

Baxter, J. and Schaefter, E. (2013) 'Who Is Benefitting? The Social and Economic Impact of Three Large-scale Land Investments in Sierra Leone: A Cost-benefit Analysis'. Report for Action for Large-scale Land Acquisition Transparency.

Beall, E. (2012) 'Smallholders in Global Bioenergy Value Chains and Certification: Evidence from Three Case Studies'. Rome: FAO.

Beall, E., Cadoni, P. and Rossi, A. (2012) 'A Compilation of Tools and Methodologies to Assess the Sustainability of Modern Bioenergy'. Rome: FAO.

BEFS (2010) 'Bioenergy and Food Security. The BEFS Analysis for Tanzania'. Edited by: Irini Maltsoglou and Yasmeen Khwaja. Available online at: http://www.fao.org/docrep/012/i1544e/i1544e.pdf

Boamah, F. (2010) 'Competition between Biofuel and Food? The Case of a Jatropha Biodiesel Project and Its Effects on Food Security in the Affected Communities in Northern Ghana'. Masters Thesis, University of Bergen.

Boamah, F. (2011) 'Competition between Biofuel and Food? Re-thinking Biofuel Narratives, Evidence from a Jatropha Biodiesel Project in Northern Ghana', in P. Matondi, K. Håvnevik and A. Beyene (eds) *Biofuels, Land Grabbing and Food Security in Africa*. Africa Now Series. London: Zed Books.

Borras, J., Franco, K., Gomez, S. and Kay, C. (2012) 'Land Grabbing in Latin America and the Caribbean'. *Journal of Peasant Studies* 39(3-4): 845-872.

Bunidarsono, S., Susanti, A. and Zoomers, A. (2013) 'Oil Palm Plantations in Indonesia: The Implications for Migration, Settlement/Resettlement and Local Economic Development', in Z. Fang (ed.) *Biofuels – Economy, Environment and Sustainability*. New York: InTech.
CAO (Office of the Compliance Advisor/Ombudsman) (2009) 'CAO Audit of IFC's Investments in Wilmar Trading, Delta-Wilmar CIS, Wilmar WCap and Delta-Wilmar CIS Expansion'. Washington, DC: CAO.
CFS (Committee on World Food Security) (2012) 'Coming to Terms with Terminology: Food Security, Nutrition Security, Food Security and Nutrition, Food and Nutrition Security'. Revised Draft. Rome: FAO.
Channing, A., Benfica, R., Tarp, F., Thurlow, J. and Uaiene, R. (2009) 'Biofuels, Poverty, and Growth: A Computable General Equilibrium Analysis of Mozambique'. International Association of Agricultural Economists Conference, Beijing, 16-22 August.
Clancy, J. (2013) *Biofuels and Rural Poverty*. London: Routledge.
Colchester, M. and Chao, S. (2013) 'Conflict or Consent: The Oil Palm Sector at a Crossroads'. Forest Peoples Programme, Sawit Watch and TUK Indonesia.
Colchester, M. et al. (2006) 'Promised Land. Palm Oil and Land Acquisition in Indonesia: Implications for Local Communities and Indigenous Peoples'. Forest Peoples Programme and Sawit Watch.
Cotula, L., Dyer, N. and Vermeulen, S. (2008) 'Fuelling Exclusion? The Biofuels Boom and Poor People's Access to Land'. London: IIED.
