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Household level spillover effects from biofuels: Evidence from castor in Ethiopia

Olivia Riera [a,c,*], Johan Swinnen [a,b]

[a] LICOS Centre for Institutions and Economic Performance and Department of Economics, University of Leuven, 6 Waaistraat, 3000 Leuven, Belgium
[b] Centre for Food Security and the Environment Stanford University, 473 Via Ortega, Stanford, 94305-4205 CA, USA
[c] European Bank for Reconstruction and Development, 1 Exchange Square, London EC2A 2JN, United Kingdom

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ABSTRACT

The indirect effects of biofuels are mostly considered negative. In this paper, we argue that there may be a positive indirect effect of biofuels on food security and poverty. Using micro-level evidence and a matched plot pair design through which we control for plot and farmer characteristics, we show that the introduction of castor production for biofuel in a poor country as Ethiopia can significantly improve food productivity of rural households who produce raw material for biofuel production. This spillover seems particularly linked to enhanced access to inputs and technical assistance which were provided as part of biofuel feedstock production contracts. Our results thus document another mechanism through which biofuels may influence smallholders' food security, a mechanism that did not receive attention so far.

Introduction

Biofuels are an increasingly controversial issue, in particular in developing countries. On one hand, the proponents of the use of biofuels in developing countries point out that three quarters of the world's poor consume only 10% of the global energy supply (Bazilian et al., 2010).[1] Because energy poverty constrains poverty reduction efforts (Lee and Chang, 2008; Odhiambo, 2009; Kebede et al., 2010), diversification of energy resources, including biofuels, is viewed as a way to improve energy access and security – and thereby development. Sovacool (2012), for example, argues that decentralized production and distribution of biofuel energy in poor countries is a 'low hanging fruit' to expand energy access to energy deprived population in low-income countries. On the other hand, those opponents of biofuels argue that biofuels cause environmental problems and worsen food security. This is reflected in the 'food' versus 'fuel' debate (Bindraban et al., 2009; Cotula et al., 2008; Pimentel et al., 2009; FAO, 2008).

Empirically, the research on the relationship between food security and biofuels reaches conflicting conclusions. Some studies on the impact of biofuels suggest that biofuel investments provide alternative income through employment, boost economic growth, and thereby reduce the incidence of poverty and improve food security (Arndt et al., 2011; Huang et al., 2012; Negash and Swinnen, 2013). Others show that biofuel expansion reduces the availability of food and increases food prices, thereby jeopardizing food security for the poor (FAO, 2008; von Braun et al., 2008; Mitchell, 2008; Zhang et al., 2013).

The debate on the costs and benefits of biofuels has been dramatically changed by two studies (Searchinger et al., 2008; Fargione et al., 2008) highlighting the so-called indirect land use change effect (ILUC) which should be taken into account when evaluating the welfare effect of biofuels. These authors pointed out to the unintended consequences of releasing more carbon emissions due to land-use changes induced by the expansion of cropland for ethanol and biodiesel in response to the increased demand for biofuels. These arguments were reinforced by the 2008 food crisis which brought the link to food prices, food security and biofuel production to the forefront. For both environmental and food security reasons, the indirect effects of biofuels are considered negative.

* Corresponding author at: LICOS Centre for Institutions and Economic Performance and Department of Economics, University of Leuven, 6 Waaistraat, 3000 Leuven, Belgium. Tel.: +32 16 32 65 98.

E-mail addresses: Olivia.riera@kuleuven.be (O. Riera), Jo.swinnen@kuleuven.be (J. Swinnen).

[1] The majority of those energy poor households live in the net oil importing Sub-Saharan Africa. They often depend on direct burning of solid biomass as a prime source of energy with undesirable effects on health and agricultural productivity (Duflo et al., 2008).

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In this paper we argue that there may be another spillover effect of biofuels which may be particularly important for smallholder feedstock production in poor countries. Using micro-survey evidence from Ethiopia and a matched plot pair design through which we control for the effect of plot and farmer characteristics, we find that food crop productivity improved on plots intercropped with castor, a crop identified as preferred feedstock for biodiesel production by the Government of Ethiopia. We show that the higher productivity is due to enhanced access to inputs and technical assistance which were provided as part of the feedstock production contracts. Our estimates are in line with studies which have identified similar spillover effects of cash crop production on food crop productivity (Maertens, 2009; Minten et al., 2007; Barrett et al., 2012).

Our paper is the first to identify these spillover effects of biofuels on food crop productivity and to provide an estimate of the potential size. There is only limited information so far on the importance and the nature of contract farming in biofuel supply chains. Yet available studies suggest that it is present in several developing countries. Contract farming in biofuel chains is documented in Jatropha production in Zambia (German et al., 2011) and Tanzania (Portale, 2012), in soybean in Brazil (Padula et al., 2012), and in palm oil in Malaysia and Indonesia (Vermeulen and Goad, 2006). Our results may therefore have far reaching implications and may potentially be important for many poor people.

