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**Article — Published Version**

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Agrekon

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*Suggested Citation:* Schuenemann, Franziska; Kerr, William A. (2019) : European Union non-tariff barriers to imports of African biofuels, Agrekon, ISSN 2078-0400, Routledge, London, Vol. 58, Iss. 4, pp. 407-425,  
<https://doi.org/10.1080/03031853.2019.1577144>

This Version is available at:

<https://hdl.handle.net/10419/224925>

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# European Union non-tariff barriers to imports of African biofuels

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## ABSTRACT

The introduction of EU mandates for biofuel use in the transport sector initially led to high expectations that African countries would benefit from biofuel exports to the EU. This market opportunity has not been realised, however, due to regulatory requirements for the production of biofuels that act as non-tariff barriers to the acceptance of African biofuels in the EU. This benefits producers of biofuel crops and processors in the EU by providing economic protection. In particular, the EU import regime fails to acknowledge the challenges faced by African (or other) developing countries in satisfying the requirements.

Using a computable general equilibrium model for Malawi, we quantify the foregone potential benefits from biofuel production for exports to the EU arising from non-tariff barriers (NTBs) embedded in the sustainability criteria. Our results show that sugarcane-ethanol production under smallholder outgrower regimes would lead to both economic growth outcomes and rural development, whereas jatropha-biodiesel fails to increase rural incomes due to low profitability. While there is widespread agreement on the latter today, our study is the first to explore the failure of jatropha in Malawi in an economy-wide framework. The ethanol results, however, also hold if land clearing is forbidden, thereby preserving biodiversity as stipulated under the sustainability criteria in the EU Renewable Energy Directive. The EU NTBs embedded in the Renewable Energy Directive thus play a much larger role for countries in Sub-Sahara Africa than simply inhibiting investment opportunities and should be refashioned to lower the entry costs for developing countries.

## ARTICLE HISTORY

Received 16 April 2018

Accepted 15 January 2019

## KEYWORDS

Non-tariff barriers; biofuels; Malawi; CGE model

## JEL CLASSIFICATION

F13; D58; O13; Q17

## 1. Introduction

When the European Union (EU) embarked upon its policy of fostering biofuels, developing countries were expected to benefit. When announcing the EU *Strategy for Biofuels*, Development Commissioner Louis Michel, prophesised that:

Many developing countries are naturally well placed for the production of biofuel feedstocks, particularly those traditionally strong in sugar production. The expanding EU market for biofuels will provide them with new export possibilities. The EU will help them maximise this opportunity with support for knowledge transfer and development of their market potential (EC Press Release, 2006).

This optimism was echoed widely (Mathews, 2007; Jank *et al.*, 2007) including predictions of African exports to the EU (Charles *et al.*, 2009; Kariuki, 2011). Exports of African biofuels, however, have not materialised. It is argued below that EU biofuels policy has been structured in ways that act as non-tariff barriers (NTBs). These impediments inhibit biofuels investment and represent opportunities

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forgone. A computable general equilibrium model for Malawi is used to illustrate benefits foregone due to EU biofuel NTBs.

NTBs can be: (1) directly trade inhibiting and (2) those that increase the risk associated with investing in EU destined biofuels. The risk increases because it is impossible to discern if a biofuel will be EU compliant until after the investment is made. If the perceived probability of success is sufficiently small, investment will be deterred. Many EU biofuel NTBs represent the latter.

## 2. EU biofuels policy

The EU's biofuels policy is a work-in-progress. There are two main drivers of policy change. The first is to reduce the contribution fossil fuels make to global warming; in particular petroleum in transportation (Williams & Kerr, 2011). The second arose after the 2007–2008 food crisis whereby the diversion of food producing land into biofuels contributed to the crisis (Heady & Fan, 2008; Molony & Smith, 2010). Subsequently biofuel targets have increased (FAS, 2017; EU, 2015) but restrictions that target reducing diversion of land from food to biofuel production – including land producing imports – have been added.

The first biofuel target (2003) was a 5.75 per cent share in transportation by 2010. This policy encouraged biodiesel production but had the unintended consequence of diverting land from food into biofuels (Williams & Kerr, 2011). The policy was revised to limit the externality of reduced food security.

Directive 2009/28/EC mandates, for transportation, a 10 per cent biofuel minimum by 2020. In 2012, the contribution of food crop-based biofuels was capped at five per cent and land conversion limited (Voegelé, 2012).<sup>1</sup>

For biofuels to count towards the target, the sustainability criteria of Directive 2009/28/EC, Article 17 (discussed below) must be met. The criteria for EU produced biofuels and imports are:

1. The greenhouse gas emission (GHG) saving<sup>2</sup> is at least 60 per cent<sup>3</sup> in 2018. If a default GHG saving is below the minimum, producers may calculate the actual value (Lendle & Schaus 2010) to establish compliance.
2. Biofuels are not produced from raw materials obtained from land with high biodiversity value and high carbon stock (paragraphs 3 and 4).
3. The raw materials for biofuels that wish to qualify for the target are produced in accordance with "Environment" provisions in part A and Point 9 of Public, Animal and Plant Health in Council Regulation (EC) No. 73/2009.

If these requirements cannot be satisfied the biofuel will: (1) not comply with the Directive concerning the national targets of EU Member States; (2) fail to comply with renewable energy obligations; and (3) be ineligible for financial support for biofuels consumption. Verification of biofuels satisfying the criteria is accomplished using the mass balance method. It allows raw materials or biofuel with differing sustainability characteristics to be mixed, but requires information about the sustainability characteristics (Article 18; paragraph 1 (a) and (b)). The Commission may, however, separately examine the sustainability information and within six months decide whether a biofuel is in compliance (Article 18 (8)). In other words, the Commission can independently rule a biofuel unfit. Hence, the Commission's influence in foreign countries is extended through its ability to judge whether an imported biofuel can be counted toward the mandate.

## 3. EU biofuels regulations that can act as NTBs

For NTBs, the devil is in the regulatory details (Hobbs, 1997). Further, as most regulations have a legitimate objective, establishing a trade inhibiting intent is difficult. Article 2.2 of the WTO's Agreement

on Technical Barriers to Trade (TBT) states: “... technical regulations shall not be more trade-restrictive than necessary to fulfil a legitimate objective ...” In the case of EU biofuels policy it appears that the regulations were crafted with little thought to obligations under Article 2.2 (Williams & Kerr, 2016).

As suggested above, NTBs can be: (1) those that directly inhibit trade<sup>4</sup> and; (2) those sufficiently opaque that they increase the risk of investing in trade enhancing activities. A number of EU biofuels import regulations qualify as the latter.

