BIOMASS AND BIOENERGY 45 (2012) 27–40

Available online at www.sciencedirect.com

SciVerse ScienceDirect

http://www.elsevier.com/locate/biombioe

The economics of short rotation coppice in Germany

*Rouven Jonas Faasch, Genevieve Patenaude**

School of Geosciences, The University of Edinburgh, Drummond Street, Edinburgh EH8 9XP, UK

ARTICLE INFO

Article history:
Received 4 January 2012
Received in revised form
27 March 2012
Accepted 9 April 2012
Available online 3 July 2012

Keywords:
Short rotation coppice
Germany
Economics
Poplar
Willow
Energy crops

ABSTRACT

Short Rotation Coppice (SRC), which entails managing wood plantations as perennial energy crops on agricultural land, has the potential to contribute significant amounts of wooden biomass to Europe's energy mix. Yet, uncertainty prevails about the future of key economic variables determining the viability of SRC cultivations. Consequently, agriculturists face challenges when conducting ex-ante economic analyses of SRC projects and measuring performance against the alternative, agricultural crops. This paper scrutinises five key determinants of SRC economic viability: yield level, woodchip market price, subsidies, cost level and opportunity costs for conventional agricultural crops. By utilising site-specific conditions and different future scenarios we provide a comprehensive economic appraisal of SRC plantations for agriculturists. We focus our analysis on Germany. Our results show that SRC plantations are less profitable under the medium scenario when compared with agricultural crops. Notwithstanding, favourable political and economic conditions such as subsidies, lower costs and higher woodchip prices can lead to SRC's superior profitability. If the German government is serious about improving investments conditions for commercial SRC plantations, we recommend introducing sufficient, efficient and consistent subsidies.

1. Introduction

Europe faces the threefold challenge of meeting increasing energy demands while reducing its dependency on fossil fuels and mitigating climate change. To effectively address these challenges, the European Union (EU) aims to support the development of renewable energy sources. This is embodied in Directive 2009/29/EC, which states that at least 20% of total energy consumption should be met by renewables by 2020. (10% in the transport sector) [1].

This target still requires ample efforts from Member States. In 2009, only 9% of EU's gross inland energy consumption was from renewable sources, of which biomass contributed the largest share (68.6%) [2]. Given its high-energy content and versatile use for electricity and heat generation, wood is a preferred source of biomass. Most wooden biomass is sourced from conventional forestry or directly derived from existing wood residues or industrial by-products.

An alternative option for wood biomass sourcing is Short Rotation Coppice (SRC). This entails managing wood plantations as perennial energy crops. Common plants suitable for SRC include poplar (*populus spp.*), willow (*salix ssp.*) and miscanthus (*miscanthus spp.*). These are planted on agricultural land and harvested in 2–5-year rotation cycles. The total operation length varies between 20 and 30 years concluding with a re-cultivation of the planted land [3–5]. SRC offers a number of advantages relative to competing agricultural crops: it requires less operational efforts; provides soil protection against wind and water erosion; limits nutrient leaching and requires reduced fertilisation. As a result, it has

* *Corresponding author*. The University of Edinburgh, School of Geosciences, Rotthäuser Weg 18a, Düsseldorf 40629, NRW, Germany. Tel.: +49 177 560290; fax: +49 211 5235100.
E-mail address: rouven.faasch@googlemail.com (R.J. Faasch).
0961-9534/$ – see front matter
doi:10.1016/j.biombioe.2012.04.012

been argued that SRC improves the sustainability of agricultural production [6,7].

Despite these advantages, plantations managed under SRC are still marginal in Europe. Sweden is the largest SRC operator (16,000 ha) followed by Poland (9000 ha), UK (6000 ha), Italy (5000 ha), Germany (5000 ha) and France (3000 ha) [7]. The lack of commercially driven SRC establishment is partially due to operators seldom achieving economically attractive yield levels under current woodchip prices [8,9].

Furthermore, much uncertainty prevails about the future of key economic variables determining the viability of SRC cultivations, such as woodchip prices or subsidies. Consequently, agriculturists face challenges when conducting ex-ante economic analyses of SRC projects and measuring performance against the alternative, annual agricultural crops, with an investment horizon of one year or less [10,11]. An additional merit of agricultural crop plantations in contrast to SRC is that agriculturists can choose what crops to grow from year to year based on their current market prices. SRC sites as long-term investments limit the opportunity to benefit from attractive agricultural crop prices.

