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## Research paper

# Competition between biofuel feedstock and food production: Empirical evidence from sugarcane outgrower settings in Malawi

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## ABSTRACT

This paper analyses the implications of the expansion of biofuel feedstock production in Malawi on local food crop production. This represents a trade-off between two provisioning ecosystem services: biofuel feedstock (i.e. sugarcane) and food crops. Specifically, we assess household-level linkages between biofuel feedstock and food crop production among farmers involved in outgrower schemes around a large-scale plantation, sugar mill and ethanol distillery complex in Dwangwa, Central Malawi. Our analysis is based on a farm household survey that targeted sugarcane outgrowers (intervention group) and households not growing sugarcane (control group). We apply econometric and matching techniques to assess the impact of household participation in biofuel feedstock production on agricultural input expenditures for food crop production, land under food crops and investment in agricultural assets. In spite of limitations to establish causality, our results suggest that participation in sugarcane outgrower schemes is associated with larger amounts of land under staple food crops and higher purchases of farm inputs compared to the control group. The results further suggest that the expansion of biofuel feedstock production does not necessarily compromise household food production for those households involved in outgrowers schemes due to potentially positive intra-household linkages. We discuss under which circumstances this is possible, and whether and how other ecosystem services may be affected by sugarcane expansion.

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## 1. Introduction

The production of biofuels has been promoted in a number of Sub-Saharan African (SSA) countries since the mid-2000s as a strategy to enhance energy security and support rural development [1–3]. At the same time, there has been a rise in large-scale commercial agricultural investments, more than 70% of which targeted biofuels between 2000 and 2010 [3–5]. The success of biofuel development in SSA, however, has been rather low [3,6], with a large number of investments failing, especially those linked to *Jatropha* cultivation for biodiesel production [7]. In contrast, large-scale sugarcane ethanol has been considered to be a commercially more viable option for SSA [1,8], with long experiences in Brazil and in some SSA countries such as Malawi [1,9].

Yet, such large-scale biofuel investments have raised a great

controversy over the potential trade-offs of feedstock production with other ecosystem services (ESS) that are vital for human wellbeing [3,10–12]. ESS can be broadly understood as the direct and indirect benefits that human obtain from nature [13]. These include provisioning services (e.g. food, fuel, fiber), regulating services (e.g. climate regulation, disease control), cultural services (e.g. recreation) and supporting services (e.g. nutrient cycling, primary production) [13]. Trade-offs arise when the provision of one ESS negatively affects the provision of another ecosystem service, whereas synergies exist if the provision of different ESS are enhanced simultaneously [13,14].

Perhaps the most prevalent trade-off discussed in the biofuel literature has to do with the competition with food security [15,16]. The potential effects of biofuels on food security, a major component of human wellbeing, have caused particular controversies (food vs. fuel debate) [17,18]. Food security is a multi-dimensional concept comprising of four pillars: food availability, access, utilization and stability [19]. Increasing feedstock production may negatively affect food availability and eventually access because of

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the direct competition for land (direct land use change). Some studies, for example [20,21] have concluded that the growing biofuel/feedstock production in industrial countries has contributed to rising global food prices [20,21]. As many low-income countries are net-food importers and food insecure households are often net-food buyers, biofuel-induced food price increases may negatively affect access to food, and thus increase food insecurity [22]. At the same time, others have argued that higher food prices may create incentives to expand food production and increase food availability [22].

The expansion of large-scale biofuel feedstock production in low-income countries has often been criticized partly due to its potential implications for local food security. Feedstock production may improve food access by increasing income, a major driver of food security. Existing research in Mozambique [23], Malawi [24] or Tanzania [25], for example, suggests significant income benefits for households directly participating in sugar and biofuel investments. However, these income effects might be less important in areas with thin and weakly integrated food markets, at least in the short-term, where food access may depend more on the level of local food production than on household income.

More importantly, local food production could be negatively affected by biofuel investments if resources (e.g. land, labor, agricultural inputs) are diverted away from food production either at the household or community level [26,27]. However, fewer trade-offs between feedstock and food production may exist locally if land is not scarce or underutilized, as often perceived in many regions of SSA where estimated yield gaps are in the order of 60–80% [4]. Soil fertility restoration and farmers' crop yields depend often more on fallowing practices rather than on external inputs, as improved technologies (e.g. improved seeds, drip irrigation) and external inputs (e.g. fertilizers, agrochemicals) are rarely available. Under such conditions, expanding smallholder feedstock production into unused agricultural land or improving access to external inputs and knowledge for cultivating staple food crops (e.g. through linkages or spillovers from biofuel supply chains) may reduce trade-offs with food production [28,29]. Biofuel supply chain arrangements that create linkages with smallholder farmers such as contract farming or outgrower schemes [30] sometimes involve directly access to input and extension services or may improve access to inputs for staple crops such as agrochemicals or mechanization via credit schemes [28,29].