One barrier in the EU’s biofuels policy is the promotion of *European values* among trading partners (Meunier & Nicolaidis, 2006; Kerr & Viju, 2018). Countries which are significant sources of biofuel consumed within the EU must have ratified and implemented the Cartagena Protocol on Biosafety<sup>5</sup>, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and eight<sup>6</sup> Conventions of the International Labour Organisation (Directive 2009/28/EC Article 17, 7) – Conventions 29, 87, 98, 100, 105, 111, 138 and 182.<sup>7</sup> Four African countries have not ratified the Cartagena Protocol on Biosafety; in Africa only South Sudan has not acceded to the CITES; all African countries have joined ILO Conventions 29, 98 and 111; one has not joined Convention 182; two have not joined 100 and 138; five are not party to 87. Malawi has been a long-standing member of all of the agreements. While these provisions would appear to directly prohibit trade for non-members, implementation pushes them into the second category – sufficiently opaque to inhibit investment in export-oriented biofuels. A number of countries supplying biofuels to the EU have not, for example, joined the Cartagena Protocol – notably Argentina, the USA<sup>8</sup> and Canada. Further, the USA has never accepted a number of the ILO Conventions.<sup>9</sup> Thus, investing in biofuels for exports in any of the countries that have not ratified one of the listed arrangements is risky because, *ex post* to the investment, imports could be prohibited. Further the wording of Directive 2009/28/EC, Article 17 (7) lacks precision as the provision only applies to countries that are a *significant source* of biofuels consumed in the EU. *Ex ante* to an investment, it is difficult to know if one will be a *significant source* and whether this could be used to restrict imports *ex post* to an investment having been made. Economies of scale in complying with EU regulations also suggest it may be important that all African countries participate.

Foreign biofuels suppliers must prove their product satisfies the sustainability criteria using one of these methods:

1. Provision of data to the relevant national authority showing compliance with the member state’s requirements (Communication Sec. 2.1 2010/C 160/02).<sup>10</sup>
2. A voluntary scheme recognised by the Commission. Recognition lasts for a maximum of five years (Communication Sec. 2.1 2010/C 160/02).
3. A bilateral/multilateral agreement concluded by the EU using sustainability criteria consistent with the directive (Communication Sec 2.1, 2010/C 160/02).

As there are no examples of criteria 3, we only consider methods 1 and 2. Method 1 means an exporter going it alone to prove compliance. Method 2 allows formation of an entity that has the skill set to ensure that biofuels meet EU requirements.

Complying with the sustainability criteria adds costs for exporters. Criteria are established by individual member states and, hence, may vary. The data submitted must include information on the country of origin of all transport fuels, fossil and renewable, used along the supply chain. Proof of origin will be challenging in most African countries. If the data is considered insufficient, the biofuel will be denied access to the Member State. Further, the information must be audited by an independent party.

The criteria for independent audits from the Implementation Plan or Communication Sec. 2.6, 2010/C 160/ are:

1. The audit is to be performed by an external auditor.
2. Auditors are independent of the activity being audited and free from conflict of interest.

3. The verification body has general auditing skills.
4. Auditors have the specific skills pertaining to the scheme's criteria.

If the auditors fail on any of these criteria, the biofuel will be denied access to the EU. African biofuel producers may struggle to find qualified local auditors.

Information must be available regarding the sustainability criteria along the entire fuel supply chain (Commission 2010/C160/02). The data must meet the requirements of the member state. Varying data requirements may be administratively challenging for suppliers wishing to export to multiple EU markets given requirements are established by individual member states rather than the Commission. Hence, a biofuel that qualifies for shipment to one member state may not qualify for another. The flexibility of exporters to take advantage of price differences among the member states is reduced. It may be impossible to satisfy more than one member state leaving exporters tied to particular importers and open to opportunism in the prices they receive (Hobbs, 1996).

Proving that the crops do not contravene land use regulations is a major challenge where records are typically not kept and rural literacy rates low. Further, inputs to biofuels cannot be obtained from what were wetlands, continuously forested areas or land spanning more than one hectare with trees higher than five metres and a canopy cover of between 10 and 30 per cent. The evidence accepted are aerial photographs, satellite images, maps, land register entries or databases and site surveys. Neither the ability to produce high tech evidence nor developed country reporting systems such as well-specified land titles are available in most African countries. Often, it will not be possible to ascertain whether a shipment qualifies for import until the investment has been made, production undertaken and a shipment arrives at an EU port. Thus, making the investment is very risky if success is dependent on receiving the EU price premium.

To be counted in the EU target biofuels must satisfy emissions savings requirements. These are now 60 per cent.<sup>11</sup> Exporters can use either actual values of these savings or EU specified default values. Calculating actual values is extremely complex – the EU document outlining calculation methods (European Commission, COM(2016) 767 final/2, 23 February 2017) runs to more than 100 pages. African firms would likely have to use the default values, which are lower than the actual values. According to Erixon (2012: 28):

Default values have been deliberately been set at low levels to ensure that no biofuels should be allowed to enter if the greenhouse gas criterion is not met. But default values are not actual values – they are rather based on “worst-case-scenario” valuations.

The default values provided in European Commission, COM(2016) 767 final/2 show that a considerable proportion of common biofuel crops have default values less than 60 per cent.<sup>12</sup>

The experience of US producers of soybean-based biodiesel is instructive. In 2010, soybean producers informed the US authorities that they believed the EU directive on renewable energy acts as a barrier to trade (Inside US Trade, 2010). This is because soybean-based biodiesel did not qualify using default GHG emission savings values. The default value for soybean-based biodiesel is 31 per cent while the EU required, at the time, a minimum of 35 per cent. The producers had the option of calculating the actual value. Qualifying biofuels must carry proof of sustainability certificates if actual values are used but producers told the Office of the United States Trade Representative (USTR) that the information required is too difficult to provide, arguing it is not feasible to trace soybeans used as feedstock back to specific farms (Williams & Kerr, 2011). If it was too difficult for producers in a developed country, firms in Africa garnering certification is problematic. Erixon's (2012: 2) assessment is blunt: “It is difficult to escape the suspicion that the default values have been set to ensure that EU production will pass the test while the main competitors to rapeseed-based biodiesel will fail.”

Given that going it alone in proving compliance is onerous, the EU may have expected exporters to choose the second option – a Commission-recognised voluntary scheme. This is a private (or possibly public) entity having expert staff and the resources to certify compliance. Instead of dealing with

individual exporters, the EU only has to deal with a scheme covering a number of exporters.<sup>13</sup> There are 14 voluntary Commission-recognised schemes (UNCTAD, 2014). These are a mix of broad based multi-stakeholder initiatives, industry initiatives and government sponsored initiatives. Three have strong ties to biofuel production in developing countries (Johnson *et al.*, 2012). Bonsucro EU is focused on Brazilian ethanol. The Roundtable for Responsible Soy, RTRS EU EU-RED, certifies soy-derived biodiesel primarily from Argentina. Greenenergy is an industry-based initiative that certifies its own suppliers of Brazilian sugar cane ethanol (Johnson *et al.*, 2012). All three are centred on large, already existing biofuels industries. For these well-established industries to put a voluntary scheme together to expand into the EU market represents a reasonable investment. No voluntary scheme has been initiated in Africa where a large scale industry does not yet exist. It takes a critical mass to justify a voluntary scheme. The potential absence of a number of African countries from such a voluntary scheme, because their biofuels are at risk of not qualifying, due to their failure to accede to the Cartagena Protocol, CITES or various ILO Conventions, reduces the market for a scheme's services. It may also simply be too difficult to provide certification *ex ante* to the industry existing compared with certifying an existing industry. It may well be a classic "chicken and egg" problem. Further, a voluntary scheme is only valid for five years. As a result, investments in land clearing or processing facilities may be at risk given their much longer investment payback horizon. Without a voluntary scheme, individual African biofuel producers must "go it alone" to obtain certification – but as outlined above this may simply be too costly.

Another facet of EU biofuels imports is anti-dumping and countervailing duties applied against successful exporters. The use of contingent protection adds weight to claims that the regulatory regime is structured to provide protection for EU biofuel producers, and not access for developing countries (Erixon, 2012). The experience should inform decisions of potential African investors. Successful exporters – the USA, Argentina and Indonesia – have had anti-dumping and/or countervailing duties imposed (ICTSD, 2014; Williams & Kerr, 2016). It is well understood that these can be manipulated to provide economic protection (Kerr, 2006). Thus, even if an African biofuels producer can garner some export success, the threat of contingent protection measures is real.