Despite increased interest in SRC as a potentially viable economic activity, the existing literature falls short of providing reliable economic benchmarks for individual SRC agriculturists. Below, we review existing literature along the five key determinants of SRC economic viability: yield level, woodchip market price, subsidies, cost level and opportunity costs. This paper aims to enhance the assessment of these key variables in order to facilitate a comprehensive economic appraisal of the competitiveness of SRC. The applied methodology considers site-specific conditions and conducts scenario analysis.

We focus our SRC analysis on Germany. The reason for this is that future political and economic developments are likely to turn SRC operations more attractive: First, a governmental scenarios analysis predicts that 450,000 ha could be planted with SRC by 2020 [12]. In order to achieve this, subsidies as well as governmental funding to private research initiatives for SRC might be necessary. In addition, increasing demand for wooden biomass can be expected [7]. Finally, large energy suppliers have recently started to develop commercial SRC projects as a means to supply their combined heat and power plants.

In the following, the five key economic variables for SRC operations will be introduced.

1.1. *Yield level*

The yield level significantly affects revenues of SRC plantations. Yield estimation depends on both managerial decisions and site-specific conditions. To avoid destructive sampling, empirical non-destructive SRC yield models are commonly used [13,14]. Model design and application are however often country-specific. For instance, Mola-Yudego & Aronsson's model [8] is based on a district-specific agro-climatic index in Sweden and Evans et al.'s model [15] requires the provision of UK grid references. In Germany, Wael [16] and Murach et al. [17] developed SRC yield estimators, yet these suffer from a number of limitations for the applications considered in our study. While Wael's model is adapted for different poplar genotypes, varying rotation lengths and site-specific data (soil quality, temperature and water supply), it only generates yield forecasts for the first harvest. The effect of increasing biomass production levels in subsequent rotations as a result of increased SRC rooting systems is neglected [5,18,19]. The same shortcoming applies to Murach et al.'s model. In addition, Murach et al.'s model exclusively forecasts yield depending on available water supply while assuming site conditions and genotype choice to be optimal.

In response to this, we propose a new yield estimator that predicts long-term yield levels for three poplar and one willow species in 3-year rotation cycles. Differing site conditions and planting densities are integrated as parameters to the estimator.[1]

1.2. *Woodchips market price*

The second key determinant impacting SRC revenue is woodchips market price. Between 2003 and 2010, real woodchip prices in Germany have increased by 56% (from 14.9 € /*MWh* to 23.2 € /*MWh*). This is a result of soaring demand and rising heating oil prices, advances in bioenergy technologies and political support for renewables. Price growth is expected to continue, albeit at lower pace. This would imply higher revenues for a given amount of produced biomass. Agriculturists are moreover interested in price developments of agricultural crops in relation to woodchip. The OECD and FAO for instance expect cereal prices to decline until 2020 which would turn SCR sites economically more attractive [20]. There is high uncertainty about both future woodchip and agricultural crop prices: key forces driving price volatility entail the evolution of the oil price, climate change legislation, improvements in yield levels and the adaptation of agriculture to climate change.

Despite the importance of woodchip and agricultural crop price volatility on SRC profitability, this impact has not been fully considered in the literature. In this study, woodchip prices were forecasted based on different heating oil price scenarios derived from the Energy Information Administration (EIA) [21].

1.3. *Subsidies*

The third determinant considered is subsidies for SRC plantations. For instance, the Federal State of Saxony reimburses up to 30% of initial SRC investments (expenditure related to site preparation, cuttings plantation and fencing) [11]. The Energy Crop Scheme in England provides a similar subsidy, which covers 50% of all eligible SRC expenses [22]. Subsidies can also be granted in the form of fixed area payments, as in Sweden [23]. In this case, operators are given a payment per hectare of planted SRC. Both subsidy designs and their impact on SRC profitability are explored in this paper.

1.4. *Cost levels*

Cost related estimates to SRC operations vary widely and are not comprehensively reviewed in the literature. This creates

[1] It should be noted that the estimator can also be applied in countries outside Germany. This will be shown in 2.1.