Evidence from existing literature reveals that only few studies have empirically analyzed the linkages between feedstock production and local food security in SSA [7,31,32]. Two studies from Ethiopia have found positive effects on household food security due to castor bean cultivation via income and spillover effects [31], and increased food crop productivity due to better access to inputs and technical assistance [32]. Another study assessed food production in *Jatropha* smallholder systems in Malawi and in large-scale plantation in Mozambique [7], yet without using rigorous evaluation methods to measure effects on yields and production. This evidence does not suggest any negative effects on food crop production [7]. Comparable studies of cash crop and food production, e.g. on cotton in Zimbabwe [28] or tea and coffee in Kenya [29], have also reported positive intra-household effects on maize yields and positive spillover effects to other farmers.

This study contributes to existing literature related to the linkages between biofuel feedstock production and food crop production. It analyzes the effects of smallholder involvement in sugarcane outgrower schemes around a large-scale sugar-ethanol investment in Malawi on food production. Specifically, we estimate the effects of biofuel feedstock production by smallholders on overall food crop production at the household level. We focus on the effect of sugarcane production on land, inputs, and agricultural

assets, using primary data collected through a household survey. We apply econometric and matching approaches to identify patterns within the collected data sets.

## 2. Methodology

### 2.1. Study site

This study focuses on Malawi, which presents an interesting case to understand potential effects of broader biofuel development. It is a landlocked country that has repeatedly been hit by fuel and food shortages. Increasing food crop production and self-sufficiency has been therefore considered crucial for national food security and poverty reduction strategies. At the same time, improving fuel self-reliance has been another policy object of the Government of Malawi. Malawi is today one of the few countries in SSA with a viable ethanol industry [9] and has, in fact, continuously produced ethanol from molasses and blended it with petrol since 1982 [9,33].

The specific study site is located in Dwangwa area, in Nkhota-kota District, Central Malawi Region. Dwangwa is one of the two main commercial sugar and ethanol production areas in Malawi. In its core it contains a sugar-ethanol processing complex comprising of a large sugarcane plantation and sugar mill (operated by Illovo), as well as an ethanol producing facility (operated by Ethanol Company Ltd., EthCo). This complex is surrounded by a large number of smallholders that grow sugarcane under irrigated and rainfed conditions (see below). The region is further characterized by abundant water sources, including Lake Malawi and different perennial rivers. Throughout the year many agricultural plots retain residual moisture from the rainy season (*dambo fields*), which allows producing sugarcane without irrigation.

Whereas sugarcane production in Malawi is still dominated by large estates, smallholder farmers have been increasingly involved in sugarcane outgrower schemes since the 1990s [34]. This supply chain arrangement is also prevalent in several other SSA countries [35]. Increasing the involvement of smallholders has been a major government objective for the sector [36]. Likewise, the expansion of smallholder sugarcane production has received widespread donor and government support with a targeted expansion of irrigation in *block farms* over the previous 15 years where several farmers operate a joint farming unit. Yet most farmers in the Dwangwa area still produce sugarcane under rain-fed conditions on their own plots.

Smallholder farmers do not have direct market access to the sugar mill but sell their sugarcane through management companies, with whom they have contractual agreements. These companies, which have contracts with the sugar company and are secured to get access to credit, support farmers to a varying degree with input loans, extension, and harvest and transport services.

### 2.2. Data collection

The data used in this paper were collected from a farm household survey conducted between November 2010 and February 2011. The farm household survey was conducted in villages in the wider vicinity of the sugar-ethanol processing complex.

In order to compile a list of all sugarcane growers in the study area, information was collected from outgrower organizations, Illovo and Concern Universal, a non-governmental organization that implemented, at that time, a European Union funded capacity building project for sugarcane farmers. In addition, meetings were held with Dwangwa Cane Growers Trust (DCGT), a government parastatal organization that is in charge of outgrower expansion, and government extension staff in order to identify other villages in

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