Meaningful African biofuels exports have not emerged in the decade of EU biofuels policy (Erixon, 2012) and have remained negligible since the 2009 policy change. UNCTAD (2014) reports that, if certification costs can be kept low, exports could begin and that 34 African countries (including Malawi) have tariff-free EU access under the Everything But Arms (EBA) initiative. Of course, the EU's import policy regime may not be the only reason why the biofuels exports from Africa have not emerged. African economies are lumbered with a host of constraints that limit economic development (Kimbugwe *et al.*, 2012). Hence, the biofuels industry may not be competitive due to the poor business climate or due to low profitability (Gelb *et al.*, 2014). While reform of the EU import regime may not be a "sufficient" condition for the emergence of African biofuel exports, it is likely a "necessary" condition. As long as the NTBs remain, it will deter any investment in supplying the EU market. If EU biofuels NTBs could be re-fashioned to be not "more trade-restrictive than necessary to fulfil a legitimate objective", what are the opportunities in Africa foregone given current EU policy? This question is answered for Malawi below.

#### 4. Malawi case study

Malawi is one of the poorest countries in Sub-Saharan Africa with 50 per cent of its population living below the national poverty line (World Bank, 2018). Agriculture is the most important sector both in terms of labour share (80%) and contribution to GDP (30%). Malawi has been on a GDP growth path of 5 per cent per year on average over the past 10 years but little has *trickled down* due to a very high population growth of 3 per cent per annum (World Bank, 2018). Most Malawian farmers are small-holders that practice rain-fed subsistence agriculture and grow Malawi's staple crop maize. Frequent adverse weather effects such as droughts or floods increase poverty and food insecurity. One strategy of the Malawian government to alleviate the negative impacts of droughts is the recently launched



Irrigation Master Plan (IMP) that aims to increase the area under irrigation by 116 000 hectares over the next 20 years (SMEC, 2015). Malawi has a well-established smallholder export sector, predominantly producing tobacco. As global tobacco demand and prices are decreasing, Malawi is looking for alternative export options such as biofuels as detailed in the National Export Strategy (GOM, 2012). Since fossil fuels are completely imported, they put a high strain on the country's current account balance. A biofuel strategy, including exports, could thus both decrease the need for fossil fuel imports if blended with gasoline and increase export earnings and rural development.

#### 4.1 Biofuel potential in Malawi

Sugarcane and ethanol production have a long history in Malawi. Sugarcane production commenced in the 1960s and is dominated by large-scale plantation farming on estates, but outgrower schemes have evolved since the 1990s and smallholders produce about 20 per cent of current sugarcane output. Irrigation and Malawi's beneficial agro-climatic conditions lead to high sugarcane yields of 100 tons per hectare (ha) on average compared with the average yield in Southern Africa of 65 mt/ha (Johnson & Matsika, 2006). The sugar sector is the second largest formal employer in Malawi and provides permanent jobs for about 15 000 people, making the industry important for employment generation and growth. In the 1980s, the Malawian government established a petrol-ethanol blending mandate of 10–20 per cent as a means to reduce the foreign exchange burden from petrol imports (Mitchell, 2011).

Given Malawi's agronomic advantages and experience in sugarcane and ethanol production, the country would benefit from increasing its production and exporting biofuels to the EU as well as a streamlining of the non-tariff regulatory barriers to biofuels imports.<sup>14</sup> Even though the government and private sector in Malawi lack the capital for investment, there is sufficient interest in producing sugarcane and ethanol in Malawi by foreign investors (GOM, 2012). Malawi's largest constraint to increased sugarcane production, however, is land availability. A recent land suitability study found that only about 14 000 ha of uncultivated land are suitable for sugarcane (Kassam *et al.*, 2012). In general, there is little scope for land expansion without deforestation or use of grasslands given Malawi's overpopulation and already extremely small farm sizes – 98 per cent of farm households cultivate only between 0.3 ha and 1 ha of land on average (NSO, 2012).

Malawi also (unsuccessfully) started biodiesel production from jatropha feedstock. Jatropha was at first celebrated as a drought-hardy oil crop that would require low inputs and still exhibit high yields even on marginal lands, but it soon became clear that jatropha is a wild plant with rather low and variable yields in the absence of high input use and good soils (von Maltitz *et al.*, 2016). In Malawi, Jatropha was mainly launched as a project by the social entrepreneur Bio Energy Resources Limited (BERL), in which smallholders produced jatropha as hedges around their fields and received guaranteed prices for the oil fruits (Lange & Klepper, 2011). In 2012, BERL started a jatropha-based biodiesel production plant and planned to begin production in 2016 (Jimu, 2015), but so far no large-scale jatropha biodiesel production has been launched (Chalanda, 2017). While BERL claimed that biodiesel production has been challenging due to low jatropha yields and a difficult business climate (RVO, 2014), there has been no analysis of the potential foregone economic gains of producing jatropha-biodiesel for export in Malawi.

#### 4.2 Malawian challenges in meeting EU regulatory requirements

Avoiding deforestation and grassland conversion for biofuel crops is not only mandatory for protecting Malawi's ecosystems but also a prerequisite to fulfil the EU sustainability criteria and to be granted access to EU biofuel markets. As stated above, biofuel crops are not allowed to be grown on land with "high biodiversity value" and "high carbon stock" including protected areas such as forests and natural grasslands. Without any land expansion an increased production of biofuel crops in Malawi will invariably lead to the displacement of other crops, including food crops. As of today, avoidance

of food crop displacement is not an explicit criterion of the sustainability criteria. While Malawi should not compromise its own food security to grow biofuel crops, a reduction of domestic food output due to crowding out by biofuels does not necessarily imply lower food security. If farmers benefit from profitable biofuel production and earn higher incomes, which means a positive impact on the access dimension of food security, food availability could also be increased through higher imports.

The sustainability criteria relate not only to biodiversity, but also to the contribution of biofuels to climate change mitigation in terms of GHG emission savings. As outlined above, the EU regulations mandate emissions savings from using biofuels of at least 60 per cent compared with fossil fuels. This means that emissions of Malawian ethanol (biodiesel) production have to stay below 1.95 (1.53) kg of carbon dioxide equivalents per litre ( $\text{kgCO}_2\text{eq/L}$ ), as the EU default GHG emission values for petrol and diesel are set to 93.3 and 95.1  $\text{gCO}_2\text{eq/MJ}$ , which correspond to about 3.25 and 3.8  $\text{kgCO}_2\text{eq/L}$ , respectively. Emissions under the current sugarcane ethanol production systems in Malawi amount to 116  $\text{gCO}_2\text{eq/MJ}$  (about 2.74  $\text{kgCO}_2\text{eq/L}$ ) and are mostly a result of unsustainable processing using coal heating and open fermentation of processing residues (Dunkelberg *et al.*, 2014). Current state-of-the-art ethanol production facilities use processing residues for steam and electricity generation, leading to processing emissions as low as 0.07  $\text{kgCO}_2\text{eq/L}$  of ethanol (Wang *et al.*, 2012). Since an increase of ethanol production would require building new ethanol plants, processing emissions are unlikely to be a problem for Malawi. Emissions of feedstock cultivation depend on which existing crops are displaced by sugarcane. Malawian sugarcane has a high soil organic carbon (SOC) potential of up to 1.2  $\text{tC/ha/yr}$ , whereas maize or soy beans only store 0.62 and 0.84  $\text{tC/ha/yr}$ , respectively (Schuenemann *et al.*, 2017). Replacing these crops with sugarcane would thus increase carbon sequestration. Baumert (2014) estimates GHG emission values for biodiesel under different jatropha production and processing systems in Burkina Faso; where the highest estimated values are 1.05  $\text{kgCO}_2\text{eq/L}$  half of which originate from processing and half from intensive feedstock cropping systems. While the feedstock values might be slightly different in Malawi due to different soils and climate, as a tree crop jatropha is generally shown to have SOC values similar to forests and higher than most agricultural crops (Romeu-Dalmau *et al.*, 2016), so that meeting the EU GHG emission reductions is unlikely to be a problem in terms of jatropha-biodiesel.

