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The rise in global biodiesel production: Implications for food security

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1. Introduction

Policies that promote biofuels in major agricultural economies raise important questions for food prices and food security at local to global scales. Global biofuel output rose from 38 billion liters to 131 billion liters between 2005 and 2015, boosting the demand for annual- and perennial-crop feedstocks such as maize, sugar, soy, rapeseed, and palm oil. Although ethanol volume was three times that of biodiesel in 2015, the share of biodiesel in total biofuel output rose from 10% to almost 25% over the course of the decade (EIA, n.d.; REN21, 2016). Biodiesel production increased 700% between 2005 and 2015 and is expected to rise by another 35% by 2025 (OECD/FAO, 2014). In this paper, we examine the linkages between biodiesel, oil crop, and energy markets, and ask: What are the food security implications of biodiesel policies in major agricultural economies? How do governments adjust biodiesel policies in response to international commodity prices, trade opportunities, and their changing economic and environmental priorities?

Biodiesel policies in a diverse set of countries have been aimed, to varying degrees, at supporting domestic oil crops and rural incomes, enhancing the efficient use of oil crop co-products, increasing the share of renewable (non-fossil) fuels in overall energy use, and reducing the net climate impact of energy use. Policymakers in large agricultural economies typically have strong interests in supporting farm incomes along various parts of the agricultural supply chain. As a result, domestically produced oil crops serve as the primary feedstock in most countries where biodiesel production and use are promoted, and support tends to be strengthened during periods of relatively low vegetable oil prices and high crude oil prices (Byerlee et al., 2017). However, even as fossil fuel prices declined between 2014 and 2016, global biodiesel output continued to rise (Fig. 1 and 2). Biodiesel feedstocks in 2015 were comprised of soybean oil (28%), rapeseed oil (23%), palm oil (18%), recycled vegetable oils (11%), animal fats (8%), and other oils (12%) (see Appendix 1). Here we focus specifically on the food security dimensions of soybean, rapeseed, and palm oil markets.

A large body of literature has emerged on the impacts of biofuels on food security since the global food price spike of 2006–2008 (as reviewed by Oladosu and Msangi, 2013; Van Dijk and Meijerink, 2014; Rosegrant and Msangi, 2014). Much of this work provides quantitative estimates of attribution, or projections of agricultural prices and food security based on different scenarios of biofuel production and policy. The studies display divergent results—both positive and negative—depending on fuel and crop selection (e.g., ethanol vs. biodiesel and their associated feedstocks), model specification, spatial scale, and time period of analysis. Given the endogenous nature of government policies in response to market conditions, and the complex trade interactions among countries in response to emerging climate and renewable fuel priorities, we use a case study approach here to highlight the important role and nuances of biodiesel policies that are often obscured by more abstract modeling approaches. Quantitative models that combine annual crops (e.g., soy and rapeseed) with perennial crops (e.g., oil palm, which has a 25-year life cycle) are often difficult to decipher in terms of biodiesel's impact on farm incomes, employment, and food access. In addition, these models often fail to reveal whether biodiesel policies are driven by agriculture versus energy interests; whether the food security impacts occur at local, regional, or global scales; how policies in one country influence biodiesel investments in another; or how governments modify biodiesel policies according to global climate agreements, new trading arrangements, or food security and environmental objectives. Our review seeks to illuminate the agriculture, energy, environment, and trade aspects of biodiesel policies that influence food security in a dynamic political and economic context.

There are several reasons why we choose to focus on biodiesel as opposed to ethanol in our analysis. From an energy perspective, diesel is gaining market share over gasoline in transportation fuels, especially in developing countries where truck fleets are expanding rapidly (EIA, 2016). The share of diesel in transportation demand is expected to increase at various rates in all countries, and at a global scale, diesel is projected to account for up to 70% of transport fuel demand growth by 2040 (Exxon Mobil, 2013). From a food and agriculture perspective, biodiesel relies on a set of oil crops that are less well understood by many food security analysts than grains and starchy staples used in ethanol production. Oil crops constitute one of the fastest growing sectors of the world food economy. Edible oils consumption has expanded at three times the rate of cereals since 1990 and has accounted for roughly one-quarter of the global increase in per capita calorie intake since 1970 (Byerlee et al., 2017). Rising consumption of vegetable oils has improved the nutrition of extremely poor individuals who were previously deficient in fats, but it has also contributed to a global

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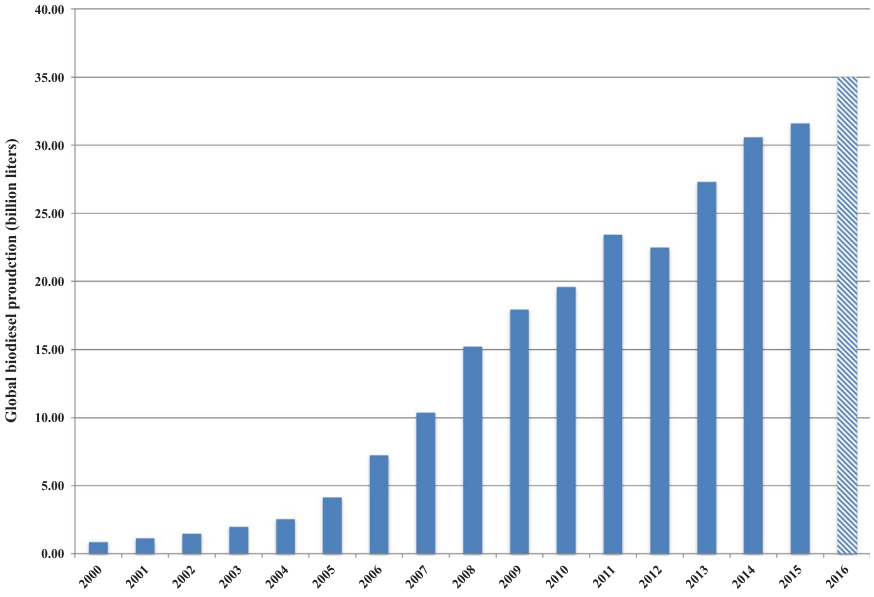