Diaz-Chavez, R.A., Mutimba, S., Watson, H., Rodriguez-Sanchez, S. and Nguer, M. (2010) 'Mapping Food and Bioenergy in Africa. Report for FARA. Accra: Forum for Agricultural Research in Africa.
DEFRA (Department for Environment, Food and Rural Affairs) (2012) 'Can Biofuels Policy Work for Food Security? Draft Discussion Paper. London: DEFRA.
Deininger, K. and Byerlee, D. (2012) 'The Rise of Large Farms in Land Abundant Countries: Do They Have a Future? *World Development* 40(4): 701-714.
De Gorter, H. and Just, D.R. (2010) 'The Social Costs and Benefits of Biofuels: The Intersection of Environmental, Energy and Agricultural Policy'. *Applied Economic Perspectives and Policy* 32(1): 4-32.
De Waal, A. (1989) *Famine that Kills: Darfur, Sudan, 1984-1985*. Oxford: Oxford University Press.
DFID (Department for International Development) (1999) 'Sustainable Livelihoods Guidance Sheets'. London: DFID.
Dyer, J., Stringer, L. and Dougill, A. (2010) 'Jatropha Curcas: Sowing Local Seeds of Success in Malawi'. *Journal of Arid Environments* 79: 107-110.
Ecofys (2013) 'Renewable Energy Progress and Biofuels Sustainability'. Report for the European Commission.
Ehrensperger, A., Kiteme, B., Portner, B. and Grimm, O. (2012) 'Impacts of Jatropha Curcas on Local Food Security in Kenya', in IFSA *Building a Sustainable Rural Future. Proceedings of the 10th European IFSA Symposium*, Aarhaus, 1-4 July.
Ehrensperger, A., Negussie, A., Kiteme, B., Grimm, O., Lyimo, R. and Birech, R. (2013) 'Biofuels: Possible Impacts on Food Security in Kenya'. Jatropha Facts 5. ERA-ARD.
Elbehri, A. Segerstedt, A. and Liu, P. (2013) 'Biofuels and the Sustainability Challenge: A Global Assessment of Sustainability Issues, Trends and Policies for Biofuels and Related Feedstocks'. Rome: FAO.
EC (European Commission) (2009) 'The Promotion of the Use of Energy from Renewable Sources and Amending and Subsequently Repealing Directives 2001/77/EC and 2003/30/EC'. Directive 2009/28/EC of the European Parliament and of the Council, 23 April.
FAO (Food and Agricultural Organization) (1996). World Food Summit, Rome 1996. View details at: http://www.fao.org/wfs/index_en.htm
FAO (2008) *The State of Food and Agriculture 2008. Biofuels: Prospects, Risks and Opportunities*. Rome: FAO.
FAO (2012) 'Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security'. Rome: FAO.
Favretto, N., Stringer, L.C. and Dougill, A.J. (2013) 'Unpacking Livelihood Challenges and Opportunities in Energy Crop Cultivation: Perspectives on Jatropha Curcas Projects in Mali'. Sustainability Research Institute Paper 45. Leeds: University of Leeds.
Fenger, W. and Owegi, F. (2012) 'Sweeting Kenya's Future – The Challenge of the Sugar Industry'. World Bank Blog, http://blogs.worldbank.org/africacan/ sweetening-kenya-s-future-the-challenges-of-the-sugar-industry