The paper is organized as follows. In Section 'Biofuels in Ethiopia', we describe the biofuel policies and castor production in Ethiopia, together with their link with food security. In Section 'Data and methodology', we present the setup of the castor outgrower scheme in the study area and explain our empirical methodology. Section 'Descriptive statistics and food productivity indicators' contains descriptive statistics on the farmers and plots producing the biofuel feedstock and a description of our measure of productivity. Productivity differences and econometric results are presented in Section 'Spillovers of biofuel production on productivity'. Section 'Conclusion' discusses and concludes.

Biofuels in Ethiopia

Ethiopia is a relevant case to study the micro-level effects of biofuels in developing countries. On the one hand, Ethiopia is a major energy importer. In fact it is considered as the number one "energy poor country" in Africa (Nussbaumer et al., 2012).[2] Developing renewable alternative resources therefore sounds appealing. On the other hand, Ethiopia's agriculture sector is heavily dominated by subsistence smallholders whose food security is vulnerable and who are often food aid recipients (Devereux and Guenther, 2009).

Biofuel policies

Enrouraged by the various commonly portrayed opportunities lying ahead of the development of biofuels (such as energy source diversification, foreign currency saving, rural poverty alleviation and technology transfers), in 2007 the Ethiopian government launched an extensive biofuels expansion strategy and an ad hoc investment promotion program for two biodiesel crops: castor and jatropha. At the same time, the government established a 10% blending requirement of ethanol with petrol, and biodiesel with diesel. While the ethanol target was successfully reached in 2012 in major cities, progress regarding the biodiesel target is meager. The government manages a vertically coordinated ethanol production system while biodiesel is left largely to private operators.

The availability of land, especially in under-developed regions makes Ethiopia attractive for the potential production of biofuel. According to government reports, 23.3 million hectares (20% of the total country area) are available for the production of both castor and jatropha (MoME, 2007). Even taking the more modest estimate by the World Bank (2011) of 7 million hectares of non-cultivated and non-protected land together with the high dependency of the country on oil imports, the development of a biofuel industry presents a notable opportunity to improve energy access and substitute fuel import for small-scale rural use, if not for the transport or industrial sector.

From 2007 onwards, the Government of Ethiopia has specifically supported the economic attractiveness of biofuel production and the expansion of investments in the sector by providing incentives to investors which include tax holidays, low-cost land leases, and long term credit facilities, among others. The government's interest in biofuels was later reemphasized in the Growth and Transformation Plan (GTP). Over a five year period (2010–2015), Ethiopia's GTP foresees increasing the production of ethanol to 194.9 million liters, biodiesel to 1.6 million liters, and an increase in blending facilities to 8 for ethanol and to 72 for biodiesel. As outlined, the main objectives for promoting biofuels are to create clean energy source diversity, serve as substitute for petroleum import and create jobs for local people. The document also recognizes the important contribution of involving the private sector and smallholders into the development of biofuel.

However, after a few years of enthusiasm, Ethiopia substantially downsized most of the incentives that were in place to promote the production of biofuels. The key reason behind this policy shift away from biofuel was an increasing concern over competition between food and biofuel crops and over bad management of land investments. This issue was raised by both the international and local communities and led to a substantive narrowing of land being allocated to investors for the production of biofuel feedstock. Now, only what is categorized as marginal land can be used for biofuel production (Negash and Riera, 2014).

Castor production and food security in Ethiopia

The emerging biofuel feedstock production from private firms in Ethiopia thus far is dominated by two major non-edible crops i.e. castor beans and jatropha (Table 1). Both have been identified by the government of Ethiopia as priority crops for biodiesel feedstock because of their numerous attractive properties (Negash and Riera, 2014; MoME, 2007).

First, castor, a non-edible crop that gives oil bearing seeds, has seen its global demand and production rise in recent years and it is believed to have strong market potential (Wijnands et al., 2007). The oil (i.e. biodiesel blended or not) can replace diesel without any engine modification. In addition, it can be used as automotive lubricant, as raw material for the cosmetic industry and in pharmaceuticals. Second, the oil contains a toxic element and hence does not compete directly with food or animal feed. Third, it can grow on marginal soils and is said to combat desertification (Reubens et al., 2011; Wani et al., 2012). These last two characteristics make castor production less threatening to local food production. However, at the same time, these marginal areas where castor production is allowed are areas with low agricultural potential and/or degraded areas and are often characterized by strong food insecurity.

There are also other potential links between castor production and food security, such as the impact of castor production on the productivity of other (food) crops, through rotation or spillover effects. This is an issue which has received little attention in the

[2] The authors constructed a Multidimensional Energy Poverty Index (MEPI) – that focuses on the deprivation of access to modern energy services and ranked countries using the scores from the index.