Even if Malawian biofuels are not produced on the above-mentioned land categories and are able to reduce emissions by 60 per cent relative to fossil fuels, the largest obstacle for biofuel producers will be the provision of proof. As discussed above, Malawian biofuel producers can either provide the necessary data showing compliance themselves to member state authorities in the EU or join a voluntary scheme that certifies the compliance of Malawian biofuels. In the former case, biofuel producers have to keep track of inputs and production methods along the entire supply chain. This might be feasible for large scale feedstock production but will be extremely difficult if feedstock is produced by smallholders. Koch and Peet (2007) find that especially smaller firms in South Africa struggle to fulfil the technical regulations pertaining to exports to the EU because information on products is difficult to obtain. In Malawi, land use rights are opaque and the majority of agricultural land is termed *customary land* ruled by village chiefs (Matchaya, 2009), making it hard to track down the initial feedstock producer and his production technique. These institutional barriers will also complicate the measurement of land use change impacts, such as deforestation and crop displacement. Moreover, the actual effects on land use and emissions will only become apparent *after* the investment in biofuel production, which could lead to Malawian biofuels not being eligible to count toward EU mandates or investment being deterred due to this risk.

Joining a voluntary certification scheme might therefore be a better option as it ensures compliance of Malawian biofuel *ex-ante*. Certification involves high costs that might significantly reduce the competitiveness of Malawian biofuel *vis-à-vis* other international exporters. Apart from explicit costs such as certification and auditing fees, indirect costs include: information costs, adaptation costs associated with certain production techniques and increased management systems costs such as quality control (Johnson *et al.*, 2012). As Malawi does not have to pay EU tariffs, Malawian ethanol at US\$0.63 per litre can compete with Brazilian at US\$0.50 per litre and US ethanol at US\$0.40 per



litre (USDA, 2017; Hanson & Hill, 2018). Both are subject to EU tariffs between US\$0.13 and US\$0.24 per litre, while US ethanol is additionally subject to anti-dumping measures at US\$ 0.06 per litre (European Commission, 2018). Original estimates for Malawian jatropha-based biodiesel from BERL amounted to US\$1.43 per litre assuming a feedstock yield of 2.5 ton/ha (Lange & Klepper, 2011), while Segerstedt and Bobert (2014) estimate production costs of US\$1.67 per litre in neighbouring Tanzania even at a feedstock yield of 4 ton/ha. To be competitive on the EU market, however, Malawian biodiesel has to stay below the FOB Rotterdam prices that are projected to stay around US\$1.04 per litre in the near future plus the 6.5 per cent tariff that applies to other countries' biodiesel exports (Debnath *et al.*, 2018; European Commission, 2018).

Commercial voluntary certification schemes usually require a fixed fee for membership and an output-dependent fee, ranging from 200 to 20 000 US\$ for membership and annual costs between 2500 and 20 000 US\$ (Pacini & Assunção, 2011). If output is high, explicit certification costs are very low per litre produced, but will be prohibitive for small scale producers. "Free" certification schemes on the other hand *only* require the producer to adapt to the postulated sustainable production techniques, which means producers incur mostly the above-mentioned indirect costs (Johnson *et al.*, 2012). Segerstedt and Bobert (2013) estimate that certification of jatropha-biodiesel will not only increase the costs per litre by US\$0.04 (in Malawi's neighbouring country Tanzania), but will also involve substantial changes in production techniques such as using no, or more expensive, agro-chemicals that could further reduce feedstock yields. Both increases in costs are likely to function as a trade barrier and to lead to foregone economic benefits.

## 5. Quantifying the foregone economic benefits

We employ a computable general equilibrium (CGE) model of Malawi to quantify the foregone economic and rural development benefits of biofuel production arising from the EU regulations that function as non-tariff barriers. Given that the production of biofuels will affect both agricultural and non-agricultural output and employment as discussed above, impacts will also be felt by both rural and urban households. National CGE models are well-suited for ex-ante analysis of policy measures that will evoke economy-wide impacts through market interactions, because – unlike partial equilibrium models<sup>15</sup> – they encompass the complete flow of income and all consumption and production linkages between economic actors.<sup>16</sup> CGE models have previously been used to study the impacts of potential biofuel production in several other Sub-Saharan countries including Mozambique (Arndt *et al.*, 2010a) and Tanzania (Arndt *et al.*, 2012; Thurlow *et al.*, 2015). We built on Schuenemann *et al.* (2017) who compare the economic and environmental impacts of biofuels and other export crops in Malawi and come to the conclusion that the EU sustainability criteria for biofuels are unfairly biased, as other export crops can produce even poorer outcomes in terms of the environment.

### 5.1 CGE model of Malawi

CGE models simulate the functioning of a market economy by combining the behaviour of microeconomic agents with closure rules of macroeconomic aggregates and are thus able to capture economy-wide impacts of policy interventions both in terms of production and income distribution. Our CGE model equations for Malawi follow the recursive-dynamic version of the International Food Policy Research Institute (IFPRI) standard CGE model (Diao & Thurlow, 2012) and can be found in Schuenemann *et al.* (2017). Profit-maximising producers and utility-maximising households come together at factor and product markets where equilibrium prices ensure that supply equals demand. Producers operate under constant elasticity of substitution (CES) functions where substitution between production factors is governed by relative factor prices and intermediate input use is determined by fixed input–output coefficients in Leontief functions. Trade with the rest of the world is based on relative prices of exports and imports. Substitution between imports and domestic commodities is determined by a CES Armington function, producers take the decision to export

based on a constant elasticity of transformation function. We fix world market prices at their exogenous level as Malawi is a small country.

To capture the structure of the Malawian economy, the model equations are calibrated to the values of a 2010 social accounting matrix (SAM) for Malawi with 58 production sectors, including 28 sectors in agriculture, 19 in industry and 11 in services. Production factors are disaggregated for six types of labour (primary, secondary, and tertiary education in rural and urban regions, respectively), four types of farmland (small, medium, and large-scale farmers and estate land) and agricultural and non-agricultural capital. These factors are mobile between production sectors (except for capital) and fully employed, leading to competition between different sectors for limited production factors. As the owners of these factors, households receive wages and rents that serve as income to be spent on consumption, savings and direct taxes. A linear expenditure system (LES) governs household consumption according to estimated income elasticities of demand. The model will display the distributional and rural development impacts of biofuel expansion, as households are disaggregated according to location, farm size and expenditure quintiles using data from Malawi's Integrated Household Survey (IHS) (NSO, 2012). We also include a micro-simulation module to assess poverty effects following Arndt *et al.* (2012). This module links households from the IHS to their corresponding household group in the CGE model. The module transfers real consumption changes from the CGE simulations to the survey households and compares per capita consumption to the official poverty line.

