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Prospects for dedicated energy crop production and attitudes towards agricultural straw use: The case of livestock farmers

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HIGHLIGHTS

- Survey of English livestock farms determining attitudes to dedicated energy crops.
- 6.3% to 7.2% of surveyed farmers would consider growing energy crops.
- Limited potential for dedicated energy crops on livestock farms in England.
- Livestock farmers would continue to buy straw, even at higher market prices.
- Wide range of reasons given for farmers' decisions related to energy crops.

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ABSTRACT

Second generation biofuels utilising agricultural by-products (e.g. straw), or dedicated energy crops (DECs) produced on 'marginal' land, have been called for. A structured telephone survey of 263 livestock farmers, predominantly located in the west or 'marginal' upland areas of England captured data on attitudes towards straw use and DECs. Combined with farm physical and business data, the survey results show that 7.2% and 6.3% of farmers would respectively consider growing SRC and miscanthus, producing respective maximum potential English crop areas of 54,603 ha and 43,859 ha. If higher market prices for straw occurred, most livestock farmers would continue to buy straw. Reasons for not being willing to consider growing DECs include concerns over land quality, committing land for a long time period, lack of appropriate machinery, profitability, and time to financial return; a range of moral, land quality, production conflict and lack of crop knowledge factors were also cited. Results demonstrate limited potential for the production of DECs on livestock farms in England. Changes in policy support to address farmer concerns with respect to DECs will be required to incentivise farmers to increase energy crop production. Policy support for DEC production must be cognisant of farm-level economic, tenancy and personal objectives.

1. Introduction

Renewable energy policies have become embodied legislation in a number of countries (e.g. the EU, Directive 2009/28/EU EU, 2009) as part of the drive to reduce reliance upon fossil fuels and mitigate greenhouse gas emissions (Goldemberg, 2007). While first generation biofuels (typically derived from crops which can be processed into food or energy [e.g. cereals, oilseed, sugar crops] Lovett et al., 2014) initially gained wide political support (Boucher, 2012), concerns over their legitimacy (Upham et al., 2011) and increasingly negative media coverage (Sengers et al., 2010) quickly surfaced. These concerns included food versus fuel land use change (LUC) (Boucher, 2012; Rathmann et al., 2010), indirect land use change (iLUC) (Kim et al., 2009) and the potential for biofuel induced land use change to lead to increased greenhouse gas emissions (Searchinger et al., 2007). Consequently, interest emerged in advanced, or second generation, biofuels that can make use of waste streams and co-products (e.g. corn stover, cereal [wheat, barley, rice] straw), or dedicated energy crops (DECs, e.g. miscanthus, short rotation coppice willow [SRC]). Hence second generation biofuels utilise biomass that is derived from non-food crops with greater energy generation efficiency (Lovett et al., 2014) or waste/co-product biomass. A commercial second generation processing plant now exists in the EU, in Italy (Anon, 2013), with development plans for other second generation plants, for example in the USA and Europe, already in place

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(Walker, 2013). However, in light of LUC and iLUC concerns, recent literature distinguishes between co-product (e.g. cereal straw) second generation biofuels (CPSGB) and dedicated energy crop second generation biofuels (DESGB; Glithero et al., 2012), providing clarity between feedstock sources used within different second generation biofuel supply chains. However, CPSGBs still have resource use implications that must be considered: straw is utilised in livestock bedding and feeding, soil conditioning, and nutrient provision for arable crops (Copeland and Turley, 2008; Glithero et al., 2013a, 2013b; Powlson et al., 2011). Cereal straw is currently used within the UK in electricity power generation (e.g. the Ely Power Station) and recent research investment (e.g. BBSRC Sustainable Bioenergy Centre) has explored the potential to use cereal straw as a feedstock for lignocellulosic biofuel. With respect to DESGB, UK policies to encourage DEC production have until recently (August 2013) existed in the form of perennial bioenergy crop establishment grants (Natural England, 2013). However, despite the financial assistance that establishment grants provide, areas of these crops currently grown in the England are small and declining: SRC 2600 ha (declining from 6200 ha to 2600 ha over the 2008–2012 period), miscanthus 7000 ha (increasing from 7400 ha in 2008 to a peak of 9200 ha in 2009, followed by a decline to current levels) (Defra, 2013). It should be noted that these data are derived from non-National Statistics approved approaches and are additionally associated with large confidence intervals around the point estimates provided. However, these data do indicate that financial assistance alone, in the form of establishment grants, is insufficient to incentivise large scale production change. Moreover, the collapse of bioenergy companies that held contracts to purchase DECs has generated increased business uncertainty for those farmers willing to produce these crops (Sherrington et al., 2008) due to limited or non-existent alternative markets. This paper seeks to provide an understanding of English livestock farmer attitudes towards using their land for DEC production and their use of cereal straw when faced by an increased straw input price. This understanding will complement previous research for the arable sector in England (Glithero et al. 2013c) and be of direct relevance to policy makers seeking to achieve an increased supply of biomass production.