Fig. 1. Global biodiesel production, 2000–2016. Note: 2016 biodiesel production is estimated.
Sources: USDA, n.d.a; EIA, n.d.a; [dataset] EIA, n.d.b; REN21, 2016; World Bank (2017)

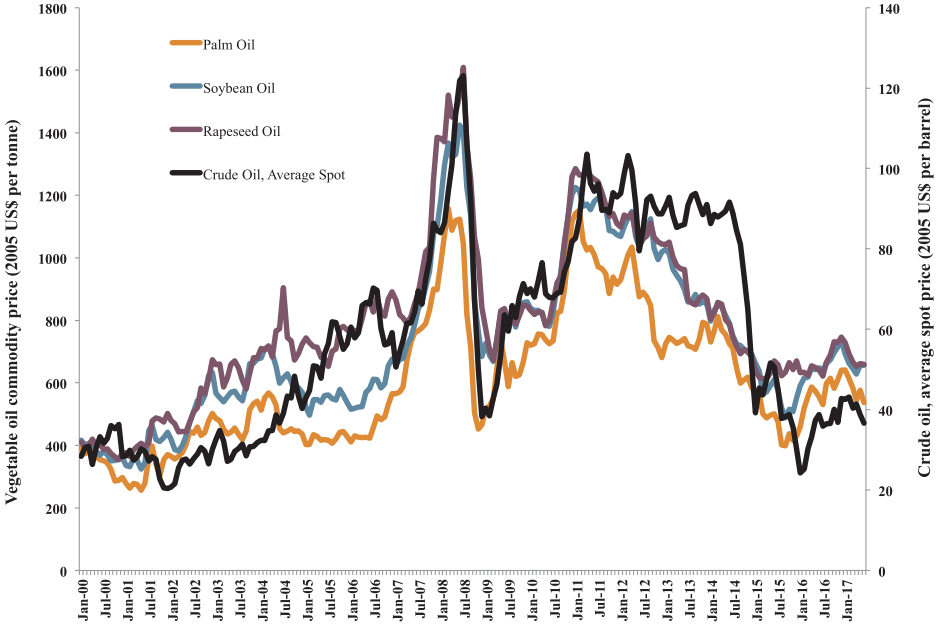

Fig. 2. Real prices of crude oil and major biodiesel feedstocks, 2000–2017. Notes: Crude oil price is an equally weighted average of Brent, Dubai, and West Texas Intermediate spot price monthly average. Palm oil price is the Malaysian bulk price, 5% FFA, C.I.F. N.W. European ports monthly average. Soybean oil price is the F.O.B. ex-mill Netherlands monthly average. Rapeseed oil price is the F.O.B. Rotterdam monthly average. One can examine either crude oil or diesel in relation to biodiesel, as the correlation between crude (European Brent) and diesel (LA Ultra Low Sulfur) prices was 0.989 between 2000 and 2015 (EIA, n.d.d).
Sources: World Bank (2017); IMF (2017)

obesity crisis affecting people of all income levels throughout the world (Naylor, 2016). Individual oil crops have different end uses as food, animal feed, industrial products, and fuel, and collectively, products derived from oil crops reach virtually all of the world's consumers. Biodiesel comprised 16.5% of global vegetable oil consumption in 2015, but it accounted for nearly 40% of the *increase* in vegetable oil demand worldwide between 2005 and 2015 (see Appendix 2).

From a global market perspective, international trade in biodiesel is substantially higher than trade in ethanol. Although biodiesel trade is only 10–15% of world production, it has been instrumental in establishing biodiesel industries in certain developing economies. As discussed in our case studies, policies introduced to expand biodiesel use in the EU and USA have provided a strong impetus for countries with large oil crop sectors to develop their biodiesel industries for export (Solomon et al., 2015; Mukherjee and Sovacool, 2014). Environmental policies in the EU and USA have also influenced patterns of trade in biodiesel and oil crops.

We begin with a description of recent trends in the global biodiesel sector and introduce a conceptual framework to trace the connections between biodiesel policies, production, and food security. We then use this framework to explore the influence of biodiesel policies on the oil crops sector in four regions: the EU, USA, Argentina, and Indonesia. Together, they account for almost 70% of global biodiesel production (Table 1). The paper concludes with a discussion of the food security implications of biodiesel growth based on experience from these countries, evidence from the literature, and global market trends in oil crops during the past 15 years.

2. Tracing the effects of biodiesel policies on food security

Global biodiesel production grew at an annual rate of 28% on average between 2005 and 2015, reaching an estimated 35 billion liters in 2016 (Fig. 1). The introduction of renewable fuel mandates and targets by the EU, USA, and other major agricultural economies in the mid-2000s helped to launch the biodiesel industry; global production doubled between 2005 and 2007 and then doubled again over the next three years. The jump in biodiesel output also corresponded with a period of rapidly rising crude oil prices (Fig. 2).