Land Use Policy 57 (2016) 229–240

Contents lists available at ScienceDirect

Land Use Policy

journal homepage: www.elsevier.com/locate/landusepol

Profits versus jobs: Evaluating alternative biofuel value-chains in Tanzania

Giacomo Branca[a,*], Luca Cacchiarelli[a], Irini Maltsoglou[b], Luis Rincon[c], Alessandro Sorrentino[a], Stefano Valle[d]

[a] Dipartimento di Economia e Impresa- DEIM, Università della Tuscia,Via del Paradiso 47, 01100 Viterbo, Italy
[b] Food and Agriculture Organization of the United Nations – FAO, V.le delle Terme di Caracalla, 00100 Rome, Italy
[c] Universidad Nacional de Colombia, Cra 27 #64-60 Manizales, Caldas, Colombia
[d] Dipartimento per la Innovazione nei Sistemi Biologici Agroalimentari e Forestali – DIBAF, Università della Tuscia, Via S. C. De Lellis snc, 01100 Viterbo, Italy

ARTICLE INFO

Article history:
Received 8 December 2014
Received in revised form 13 March 2016
Accepted 20 May 2016
Available online 10 June 2016

Keywords:
Liquid biofuel
Smallholder
Contract farming
Production cost
Rapid assessment

ABSTRACT

Biomass production for bioenergy use may contribute to rural development by increasing household incomes, local employment and energy supply, especially in developing countries. This paper presents a value-chain approach to evaluating the profitability and competitiveness of producing biodiesel or ethanol. We apply a 'rapid appraisal' accounting framework to the case of Tanzania, which is a data scarce setting and therefore well-suited to the proposed approach. The framework also estimates the number of jobs created in the biofuel sector under different production arrangements and related demand for land resource. We evaluate the potential trade-offs between different scales of biofuel production (both the scale of feedstock production and biofuel processing). We find that only sunflower-biodiesel is profitable, especially if produced in large-scale estate farming systems. Estate farming is the best option for profits and competitiveness, even if domestic biofuel production is never competitive on the international market for energy. We also find that the number of jobs depends crucially on the involvement of smallholders. Establishing out-grower schemes (or similar arrangements), rather than estate farms, should be a key policy objective if biofuels production is going to improve rural economy. However social benefits may be gained at a cost of reduced international competitiveness and increased land exploitation.

1. Introduction

Liquid biofuel[1] is a fast-growing market for agricultural products (Junginger et al., 2014; Lamers et al., 2011; Mathews, 2007; Matzenberger et al., 2015). Many developing countries have initiated biofuels development programs and in some contexts production is expanding quite rapidly. A large body of literature has focused on the global and regional impact of biofuel production (Esposti, 2008; Jaeger and Egelkraut, 2011; Schmidhuber, 2008). Many authors highlight that biofuel production in developing countries can enhance energy security, open export markets, create income-generating activities and new job opportunities therefore contributing to rural development and overall poverty reduction (Arndt et al., 2012; Ewing and Msangi, 2009; Hill et al., 2006; FAO, 2010, 2012; Müller et al., 2008; Negash and Swinnen, 2013; Pingali et al., 2008).

One key element of this debate is that biofuel investments could potentially enhance economic growth in rural areas but this will crucially depend on the role of smallholders in the biofuel economy and on the associated institutional set up (Arndt et al., 2010). As the biofuel industry is an emerging industry in most developing countries, fully developed supply chains hardly exist. Contract farming models can provide the coordination that is needed in newly developing supply chains (Bijman et al., 2009) while contractual arrangements that favour an outgrower configuration over estate farming may provide direct welfare benefits to smallholders (Ewing and Msangi, 2009). There is evidence that food crop yields increase after engaging in outgrower programs due to technology spillovers when inputs and extension services are supplied (Benfica, 2006; Glover, 1990; Uaiene, 2008). Additional benefits expected under the outgrower scheme include guaranteed markets, grants for community projects and employment opportunities (CSBF, 2009; Mwakaje, 2012; Phalan, 2009; Porter and Phillips-Howard, 1997).

* Authors are listed in alphabetical order. However, Giacomo Branca is the principal contributor and the corresponding author.
E-mail address: branca@unitus.it (G. Branca).

[1] In this paper biofuel refers to biologically based fuels produced from biomass, i.e. biodiesel and bioethanol. In Tanzania, straight vegetable oil is also used as a diesel alternative but it is not included as biofuel in this context.

http://dx.doi.org/10.1016/j.landusepol.2016.05.014

However, private investors may favour different institutional arrangements which can be more profitable (e.g. estate farming), especially in developing countries where smallholders' productivity and profitability are held back by lack of access to and poorly functioning commodity markets, limited access to financial markets, poorly performing producer organizations and absence of input markets. Trade-offs between private and social optimal outcomes exist and this may result in market failures to be corrected through adequate policy incentives. For example, it is argued that governments should consider not only financial incentives but also actions aimed at protecting smallholder by ensuring contracts mutually beneficial to growers and investors and supporting poorer households to overcome barriers to market entry (Ewing and Msangi, 2009).