Macroeconomic closure rules ensure that the microeconomic dimension is consistent with macroeconomic aggregates. Investment is savings-driven, so that households' marginal propensities to save determine investment levels. Government revenues are determined by fixed tax rates and transfers, while growth in recurrent spending is also fixed. Total government expenditures and revenues are balanced by the recurrent deficit. Foreign savings are fixed and a flexible exchange rate balances the current account. The *numeraire* for the whole model is the domestic price index and all other prices move in relation to this index. We run a recursive-dynamic model for a period of 10 subsequent years, where several parameters have to be updated between the years: labour, land and sectoral productivity growth are exogenously defined along projected growth trends (World Bank, 2018). Capital stocks of each sector are updated each year depending on previous investment levels discounted for depreciation.

## 5.2 Expanding biofuel production in Malawi

We simulate the establishment of a sizeable biofuel industry with an available 116 000 hectares of irrigated land for sugarcane feedstock production. This is the exact amount of land that the Malawian government is hoping foreign and domestic investors will equip with irrigation infrastructure under the Irrigation Master Plan (SMEC, 2015). Schuenemann *et al.* (2017) have shown that while large-scale estate production of sugarcane feedstock increases the overall economic growth effects of biofuels in Malawi, outgrower schemes have a higher poverty reduction impact. Thus we add the sugarcane production sectors from the former study – one producing feedstock on estate land and the other on smallholder land – and their respective ethanol processing sectors to our model to quantify the foregone benefits of each technology and to replicate their results with the 116 000 hectares from the Irrigation Master Plan. The processing technology is essentially the same for large-scale and small-scale production. We then add two new biofuel sectors in the same vein to better compare sugarcane-ethanol and jatropha-biodiesel: the first one produces jatropha under large-scale estate conditions, the second on smallholder land, both use the same large-scale processing technology. The large-scale processing technologies are based on Arndt *et al.* (2010b), whereas the jatropha technologies are based on cost estimates from Segerstedt and Bober (2013) and Arndt *et al.* (2010b) for Tanzania and adjusted to Malawian feedstock and labour costs.<sup>17</sup> Table 1 shows the technologies for the four types of feedstock-biofuel production sectors. The most striking differences appear in the feedstock yields between sugarcane and jatropha (108 and 99 mt/ha vs 4 and 2 mt/ha), which also result

**Table 1.** Biofuel production technologies.

|   | Input requirements |                       |                    |                       |
|---|--------------------|-----------------------|--------------------|-----------------------|
|   | Sugarcane-ethanol  |                       | Jatropha-biodiesel |                       |
|   | Estate large-scale | Outgrower small-scale | Estate large-scale | Outgrower small-scale |
| Land available (ha)                       | 117                | 116                   | 116                | 116                   |
| Feedstock produced (1000 mt)              | 12 610             | 11 484                | 464                | 232                   |
| Land yield (mt/ha)                        | 108                | 99                    | 4                  | 2                     |
| Liquid yield (litre/mt)                   | 70                 | 70                    | 350                | 350                   |
| Biofuel produced (mil. litres)            | 883                | 804                   | 162                | 81                    |
| Workers employed (people)                 | 43 321             | 43 016                | 45 415             | 41 161                |
| Feedstock                                 | 43 005             | 42 728                | 45 348             | 41 128                |
| Processing                                | 315                | 287                   | 67                 | 33                    |
| Labour yield (people/mil. litres)         | 49                 | 54                    | 280                | 507                   |
| Capital employed (capital units)          | 20 758             | 9755                  | 3351               | 512                   |
| Feedstock                                 | 11 946             | 1730                  | 2328               | 0                     |
| Processing                                | 8812               | 8026                  | 1022               | 511                   |
| Capital yield (capital units/mil. litres) | 23.5               | 12.1                  | 20.6               | 6.3                   |

Source: Own estimates using farm budget survey data (Herrmann & Grote, 2015) and cost estimates (Quintero *et al.*, 2010; Arndt *et al.*, 2010; Segerstedt & Bobert, 2013).

in a much lower number of litres of biodiesel produced compared to ethanol, even though the liquid yield of jatropha is higher than that of sugarcane. For both types of biofuel feedstock, small-scale production is less capital intensive and has lower yields than large-scale production. As sugarcane is irrigated, it has higher capital costs than jatropha on average. Labour input is similar in all four technologies, but jatropha-biodiesel production requires five to 10 times the number of workers per litre produced compared with sugarcane-ethanol.

Like Schuenemann *et al.* (2017), we include a *foreign capital* factor being available to the biofuel sectors mirroring foreign investment to expand biofuel production in Malawi. Over the simulation period, we gradually increase the investment of foreign capital in the respective biofuel processing sector, thereby increasing demand for production factors and intermediate inputs. The growth in demand for feedstock then triggers growth in the sugarcane/jatropha production sectors, drawing in land and farm labour. The amount of feedstock production is therefore constrained by the 116 000 hectares of land available. Eventually, irrigation equipment costs and biofuel profits have to be repatriated to the foreign investors. As we want to measure the foregone benefits of biofuels expansion due to the EU non-tariff barriers, we assume that all additional biofuel production is exported.

Malawi's benefits from biofuel production depend on whether producers can prove that they fulfil the EU criteria. Therefore, we run two types of scenarios for all four biofuel sectors. In the first set of scenarios, we allow for the 14 000 hectare land expansion as estimated by the land suitability study (Kassam *et al.* 2012). As explained above, Malawi is likely to have difficulties proving that the land expansion does not happen on land with high biodiversity. Therefore, we run a second set of scenarios where there is no land expansion and all feedstock has to be produced on cropland that is already under cultivation. Crop displacement effects will thus be larger in the second set of scenarios.

## 6. Results and discussion

We run the model for a period of 10 subsequent years starting in 2010. The first column of Table 2 lists the initial structure of the Malawian economy in the base year. We compare our scenarios to a *business as usual* baseline that follows projected and observed trends in population and economic growth in Malawi. Malawi's population is projected to continue to grow at 3 per cent per annum, labour supply grows at 2 per cent and agricultural land along the lines of the growth in the 2000s at 1.7 per cent per year (World Bank, 2018). We choose an unbiased total factor productivity growth of 2.74 per cent per annum for all sectors to match Malawi's projected growth path (World