The rationale for examining attitudes of livestock farmers in part flows from calls to produce DECs on land not needed, or unsuitable, for food crops. Agricultural land use in the UK is dominated by both crop and livestock production. However, issues of land use appropriate for energy production represent global concerns, and are not restricted to a European or Western view alone (Fritsche et al., 2010; Zhuang et al., 2011; Tang et al., 2010). Previous studies have also considered the suitability of using 'marginal' land for energy crop production (McElroy and Dawson, 1986). However, defining 'marginal' land is potentially problematic; marginality can be defined in terms of economic output or reduced crop yield potential (e.g. Shortall, 2013; Gopalakrishnan et al., 2011), unsuitability for food crop production (e.g. Royal Society, 2008) or of low value for agricultural or biodiversity use (Royal Society, 2008). More structural definitions of land restrictions placed on energy crop production include excluding grade 1 and 2 land (the most productive for arable cropping) and land with slopes of $>15\%$ (Lovett et al., 2014; Wang et al. 2014). Swinton et al. (2011) question whether marginal land can be made available at sufficiently low cost, while Garnett (2009) argues that livestock farms on 'marginal' agricultural land may provide an important role in maintaining grasslands and the carbon sinks associated with these areas. Within the UK, grazing livestock production systems are predominantly located in western and upland areas (Fogerty et al., 2013; Harvey and Scott, 2013), where respectively higher annual rainfall and poorer quality agricultural land exists relative to the main arable cropping areas. Hence, while a standard definition of 'marginal' land does not exist, within the context of bioenergy production, the approach of considering agricultural land grades 3–5 as appropriate for bioenergy crops (Lovett et al., 2014) highlights the need to understand farm decision making within the livestock sector. Several authors have examined the environmental consequences of livestock production on marginal land (e.g. Acs et al. 2010; Oglethorpe, 2005) with respect to understanding livestock farmer behaviour and decision making in response to market and policy signals. To complement understanding of farmer behaviour in the arable sector (Glithero et al., 2013c), we therefore need a greater understanding of marginality with respect to livestock farmer decision-making and DEC production, particularly as livestock production is both an important component of the UK's agricultural economy and its land use.

With respect to cereal straw, Glithero et al. (2013a) note the potential supply for larger scale use of straw in lignocellulosic processing facilities in England, estimating that 2.5 mt of cereal straw could be made available for bioenergy purposes. Such volumes of feedstock supply to biofuel uses will affect current straw markets (Glithero et al., 2013a), driving up product prices; the response of livestock farmers to this price increase is currently unknown but is of fundamental importance to any competing CPSGB industry, because the input feedstock cost is likely to form a substantial proportion of the overall costs of biofuel production.

Previous research examining farmer attitudes towards DEC production identified that availability of land (Adams et al., 2011), committing land to a single crop for a long time period (Glithero et al., 2013c), impact of DECs on land quality (Glithero et al., 2013c; Sherrington et al., 2008), relative financial return and cash-flow considerations (Adams et al., 2011; Glithero et al., 2013c), and knowledge of, or familiarity with, the crop (Glithero et al., 2013c) can have a direct impact upon farmer decisions about DEC production. Significant effects relating to managerial biographical factors (e.g. farmer age; Paulrud and Laitlia, 2010), managerial attitudes (e.g. objectives towards the environment; Augustenborg et al., 2012) and farm business physical factors (e.g. farm size and location; Paulrud and Laitlia, 2010) on attitudes towards DEC production have also been found. Conversely, other researchers have not identified significant relationships between farm and farmer characteristics and attitudes towards DEC production (Glithero et al., 2013c). Additional farmer attitude factors towards the production of DECs include the remoteness or location of their farm in relation to a bioenergy plant, the topography of their farm land, and prevailing climatic conditions that impact on soil moisture content (for both crop production and harvesting). The presence of farm advisors has been cited as a mechanism by which DEC production can be encouraged (Velandia et al., 2010; Glithero et al., 2013c; Alexander et al., 2014a) in an environment where lack of knowledge of the crops exist. With respect to quantifying the potential production of DEC within England, taking into account farmer willingness to consider growing SRC and miscanthus, either separately or jointly, Glithero et al. (2013c) estimate that arable farms in England could potentially supply 50,700 ha of SRC and 89,900 ha of miscanthus, assuming farmers would convert less than 10% of their land area. Other researchers have identified that farmers in the UK are only likely to convert a small proportion of the land area to DEC, and on their least productive land, even where interest in these crops exists (Sherrington et al., 2008).

Understanding both the factors that influence the supply of biomass feedstock and the competing demands for feedstock are therefore crucial to the development of a commercial bioenergy sector, in particular for second generation feedstock in its current embryonic commercial stage (Walker, 2013). By using survey techniques, this paper examines some of these potentially