In this frame, we present a value-chain approach to evaluating the profitability and competitiveness of producing biodiesel or ethanol. There is an extensive economic literature on the quantitative analysis of bioenergy value chains and food security in developing countries. Methodological approaches adopted can be grouped as follows. A first set of studies rely on Computable General Equilibrium (CGE) models. For example, FAO (2010) illustrates how biofuels investments in Tanzania affect economic outcomes and how economic growth is linked to household incomes; Arndt et al. (2010, 2012) evaluate different biofuels production options and estimate their impacts on food crops, economic growth, income distribution and poverty in Mozambique and Tanzania; Timilsina et al. (2012) analyze the long-term impacts of large-scale expansion of biofuels on land-use change, food supply and prices, and the overall economy in several countries. A second group of studies makes use of various micro-econometrics approaches. For example, Negash and Swinnen (2013) apply endogenous switching regression methods on survey data to assess the impact of castor production on poor and food insecure rural households in Ethiopia. Rajcaniova et al. (2014) apply time-series analytical mechanisms to estimate the long-run relationship between energy prices, bioenergy production, agricultural commodity prices and production, and the global land use change. A third set of studies adopts Spatial Decision Support Systems (SDSSs) models. For example, Verstegen et al. (2012) illustrate a case study for Mozambique in which it is evaluated where bioenergy crops can be cultivated without endangering nature areas and food production, when population and food intake per capita will increase and thus arable land and pasture areas are likely to expand. Last, several studies rely on a set of indicators which usually consider socio-economic and environmental sustainability of bioenergy systems. For example, Dale et al. (2013) identify 16 indicators that fall into the categories of social well-being, energy security, trade, profitability, resource conservation, and social acceptability. Florin et al. (2014) review indicator assessments of biofuel production involving smallholders and highlight the importance of holistically considering a range of social, economic and environmental criteria. Maltsoglou et al. (2015) use interdisciplinary indicators (socioeconomic and natural resources, agriculture sector and food security, energy supply and demand requirements) to define the country context for investments in bioenergy production and estimate the biomass available for bioenergy production linking this amount to specific bioenergy supply chains.

We present here a 'rapid appraisal' accounting framework which decomposes the costs of supplying a product from producer to market, and partially assesses the impact on profitability of investments in biofuel production, under minimum (agronomic, engineering and economic) data requirements and different production arrangements, i.e. small scale production and outgrower schemes versus large scale and estate farming. This framework offers a more tractable approach to assessing first-order profitability and employment considerations than other approaches reviewed above which, in general, require more time and use more data-intensive methods. This is the main methodological contribution of the paper. The proposed approach could provide preliminary information to policy makers in developing countries on how to promote biofuel production calibrating adequately incentives structure, contractual arrangements and services provision. We apply the framework to the case of Tanzania, which is a data scarce setting and therefore well-suited to the proposed method.

The framework also allows estimating the size of land needed to produce biomass, and the number of jobs created in the biofuel sector which in the end may impact overall food security and rural development, for different scales of biofuel production (both the scale of feedstock production and biofuel processing) and related contractual arrangements. We discuss the possible trade-offs between profitability and job opportunities in the rural areas under different biofuel production settings. While it is acknowledged that threats to food availability consequent to biofuels investment are big concerns in developing countries and that there is a considerable debate on the trade-offs between biofuels and food production (Acosta-Michlik et al., 2011; Anderman et al., 2014; Cassman and Liska, 2007; Molony and Smith, 2010; Moschini et al., 2012; Tenenbaum, 2008; Zezza, 2007), this dimension of food security is not taken into account in this paper.

Apart the CGE modelling work from FAO (2010) and Arndt et al. (2010, 2012) already taken into consideration above, other studies examine explicitly the role of smallholders in bioenergy chains and related contractual arrangements issues in South-East Africa. For example, investigating about jatropha production in Mozambique, Bijman et al. (2009) found that contract farming could reduce at least part of the transaction costs and risks related to biofuel production, also generating knowledge useful for smallholder farmers. According to Hoffmann et al. (2010), outgrower schemes might avoid most of the potentially negative environmental effects of intensive jatropha monocultures and promise to be better accepted by producers and decision makers of Tanzania. However, most of these studies do not provide a quantitative analysis of the production costs in the biofuel value chain and fail to look at the implications of the scale of production which we address here.

The paper is organized as follows. Section 2 presents the model specification and describes the dataset used. Section 3 reports results of the case study. Conclusions are reported in Section 4.

2. Materials and methods

2.1. The model

The methodology presented here is based on a value-chain top-down spread sheet based framework aimed at estimating profitability of first generation liquid biofuel production from feedstock crops using 'on-farm' and 'on-plant' financial budgets. The model can simulate different legal contractual arrangements (i.e. outgrower and estate farming schemes) and estimate demand for biomass production and land resource. Also, in order to determine the potential smallholder involvements in biofuel production, a simple methodology was built to capture the land requirements and biofuel conversions in the feedstock production for the implementation of ethanol and biodiesel plants and translate them into the number of smallholders involved.

The spread sheets are organized among three core components: 'crop budget', 'processing budget', 'employment & land use sub-model'. Crop budget component provides detailed estimation of feedstock production costs for three different technology levels (namely 'low-', 'intermediate-' and 'high-input'), corresponding to three possible contractual arrangements (independent, outgrower and estate farming, respectively). Results from the crop budget are