**Table 2.** GDP and price impacts.

|                             | Initial share or value, 2010 | Baseline growth rate or total change (%) | Deviation from final year baseline value (%) |                       |                    |                       |                        |                       |                    |                       |
|-----------------------------|------------------------------|--|--|-----------------------|--------------------|-----------------------|------------------------|-----------------------|--------------------|-----------------------|
|                             |                              |  | With land expansion                          |                       |                    |                       | Without land expansion |                       |                    |                       |
|                             |                              |  | Sugarcane-ethanol                            |                       | Jatropha-biodiesel |                       | Sugarcane-ethanol      |                       | Jatropha-biodiesel |                       |
|                             |                              |  | Estate large-scale                           | Outgrower small-scale | Estate large-scale | Outgrower small-scale | Estate large-scale     | Outgrower small-scale | Estate large-scale | Outgrower small-scale |
| Total GDP growth (%)        | 100.00                       | 4.74                                     | 1.6  | 1.2                   | 0.7                | 0.0                   | 1.6                    | 1.1                   | 0.6                | -0.1                  |
| Agriculture                 | 32.34                        | 4.61                                     | 1.6  | 1.7                   | 1.9                | 0.4                   | 1.5                    | 1.5                   | 1.7                | 0.3                   |
| Food crops                  | 16.60                        | 4.50                                     | 0.1  | 0.9                   | -0.8               | -1.1                  | -0.2                   | 0.7                   | -1.1               | -1.3                  |
| Export crops                | 3.12                         | 4.50                                     | 18.7   | 13.4                  | 24.2               | 10.2                  | 18.5                   | 13.2                  | 24.0               | 10.1                  |
| of which non-biofuels       | 3.12                         | 4.50                                     | -17.4  | -22.0                 | -8.6               | -6.1                  | -17.5                  | -22.2                 | -8.7               | -6.3                  |
| Industry                    | 16.45                        | 5.55                                     | 1.5  | -0.4                  | -0.5               | -0.4                  | 1.6                    | -0.3                  | -0.4               | -0.4                  |
| of which ethanol            | 0.00                         | 0.00                                     | ∞  | ∞                     | ∞                  | ∞                     | ∞                      | ∞                     | ∞                  | ∞                     |
| Services                    | 51.21                        | 4.54                                     | 1.6  | 1.4                   | 0.3                | -0.2                  | 1.6                    | 1.4                   | 0.3                | -0.2                  |
| Change in price indices (%) |                              |  |  |                       |                    |                       |                        |                       |                    |                       |
| Real exchange rate          | 1.00                         | 1.06                                     | -2.0   | -2.4                  | -0.6               | -0.1                  | -1.9                   | -2.3                  | -0.5               | 0.0                   |
| Real food prices            | 1.00                         | 1.04                                     | -0.3   | -0.1                  | 0.2                | 0.3                   | -0.2                   | -0.1                  | 0.2                | 0.4                   |
| Total crop land (1000ha)    | 4233                         | 777                                      | 13.6   | 13.6                  | 13.6               | 13.5                  | 0.1                    | 0.0                   | 0.1                | 0.0                   |
| Food crops                  | 3540                         | 848                                      | -11.2  | 14.9                  | -44.4              | -52.2                 | -21.4                  | 4.5                   | -54.6              | -62.4                 |
| Existing export crops       | 693                          | -71                                      | -91.9  | -117.4                | -58.0              | -50.2                 | -95.3                  | -120.5                | -61.4              | -53.6                 |
| Feedstock crops             | 0                            | 0  | 116.8  | 116.0                 | 116.0              | 116.0                 | 116.8                  | 116.0                 | 116.0              | 116.0                 |

Notes: Biofuels processing grows from a zero base and so growth is infinite.

Source: Results from the Malawi CGE model.

Bank, 2018). These trends lead to a total GDP growth of 4.7 per cent in the baseline as shown in the second column of Table 2. More than 80 per cent of agricultural land is used for food crop production in the baseline indicating the importance of food crop production and subsistence agriculture for the Malawian economy.

### **6.1 Expanding biofuel production on large-scale estate land**

In the first biofuel scenario, we expand sugarcane-ethanol production on estate land by 116 000 hectares and allow for 14 000 hectares previously uncultivated land to come into production. Results can be found in the third column of Table 3 as deviations from the baseline value in the last year of the simulation period (2020). As exports of biofuels increase strongly and reach 883 million litres of ethanol, the Malawian real exchange rate appreciates, making traditional Malawian export crops including tobacco relatively more expensive on global markets. This leads to a decrease in the production of these crops by 17 per cent relative to the baseline and a reallocation of crop land from traditional Malawian export crops to sugarcane. While this shows that sugarcane can be a viable alternative to tobacco<sup>18</sup>, there is also some displacement of food crops. Overall agricultural GDP increases as sugarcane exhibits a higher value-added per hectare of land than the crops that get displaced and the additional 14 000 hectares act as an exogenous increase in the production factor land.

All new large-scale sugarcane production, however, happens on previously small-scale land, which affects labour demand and households as shown in the third column of Table 3. As large-scale estate production is less labour intensive than smallholder farming, the labour share of the agricultural sector decreases. Nevertheless, rural wages increase slightly due to increasing demand for workers on estate farms and on the newly cleared 14 000 hectares. The majority of farm households, however, experience a decrease in welfare as measured in real consumption expenditure as well as an increase in poverty. Since they lose their formerly productive export crop land to large-scale production of sugarcane, farmers lose a large part of their assets and income. The decrease in consumption is also the reason why there is a slight decrease in food prices even though food crop output remains largely unchanged. These results underpin concerns about land grabbing by foreign investors, showing that rural development crucially depends on small-scale farmers having access to productive land.

Urban workers and non-farm households, on the other hand, are positively affected by large-scale biofuel production. Although there is some increase in labour demand from ethanol processing, other downstream processing of now displaced traditional export crops (mainly tobacco curing) contracts and releases workers to the urban labour market. These workers find jobs in trading and business in the growing service sector where they receive higher wages, causing urban wages to rise on average and leading to higher welfare and lower poverty.

On the national level, expansion of large-scale biofuel production not only positively affects agricultural GDP but also industrial and service sectors (Table 2). As sugarcane is irrigated, it is much more energy-intensive (and electricity-intensive) than the rain-fed export and food crops it crowds out. Moreover ethanol processing requires electricity while the displaced tobacco curing uses bio energy from collected firewood. The higher demand for electricity from these new sectors thus more than offsets the losses through tobacco processing in the industrial sector. Likewise, the service sector benefits from the increased demand for trade services from the sugarcane and electricity sectors. The expansion of biofuels thus triggers important spillover and multiplier effects on the rest of the economy. Overall, large-scale biofuels production leads to an increase in GDP by 1.6 per cent relative to the baseline without biofuel production. Moreover, some of the unprofitable tobacco can be exchanged for more profitable sugarcane. However, tradeoffs exist in terms of rural development as smallholder farm households are negatively affected. If EU NTBs for biofuels are reformulated in ways that make it difficult for small-scale outgrower producers to satisfy, this could be the more likely future for Malawi's ethanol industry.

**Table 3.** Household impacts.

|                             | Initial value or share, 2010 | Baseline growth rate or total change (%) | Deviation from final year baseline value (%) |                       |                    |                       |                        |                       |                    |                       |
|-----------------------------|------------------------------|--|--|-----------------------|--------------------|-----------------------|------------------------|-----------------------|--------------------|-----------------------|
|                             |                              |  | With land expansion                          |                       |                    |                       | Without land expansion |                       |                    |                       |
|                             |                              |  | Sugarcane-ethanol                            |                       | Jatropha-biodiesel |                       | Sugarcane-ethanol      |                       | Jatropha-biodiesel |                       |
|                             |                              |  | Estate large-scale                           | Outgrower small-scale | Estate large-scale | Outgrower small-scale | Estate large-scale     | Outgrower small-scale | Estate large-scale | Outgrower small-scale |
| Agriculture labor share (%) | 63.5                         | 64.2                                     | -1.3   | 0.4                   | 3.5                | 3.6                   | -1.3                   | 0.4                   | 3.4                | 3.6                   |
| Real wage (%)               |                              |  |  |                       |                    |                       |                        |                       |                    |                       |
| Rural workers               | 3616.7                       | 2.7                                      | 0.3  | 0.5                   | 0.2                | 0.2                   | 0.3                    | 0.5                   | 0.1                | 0.1                   |
| Urban workers               | 3834.6                       | 2.6                                      | 1.2  | 1.1                   | -0.1               | -0.4                  | 1.1                    | 1.1                   | -0.1               | -0.4                  |
| Household welfare (%)       |                              |  |  |                       |                    |                       |                        |                       |                    |                       |
| Farm households             | 329.8                        | 1.6                                      | -0.2   | 0.9                   | -0.4               | 0.0                   | -0.2                   | 0.9                   | -0.5               | -0.1                  |
| Non-farm households         | 1018.5                       | 1.5                                      | 1.3  | 0.6                   | 2.1                | -0.2                  | 1.3                    | 0.5                   | 2.1                | -0.2                  |
| Poverty headcount rate (%)  |                              |  |  |                       |                    |                       |                        |                       |                    |                       |
| Farm households             | 48.1                         | 27.6                                     | 0.9  | -1.2                  | 0.8                | 0.0                   | 0.9                    | -1.1                  | 0.9                | 0.0                   |
| Non-farm households         | 2.8                          | 1.1                                      | -0.7   | -                     | -                  | 1.2                   | -0.7                   | -                     | -                  | 1.2                   |