Feintrenie, L., Schwarze, S. and Levang P. (2010) 'Are Local People Conservationists? Analysis of Transition Dynamics from Agroforests to Monoculture Plantations in Indonesia'. *Ecology and Society* 15(4): 37.
FIAN (2010) 'Land grabbing in Kenya and Mozambique'. Heidelberg, Germany: FIAN
Finco, M. and Doppler, W. (2010) 'Bioenergy and Sustainable Development: The Dilemma of Food Security and Climate Change in the Brazilian Savannah'. *Energy for Sustainable Development* 14: 194-199.
Gasparatos, A., Lee, L.Y., von Maltitz, G., Mathai, M.V., Puppim de Oliveira, J.A. and Willis, K.J. (2012) 'Biofuels in Africa: Impacts on Ecosystem Services, Biodiversity and Human Well-being'. Policy Report. Yokohama: UNU-IAS
GBEP (2011) 'The Global Bioenergy Partnership Sustainability Indicators for Bioenergy' Rome: FAO
German, L. and Schoneveld, G. (2011) 'Social Sustainability of EU-approved Voluntary Schemes for Biofuels: Implications for Rural Livelihoods'. Working Paper 75. Bogor: CIFOR.
German, L., Schoneveld, G.C and Gumbo, D. (2011a) 'The Local Social and Environmental Impacts of Smallholder-based Biofuel Investments in Zambia'. *Ecology and Society* 16(4): 12.
German, L., Schoneveld, G.C. and Pacheco, P. (2011b) 'The Social and Environmental Impacts of Biofuel Feedstock Cultivation: Evidence from Multi-site Research in the Forest Frontier'. *Ecology and Society* 16(3): 24.
Gordon-Maclean, A, Laizer, J., Harrison. P.J. and Shemdoe, R. (2008) 'Biofuel Industry Study, Tanzania'. Dar es Salaam: WWF.
Govereh, J., Jayne, T.S. and Nyoro, J. (1999) 'Smallholder Commercialization, Interlinked Markets and Food Crop Productivity: Cross-country Evidence in Eastern and Southern Africa'. Lansing, MI: University of Michigan.
Grimm, O. (2012) 'Understanding Spatial Patterns of Food Insecurity in Kenya as a Contribution to Sustainable Rural Development Policies'. MSc Thesis, University of Bern.
Grimsby. L., Aune, J. and Johnsen, F. (2012) 'Human Energy Requirements in Jatropha Oil Production for Rural Electrification in Tanzania'. *Energy for Sustainable Development* 16: 297-302.
Hall, R. and Paradza, G. (2012) 'Pressures on Land in Sub-Saharan Africa: Social Differentiation and Societal Responses'. Background Paper for the European Report on Development.
Havnevik, K., Haaland, H. and Abdallah, J. (2011) 'Biofuel, Land and Environmental Issues: The Case of SEKAB's Biofuel Plans in Tanzania'. Final Report.
Helming, J.F.M, Pronk, A. and Woltjer, G. (2010) 'Stabilisation of the Grain Market by Flexible Use of Grain for Bioethanol'. LEI Report 2010-039. Wageninen: Wageninen University.
Hermann, R., Grote, U. and Brüntrup, M. (forthcoming) 'Household Welfare Outcomes of Large-scale Agricultural Investments: Insights from Sugarcane Outgrower Schemes and Estate Employment in Malawi'.
HLPE (High Level Panel of Experts on Food Security and Nutrition) (2013) 'Biofuels and Food Security'. Rome: FAO, Committee on World Food Security.
Hodbod, J. and Tomei, J. (2013) 'Demystifying the Social Impacts of Biofuels at Local Levels: Where Is the Evidence?' *Geography Compass* 7(7): 478-488.
Hought, J. et al. (2012) 'Biofuels, Land Use Change and Smallholder Livelihoods: A Case Study from Banteay Chhmar, Cambodia'. *Applied Geography* 34: 525-532.
Hunsberger, C. (2010) 'The Politics of *Jatropha*-based Biofuels in Kenya: Convergence and Divergence among NGOs, Donors, Government Officials and Farmers'. *Journal of Peasant Studies* 37(4): 365-389.
IF Campaign, 2013. http://enoughfoodif.org/
Jackson, J. and Cheater, A. (1994) 'Contract Farming in Zimbabwe: Case Studies of Sugar, Tea and Cotton', in P.D. Little and M. Watts (eds) *Living Under Contract: Contract Farming and Agrarian Transformation in Sub-Saharan Africa*. Madison, WI: University of Wisconsin Press.
Jelsma, I., Giller, K. and Fairhurst, T. (2009) 'Smallholder Oil Palm Production Systems in Indonesia: Lessons Learned from the NESP Ophir Project'. Report for Shell Global Solutions International.
Jelsma I., Bolding A. and Slingerland M. (2010) 'Smallholder Sugarcane Production in Xinvane, Mozambique – Report from the Field'. Wageninen: Wageninen University.
Kennedy, E.T. and Cogill, B. (1987) 'Income and Nutritional Effects of the Commercialization of Agriculture in Southwestern Kenya'. Research Report 63. Washington, DC: IFPRI.
KESREF (Kenya Sugar Research Foundation) (2006) 'Technical Bulletin 1'. Nairobi: KESREF.