Notes: Welfare is measured using real consumption expenditure, the initial value is average per capita US\$ expenditure. Poverty headcount rate is the share of the population with per capita expenditures below the national poverty line.

Source: Results from the Malawi CGE and microsimulation models.



## 6.2 Sugarcane production by small-scale outgrowers

The negative impacts on rural development could be reversed if sugarcane feedstock is produced through outgrower schemes by smallholder farmers as portrayed in our second scenario. Again, we allow for 14 000 hectares of land expansion. Simulation results for production can be found in the fourth column of [Table 2](#). As in the previous scenario, the increase in biofuel exports leads to an appreciation of the real exchange rate so that traditional Malawian export crops become less competitive on the world market. The real exchange rate appreciation is even higher than in the estate scenario, as sugarcane is grown on outgrower land and most profits remain with the small-scale farmers instead of being returned to foreign investors. Now all the biofuel feedstock is produced on land formerly used for traditional export crops. As the increase in farmers' incomes leads (among others) to higher demand for food, the newly cleared lands are exclusively used for food crop production, leading to an increase in food production by 0.9 per cent and an increase in the availability dimension of food security. Together with the higher value-added per hectare of land from sugarcane production, this generates an increase in agricultural GDP that is even slightly higher than in the estate scenario.

Despite higher food production, food prices only decrease slightly given the simultaneously high demand for food products. Nevertheless, labour and household impacts are beneficial for both rural and urban households as shown in the fourth column of [Table 3](#). As the newly cleared lands come into production, the labour share of agriculture increases relative to the baseline. The growing labour demand from agriculture also translates into an increase in rural wages. The higher value-added per land from sugarcane compared with the displaced export crops directly increase farm incomes, generating higher welfare outcomes as well as a decrease in poverty by 1.2 per cent for farm households. Urban households are more affected by structural change in the industrial sector. Since the displacement of existing export crops is larger than in the estate scenario, more downstream processing is crowded out. Urban workers still migrate into services and benefit from higher wages. As food prices decrease a little less than in the previous scenario, increases in welfare are lower and there is no decrease in non-farm poverty levels.

The negative structural change in the industrial sector through lower downstream processing is also much more pronounced in this scenario, as smallholders in Malawi do not use the electricity intensive irrigation techniques. As there is no expansion in the electricity sector, industry is negatively affected by biofuel production using outgrower schemes. Nevertheless, total GDP growth is still 1.2 per cent higher than in the baseline. This means that an expansion of biofuels in Malawi with smallholder feedstock production can not only increase economic growth, but can positively affect rural development and both the availability and access dimension of food security. There are thus considerable foregone benefits arising from the non-tariff barriers embedded in EU biofuel policies.

## 6.3 Jatropha-biodiesel production

Biofuel production impacts are more diverse when biodiesel using jatropha feedstock is produced by estates on the 116 000 hectares of land as shown in the fifth column of [Table 2](#). As the amount of biodiesel produced is much lower compared to the ethanol in the previous scenarios, biofuel exports are much lower, leading to a lower appreciation of the real exchange rate. This means that most of Malawi's traditional exports remain competitive on the world market so that jatropha crowds out food crops to a larger extent. Growth in the agricultural sector thus is higher than in the sugarcane scenarios as traditional export crops remain strong. Jatropha production is very labour intensive as shown in [Table 1](#) so that the agricultural labour share and rural wages increase. Nevertheless, large-scale jatropha production now happens on previous smallholder land. Together with higher food prices due to lower food production, this leads to a reduction in farm household welfare and increases in poverty (fifth column of [Table 3](#)). Non-farm households on the other hand exhibit higher welfare on average as the owners of both jatropha and remaining traditional

export crop land. As this mainly affects the higher quintiles, the higher food prices ensure that there is no decrease in non-farm poverty. There is actually a decrease in urban wages as growth in the services (and industrial) sector is much lower compared with sugarcane-ethanol since jatropha is not irrigated and fewer services and machinery are required. Even though total GDP increases by 0.7 per cent compared with the baseline, the lower amount of biofuel exports means that traditional exports remain competitive and biofuel production happens at the expense of food security and rural development.

This result does not change much if jatropha is produced by smallholders (sixth column of Table 2). As small-scale jatropha production provides lower yields than large-scale, biodiesel exports are lower, which also means a lower exchange rate appreciation. There is thus even less crowding out of traditional exports crops as in the large-scale jatropha scenario and more crowding out of food crops. Growth in agriculture is thus only 0.4 per cent higher than in the baseline even though land endowment increased by 14 000 hectares. Non-farm households now exhibit lower welfare and higher poverty through increased food prices and lower wages because of lower demand for services and downstream processing (sixth column of Table 3). As in the large-scale scenario, labour intensive jatropha production leads to a higher agricultural labour share and higher rural wages. Workers migrate from the services sector into agriculture leading to a contraction in services. Given that smallholders are now the owners of jatropha cultivated land, their welfare and poverty is not negatively affected. Even though small-scale jatropha production reduces negative impacts on the rural poor, income increases from low-yielding jatropha sales are too small to increase rural development or GDP growth given the prices received on the world market. This means that even in the absence of EU biofuel regulations, jatropha-biodiesel is unlikely to offer economic development prospects for Malawi and emphasises the reasons for failure of this biofuel crop.

#### **6.4 Producing biofuels without land expansion**

Given the land constraints and the structural issues explained above, Malawi will struggle to prove to the EU that there is no land clearing of high biodiversity land. We therefore repeat the four scenarios from above without allowing any land expansion. In this set of scenarios, the competition for land increases and more crops get displaced by feedstock. In the following each “without land expansion” or land constraint scenario is compared with its “with land expansion” counterpart.

The impacts in the land constraint sugarcane estate scenario closely track results of its land expansion counterpart and are shown in the seventh columns of Tables 2 and 3. The main difference is that due to the increased land competition, relatively more smallholder food crop land than export crop land is displaced by large-scale sugarcane. This leads to negative growth in food production and slightly lower growth in agriculture than in the land expansion scenario. In addition, the labour share of agriculture is lower as there is no labour demand increase from a higher land endowment. Therefore, rural wages do not increase as much as in the land expansion counterpart. The farm household poverty rate is higher, since more smallholder land previously cultivated both with food crops and productive export crops is turned into estate land. Again, urban and non-farm households are the winners and benefit from higher wages in the industrial and services sector as well as lower food prices. Total GDP growth relative to the baseline remains the same as in the land expansion scenario.

Looking at the results for the land constraint sugarcane outgrower scenario in the eighth columns of Tables 2 and 3, they exhibit very similar economic and social impacts compared with the outgrower land expansion scenario. However, there is more displacement of traditional Malawian export crops as well as a lower increase in food crop production. Nevertheless, growth in the food crop sector is still higher than in the baseline leading to an increase in food security. Total GDP and agricultural GDP growth are only 0.1 percentage points lower than in the land expansion scenario. As there is no increase in land endowment, the labour share of agricultural and poverty decreases are a bit lower than in the land expansion scenario. Otherwise, wage and welfare effects are almost exactly the same without land expansion as with land expansion.

Similarly, both “without land expansion” jatropha-biodiesel scenarios track the results of their land expansion counterparts so that the negative impacts on rural development and food security are even worse than in the “with land expansion” scenarios (ninth and tenth columns of [Tables 2](#) and [3](#)). In the small-scale jatropha scenario, there is now even a reduction in farm household welfare and in GDP growth compared with the baseline, showing once more that jatropha-biodiesel is not a viable export crop growth path.

In sum, the differences between the “with land expansion” and “without land expansion” scenarios are very small. Given Malawi’s land constraints and the difficulties in fulfilling the EU sustainability criteria, growing biofuel feedstock without land clearing might therefore be preferable.

Overall, we find that small-scale sugarcane outgrower production of biofuel feedstock increases economic growth, rural development and food security in Malawi. Large-scale sugarcane production has slightly larger GDP growth effects, but should not be pursued due to its negative impacts on rural development and poverty. These findings are in line with Schuenemann *et al.* (2017) and Arndt *et al.* (2012), although Arndt *et al.* (2010a) find some negative impacts of biofuel expansion on food availability in Mozambique. Both large-scale and small-scale jatropha-biodiesel production, however, negatively affects food security and rural development because of low yields and has likely not commenced for these reasons as already mentioned above. This is in contrast to Arndt *et al.* (2010b), who find positive impacts of jatropha in Tanzania because they assume that smallholder farmers can produce 4 mt/ha as well as high land expansion possibilities.

Nevertheless, a country like Malawi can only realise potential benefits from ethanol production if it can rely on secure and continued access to the high priced EU markets. Our results show that Malawi does not have to conduct any land clearing to produce growth and development enhancing biofuels and can simultaneously realise food security increases and poverty reductions. This implies that the biodiversity and food security concerns under the EU sustainability criteria for biofuels are not always justified and might simply increase costs or provide insurmountable structural NTBs to biofuel production in African countries.

## 7. Conclusion

The introduction of the EU mandates for biofuel use in the transport sector generated high expectations for African countries to benefit from biofuel exports to the EU. These opportunities, however, have not been realised. We hypothesise that the EU sustainability criteria act as non-tariff barriers (NTBs) that prevent access for African countries to EU markets through prohibitively high costs and structural barriers. Despite the EU’s WTO obligation to ensure “technical regulations shall not be more trade-restrictive than necessary to fulfil a legitimate objective”, the regulatory regime for imports of biofuels acts as a major impediment to imports of biofuels. This benefits producers of biofuel crops and processors in the EU by providing economic protection.<sup>19</sup> In particular, the EU import regime fails to acknowledge the challenges faced by African (or other) developing countries in satisfying the requirements.

We use a computable general equilibrium model for Malawi to quantify the foregone benefits of biofuel production for exports to the EU under both small-scale and large-scale feedstock cultivation. Our results show that benefits are highest for sugarcane-ethanol if sugarcane is produced under smallholder outgrower regimes. While large-scale production exhibits slightly higher economic growth outcomes, small-scale production increases rural development through decreasing poverty and enhancing food security. Biodiesel production based on jatropha, however, fails to increase rural incomes and economic growth due to low yields and profitability. While there is widespread agreement on the latter today, our study is the first to explore the failure of jatropha in Malawi in an economy-wide framework. The ethanol results, however, also hold if land clearing is forbidden, thereby preserving biodiversity as stipulated under the sustainability criteria in the EU Renewable Energy Directive. This is an important finding because even small rural development increases and poverty reductions represent high foregone benefits for many least developed countries. The EU

non-tariff barriers through the Renewable Energy Directive thus play a much larger role for countries in Sub-Sahara Africa than simply inhibiting investment opportunities and should be refashioned to lower the entry costs for developing countries.

## Notes

1. The revisions also aim to skew the production towards second generation fuel sources such as cellulosic and other non-food-based technologies.
2. See Annex V of Directive 2009/ 28/EC for typical and default greenhouse gas emission saving values by production pathway if no net carbon emissions is from land use change.
3. Up from the original 35 per cent.
4. These include both sanitary and phytosanitary standards (SPS) and technical barriers to trade (TBT) such as food safety standards. Dal Bianco *et al.* (2015) show that while TBT can be as trade impeding as tariffs with regard to the global wine trade, SPS did not inhibit trade. Otsuki *et al.* (2001), for example, find that the allowable levels of Aflatoxin in groundnut imports to the EU are severely inhibiting trade between African countries and the EU.
5. Also known as the Biosafety Protocol, it regulates trade in genetically modified organisms (Hobbs *et al.*, 2005).
6. See Article 17, paragraph 7 of Directive 2009/28/EC.
7. 29 – concerning Compulsory Labour; 87 – concerning Freedom of Association and Protection of the Right to Organise; 98 – concerning the Principles of the Right to Organise and Bargain Collectively; 100 – concerning Equal Remuneration of Men and Women Workers for Work of Equal Value; 105 – concerning the Abolition of Forced Labour; 111 – concerning Discrimination in Respect of Employment and Occupation; 138 – concerning Minimum Age for Admission to Employment; 182 – concerning the Prohibition and Immediate Action for the Elimination of the Worst Forms of Child Labour.
8. The US technically cannot join the Protocol because it has never ratified the umbrella organisation under which the Cartagena Protocol operates – the Convention on Biological Diversity (CBD).
9. The US has not ratified Conventions 28, 87, 98, 100, 111 and 138.
10. Communication from the Commission on the practical implementation of the EU biofuels and bioliquids sustainability scheme and counting rules for biofuels.
11. Up from an original 35 per cent that had increased to 50 per cent.
12. Although many more would have qualified if the emissions saving threshold had remained at the original 35 per cent.
13. Once a scheme is approved by the Commission, all member states must recognise the scheme within 20 days after the decision (Williams & Kerr, 2016).
14. Malawi is a member of the Southern African Development Community (SADC) free trade area, where many countries have a high demand for ethanol.
15. Meyer *et al.* (2010), for example, simulate the impacts of biofuels production in South Africa using a partial equilibrium model of the agricultural sector and therefore miss important multiplier effects on the rest of the economy.
16. For a detailed discussion on the benefits of CGE models for analysing biofuel production policies see Schuene-mann, 2018.
17. Whereas Arndt *et al.* (2010b) assumed high *jatropha* yields of 4 mt/ha for small-scale production, we adopt the more realistic smallholder yields of 2 mt/ha from Segerstedt and Bober (2013).
18. Tobacco is not considered a food crop for land displacement purposes by the EU.
19. The anti-dumping and countervailing duties applied on the products of successful foreign biofuels suppliers can also be interpreted as evidence of protectionist intent.

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