Kojima, M. and Johnson, T. (2005) 'Potential for Biofuels for Transport in Developing Countries'. Washington, DC: ESMAP, World Bank.
Kropiwnicka, M. (2013) 'The European Commission's Renewable Energy Progress and Biofuels Sustainability Reports 2013: A Critical Analysis of the Coverage of Land Rights and Socio Economic Impacts'. Briefing for ActionAid.
Locke, A. and Henley, G. (2013) 'Scoping report on biofuels projects in five developing countries'. London: ODI
Loos, P. (2008) 'Socio-economic Impact of a Jatropha-Project on Smallholder Farmers in Mpanda, Tanzania'. Masters Thesis, University of Hohenheim.
Lyimo, R. (2010) 'Jatropha Curcas Cultivation and Its Impact on Land Use and Land Cover Change in Monduli and Mpanda Districts, Tanzania'. MSc Thesis, Sokoine University.
Kalumiana, O.S. (2009) 'Bioenergy Policy Implementation in Zambia'. COMPETE Policy Conference, Lusaka, May 26-28.
Matango, R. (2006) 'Mtibwa Outgrowers Scheme: A Model for Small Holder Cane Production in Tanzania'. UNCTAD Expert Meeting on Enabling Small Commodity Producers in Developing Countries to Reach Global Markets, Geneva, 11-13 December.
Maltosoglu, I. and Dawe, D. (2010) 'Household Level Food Security and Vulnerability', in I. Maltsoglu and Y. Khwaja *The BEFS Analysis for Tanzania. The Bioenergy and Food Security Project*. Rome: FAO
Martinelli, L. A., & Filoso, S. (2008). Expansion of sugarcane ethanol production in Brazil: environmental and social challenges. *Ecological Applications*, *18*(4), 885-898.
Martinelli, L. A., Garrett, R., Ferraz, S., & Naylor, R. (2011). Sugar and ethanol production as a rural development strategy in Brazil: Evidence from the state of São Paulo. *Agricultural systems*, *104*(5), 419-428.
Maxwell, D.G. (1996) 'Measuring Food Insecurity: The Frequency and Severity of "Coping Strategies"'. *Food Policy* 21(3): 291-303.
Mbilinyi, M. and Semakafu A.M.1995. Gender and Employment in Sugarcane Plantations in Tanzania. Sectoral and Working Discussion Papers, SAP, 2.44/WP.85. Geneva: International Labour Organisation.
Mitchell, A. (2008) 'The Implications of Smallholder Cultivation of the Biofuel Crop, Jatropha Curcas, for Local Food Security and Socioeconomic Development in Northern Tanzania'. MSc Thesis, University College London.
McCarthy, J. (2010) 'Processes of Inclusion and Adverse Incorporation: Oil Palm and Agrarian Change in Sumatra, Indonesia'. *Journal of Peasant Studies* 37(4): 821-850.
McCarthy, J. and Cramb, R. (2009) 'Policy Narratives, Landholder Engagement and Oil Palm Expansion on the Malaysian and Indonesian Frontiers'. *The Geographical Journal* 175(2): 112-123.
Muys, B. et al. (2013) 'Integrating Mitigation and Adaptation into Development: The Case of Jatropha Curcas in Sub-Saharan Africa'. Editorial. *Global Change Biology*.
Mutopo, P. and Manase, C. (2012) 'Large Scale Land Deals, Global Capital and the Politics of Livelihoods: Experiences of Women Smallholder Farmers in Chisumbanje, Zimbabwe'. International Conference on Global Land Grabbing II, Ithaca, NY, 17-19 October.
Nayang Dorwana, A. et al (2011) 'The Local Impacts of Oil Palm Expansion in Malaysia: An Assessment Based on a Case Study in Sabah State'. Working Paper 78. Bogor: CIFOR.
Negash M. and Swinnen J. (2012) 'Biofuels and Food Security: Micro-evidence from Ethiopia'. LICOS Discussion Paper 319/2012. Rome: FAO.
Nyberg, J. and Raney, T. (2007) 'Bioenergy and Food Security – A Concept Note'. Rome: FAO.
Oakland Institute (2012) 'Understanding Land Investments in Africa. Tanzanian Villagers Pay for Sun Biofuels Investment Disaster'. Land Deal Brief. Oakland, CA: Oakland Institute.
Obidzinski, K., Andriani, R., Komarudin, H. and Andrainto, A. (2011) 'Environmental and Social Impacts of Oil Palm Plantations and Their Implications for Biofuel Production in Indonesia'. *Ecology and Society* 16(3): 24.
Orth, M. (2007) 'Subsistence Foods to Export Goods. The Impact of an Oil Palm Plantation on Local Food Sovereignty. North Barito, Central Kalimantan, Indonesia [Monograph]'. London: Biofuelwatch.
Oya, C. (2013) 'Methodological Reflections on "Land Grab" Databases and the "Land Grab" Literature Rush'. *Journal of Peasant Studies* 40(3): 503-520.
Pangea (2013) 'Myths and Facts about Bioenergy in Africa', www.jatropha.pro/PDF% 20bestanden/Myths-vs-Facts-Proof-web.pdf

Peters, F. (2009) 'Socio-economic Impact Study of Biofuel Plantation on Farm Households in Mozambique'. MSc Thesis, Wageningen University.
Rathmann, R., Szklo, A. and Schaeffer, R. (2010) 'Land Use Competition for Production of Food and Liquid Biofuels: An Analysis of the Arguments in the Current Debate'. *Renewable Energy* 35: 14-22.
Richardson, B. (2010a) 'Sugar Cane in Southern Africa: A Sweeter Deal for the Rural Poor'. Oullins: Ethical Sugar.
Richardson, B. (2010b) 'Big Sugar in Southern Africa: Rural Development and the Perverted Potential of Sugar/Ethanol Exports'. *Journal of Peasant Studies* 37(4): 917-938.
Rist, L., Feintrenie, L. and Levang, P. (2010) 'The Livelihood Impacts of Oil Palm: Smallholders in Indonesia'. *Biodiversity Conservation* 19: 1009-1024.
Rogers, B.L. (2002) 'Health and Economic Consequence of Malnutrition'. Background Paper, World Bank/UNICEF Nutrition Assessment.
Rossi, A. and Lambrou, Y. (2008) 'Gender and Equity Issues in Liquid Biofuels Production. Minimizing the Risks to Maximize the Opportunities'. Rome: FAO.
Sayer, J., Ghazoul, J., Nelson, P. and Boedhihartono, A. (2012) 'Oil Palm Expansion Transforms Tropical Landscapes and Livelihoods'. *Global Food Security* 1(2): 114-119.
Schoneveld, G.C., German, L. and Nutakor, E. (2011) 'Land-based Investment for Rural Development? A Grounded Analysis of Local Impacts of Biofuel Feedstock Plantations in Ghana'. *Ecology and Society* 16(4): 10.
Schut, M. and Florin, M.J. (forthcoming) 'The Policy and Practice of Sustainable Biofuels: Between Global Frameworks and Local Heterogeneity. The Case of Food Security in Mozambique'.
Sen, A.K. (1981) *Poverty and Famines: An Essay on Entitlement and Deprivation*. Oxford: Clarendon.
Shumba, E., Roberntz, P. and Kuona, M. (2011) 'Assessment of Sugarcane Outgrower Schemes for Biofuel Production in Zambia and Zimbabwe'. Harare: WWF.
Skutsch, M., et al. (2011) 'Jatropha in Mexico: Environmental and Social Impacts of an Incipient Biofuel Program'. *Ecology and Society* 16(4): 11.
Smalley, R. (2013) 'Plantations, Contract Farming and Commercial Farming Areas in Africa: A Comparative Review'. Working Paper 055. Cape Town/Brighton: FAC.
Smeets, E., Faaij, A.P.C. and Lewandowski, I. (2007) 'A Quickscan of Global Bio-energy Potentials to 2050: An Analysis of the Regional Availability of Biomass Resources for Export in Relation to Underlying Factors'. Utrecht: Copernicus Institute, Utrecht University.
Sulle, E. and Nelson, F. (2009) 'Biofuels, Land Access and Rural Livelihoods in Tanzania'. London: IIED.
Tanner, C. (2013) 'Large-scale Land Acquisition and Food Security: Evidence on Demand'. Helpdesk Report.
Teman, S. (2010) 'Effects of Biofuel Production on Farmers' Livelihoods in Mieso District of West Hararghe Zone, Oromiya Region'. MSc Thesis, Haramaya University.
Thurlow, J. (2010) 'Economy Wide Effects of Bioenergy Developments', in I. Maltsoglu and Y. Khwaja *The BEFS Analysis for Tanzania. The Bioenergy and Food Security Project*. Rome: FAO.
Tyler, G. (2008) 'The African Sugar Industry – A Frustrated Success Story'. Background Paper for the Competitive Commercial Agriculture in Sub-Saharan Africa Study.
UN Energy (2007) 'Sustainable Bioenergy: A Framework for Decision Makers'. www.fao.org/docrep/010/a1094e/a1094e00.htm, accessed 26 July 2010.
UNEP (UN Environment Programme) (2011) *Biofuels Vital Graphics: Powering a Green Economy*. Geneva: UNEP.
Vanwey L. (2008) 'Social and Distributional Impacts of Biofuel Production', in R.W. Howarth and S. Bringezu (eds) (2009) *Biofuels: Environmental Consequences and Interactions with Changing Land Use*. Proceedings of the Scientific Committee on Problems of the Environment International Biofuels Project Rapid Assessment, Gummersback, 2-25 September 2008.
Vermeulen, S. and Goade, N. (2006) 'Towards Better Practice in Smallholder Palm Oil Production'. Natural Resource Issues Series 5. London: IIED.
Von Braun, J. (1995) 'Agricultural Commercialization: Impacts on Income and Nutrition and Implications for Policy'. *Food Policy* 20(3): 197-202.
Wafula Netondo, G., Waswa, F., Maina, L., Naisiko, T., Masayi, N. and Ngaira, J. (2010) 'Agrobiodiversity Endangered by Sugarcane Farming in Mumias and Nzoia Sugarbelts of Western Kenya'. *African Journal of Environmental Science and Technology* 4(7): 437-445.

Waswa, F., Mcharo, M. and Netondo, G. (2009) 'Enhancing Household Food and Income Security through Crop Diversification in the Nzoia and Mumias Sugarbelts in Kenya'. *Journal of Applied Biosciences* 23: 1406-1415.

Waswa, F., Gweyi-Onyango, J.P. and Mcharo, M. (2012) 'Contract Sugarcane Farming and Farmers' Incomes in the Lake Victoria Basin, Kenya'. *Journal of Applied Biosciences* 52: 3685-3695.

Wegulo, F. and Obulinji, H. (1999) 'The Interface between Farm and Non-farm Activities among the Mumias Sugarcane Growers'. Working Paper 524. Brighton: IDS.

WFP (World Food Programme) (2012) 'Monitoring Food Security: Technical Guidance Sheet 2. Indicators Compendium'. Rome: WFP.

White, B. and Dasgupta, A. (2010) 'Agrifuels Capitalism: A View from Political Economy'. *Journal of Peasant Studies* 37(4): 593-607.

White, B., and White, J. (2011) "The gendered politics of dispossession: oil palm expansion in a Dayak Hibun community in West Kalimantan, Indonesia." *International Conference on Global Land Grabbing*. 2011.

Wiggins, S., Fioretti E., Keane J., et al. (2008), Review of the indirect effects of biofuels: Economic benefits and food insecurity, Report to the Renewable Fuels Agency

Wiggins, S., Keane, J., Kennan, J., Leturque, H. and Stevens, C. (2011) 'Biofuels in Eastern Africa: Dangers Yes, but Much Potential as Well'. Project Briefing Paper 66. London: ODI.

Wiggins, S and Keats, S. (2013) Leaping and learning: linking smallholders to markets. London: ODI

Wilkinson, J. and Herero, S. (2010) 'Biofuels in Brazil: Debates and Impacts'. *Journal of Peasant Studies* 37(4): 749-768.

Zen, Z., Barlow, C. and Gondowarsito, R. (2005) 'Oil Palm in Indonesian Socio-Economic Improvement – A Review of Options'. *Oil Palm Industry Economic Journal* 6(1).

Zilberman, D., Hochman G., Rajagopal, D., Sexton, S. and Timilsina, G. (2012) 'The Impact of Biofuels on Commodity Food Prices: Assessment of the Findings'. *American Journal of Agricultural Economics* 95(2): 275-281.

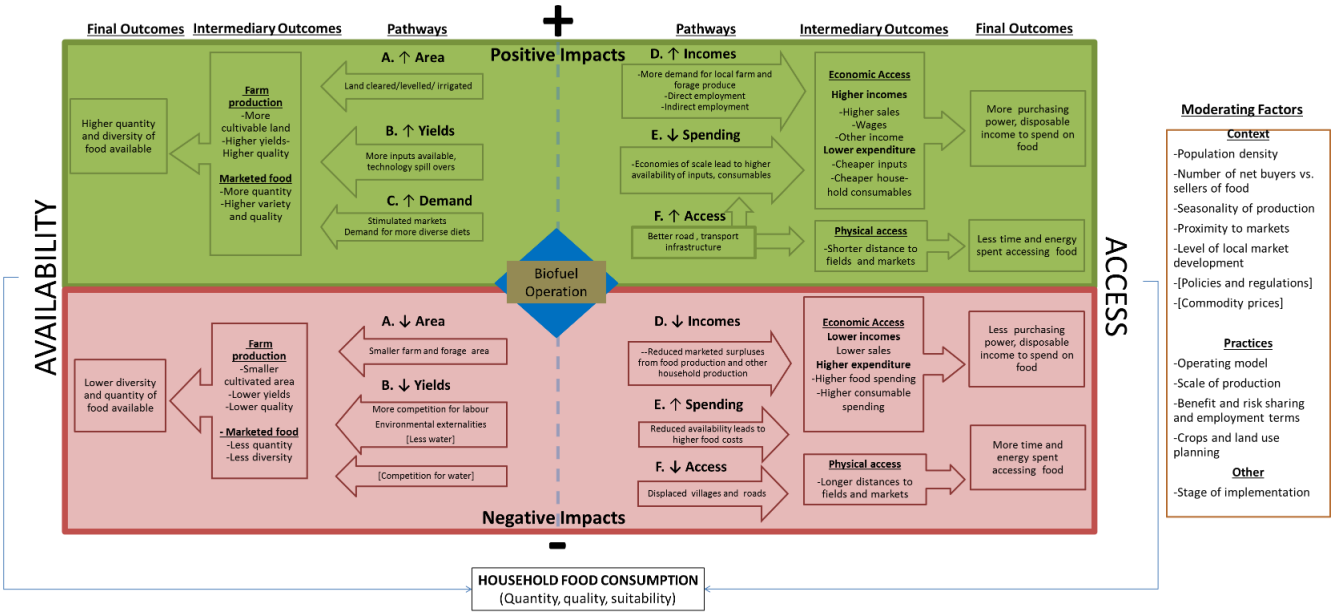
Appendix

Figure A1 presents the framework developed for analysing the linkages between a biofuel project and:

- The quantity and diversity of food available to households in the region of a biofuels project; and
- Physical and economic access to food at the local household level, expressed through changes in the purchasing power and disposable income for food in local households, and the time and energy spent accessing food.

The figure shows the causal pathways (arrows) that lead to positive or negative outcomes (boxes) for food availability and food access at the local level. Moderating factors are shown on the right-hand side of the diagram.[53]

Figure A1: Causal pathways connecting biofuel operations and household community level



Note: The top half of the figure illustrates potential positive impact chains. Potential negative impacts are shown in the lower half. The starting point for the diagram is the biofuel operation in the centre of the diagram. The left-hand side of the diagram illustrates the causal chains related to food availability. The right-hand side illustrates those related to food access.

[53] This framework purposefully ignores the effects associated with international price transmissions and national level changes in food availability owing to displacement by biofuel production, to focus on the effects that can be theorised at the operator level.

ODI is the UK's leading independent think tank on international development and humanitarian issues.

Our mission is to inspire and inform policy and practice which lead to the reduction of poverty, the alleviation of suffering and the achievement of sustainable livelihoods.

We do this by locking together high-quality applied research, practical policy advice and policy-focused dissemination and debate.

We work with partners in the public and private sectors, in both developing and developed countries.

This material has been funded by UK aid from the UK Government, however the views expressed do not necessarily reflect the UK Government's official policies.

ISSN: 2052-7209

Overseas Development Institute

203 Blackfriars Road

London SE1 8NJ

Tel +44 (0)20 7922 0300

Fax +44 (0)20 7922 0399