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More than food or fuel. Stakeholder perceptions of anaerobic digestion and land use; a case study from the United Kingdom

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HIGHLIGHTS

- Drivers and benefits of AD are not necessarily the production of biogas or energy.
- Stakeholders perceive policy uncertainties as major challenge.
- Land use conflicts of no concern as long as AD provide agricultural solutions.
- Policies should consider synergies between energy generation and agricultural systems.

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ABSTRACT

Anaerobic digestion (AD) is of growing importance within the UK as it can make an important contribution to the countries energy and climate change targets. With the growth of the sector, discussions about competing land uses are likely to increase. For a better understanding of the synergies between agricultural land, its role and bioenergy the perception of the different stakeholders will play an important role. The perception of stakeholders related to AD, feedstock and energy crop production was investigated through interviews and a stakeholder workshop. The results indicated that from an AD operator and feedstock producer perspective, on-farm AD is more an additional activity integrated into existing agricultural systems than a renewable energy technology. The risk of a shift in agricultural practices and large areas to grow energy crops for AD is seen as low for the UK. Nonetheless, land use and related challenges need to be considered as the demand for AD feedstocks increases with the fast growth of the sector. Considering the synergies between bioenergy and agriculture as well as the motivations and benefits perceived by stakeholders will play an important role in a successful policy design to provide the required emission reduction in both sectors without subverting sustainability.

1. Introduction

Anaerobic digestion (AD) is a technology of growing importance within the UK's bioenergy sector. AD produces two main products: biogas and digestate. Biogas can be used for heat, power and as transport fuel. Digestate can be applied to the land as organic fertiliser. With this AD is considered to contribute to the UK's energy and climate change targets and to provide several benefits such as waste management, environmental sustainability or renewable energy (Defra, 2015a; KADA, 2013). At the same time it evokes a discussion about competing land use for food or bioenergy feedstock production (ADBA, 2012; Defra, 2015a; FoE, 2014; Havlik et al., 2010; Styles et al., 2014). This is mainly the result of experiences made in countries with a large AD sector such as Germany, France, Denmark or Italy (Defra, 2011) and experiences made with other bioenergy applications and 1st generation biofuels in relation to land use change (ADBA, 2011; Defra, 2011; FoE, 2014). The environmental and socio-economic impacts of land use change can be found in existing literature (Creutzig et al., 2015; Gawel and Ludwig, 2011; Havlik et al., 2010; Humpenöder et al., 2013; Jean Vasile et al., 2016; Searchinger et al., 2008; Van Stappen et al., 2011) and are not the main focus of this research. In the UK currently about 0.5% of the arable cropping land is used to produce purpose grown crops (PGC) for AD (NNFCC, 2015). PGC are crops grown for a single-specific use with characteristics and properties most relevant for the end-use. In the case of this research, PGC are grown as feedstocks for bioenergy (AD) applications. It is projected that the annual demand for land to produce PGC for AD will increase to about 1% of the UK's arable cropping land until 2020 (NNFCC, 2015). The AD sector and policy makers are aware of

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concerns linked to the use of PGC and land use (ADBA, 2011). However, the current risk for intensive production of a single crop as monoculture for AD is seen as low (ADBA, 2012; Defra, 2011). This is mainly due to recommendations for good agricultural practice and tariffs in place, influencing the technology pick-up and sectors' growth rate (Decc, 2014a,b,c; Defra, 2011; NNFCC, 2015). Nonetheless, the AD sector in the UK shows currently a high growth rate (IEA, 2014; Thrän et al., 2014) and little is known what role PGC will play and their land use consequences in the medium- and long-term future.

There is an increasing amount of research taking place relating to AD processes and associated technologies in the UK (BBSRC, 2016). To date little attention has been paid to the social elements related to AD facility developments, operations and the role of agricultural land. Despite an awareness of stakeholder perceptions related to growing energy crops, no research considering the social elements of PGC for AD has been undertaken in the UK. The awareness of bioenergy has been identified as lower compared to other renewables among the general public (Halder et al., 2010; Popp et al., 2009; Upham and Shackley, 2007; Upreti and van der Horst, 2004). Lack of familiarity or awareness of bioenergy projects may result in resistance, even if the projects are environmentally and economically viable and technologically robust (Halder et al., 2010; Jenssen, 2010; Mattison and Norris, 2007; Rohracher, 2010; Upham and Shackley, 2007). Public understanding and support of bioenergy is an essential element for policies aimed at the introduction and wider use of bioenergy (Rohracher, 2010). The impact and influence of stakeholders should therefore not be underestimated (Sinclair and Löfstedt, 2001; Upham and Shackley, 2006; Upreti and van der Horst, 2004). Research investigating stakeholder perception is usually done from the perspective of the public, while directly involved supply chain actors get less attention (Radics et al., 2015). This research investigated directly involved supply chain actors such as farmers, feedstock providers, AD operators, AD developers and trade organisations to identify their views on land use and general motivations, benefits, challenges of AD operations. This will add to the limited available evidence in this research area.

First, the paper gives a short overview on agricultural land use in the UK. Secondly, it will present the results from the stakeholder engagement process. The main objective was to examine the stakeholders' perception of land use and the role of agricultural land in the context of AD from a supply chain actor's perspective. The investigation of drivers, benefits and challenges for AD built an important part to understand the context and wider impacts of this specific bioenergy sector. The stakeholder engagement process presents two levels of activities. Firstly, the results from interviews with stakeholders, partly combined with site visits, are described. Based on these, a ranking exercise was conducted during a workshop with the participating stakeholders to quantify the preliminary results in an order of importance. With this, the research will provide insights into AD related stakeholder perception, which so far has not been investigated for the UK.

2. AD sector in the UK and land use implications

2.1. Purpose Grown Crops (PGC) for anaerobic digestion in the UK

In the UK about 18.5 million hectares are used as agricultural land (Defra, 2014). Fig. 1 shows that the use of this land is dominated by permanent grassland (Defra, 2014). About 27% of the agricultural land is used for crops, which makes up about 4.7 million hectares in total (Defra, 2014). This agricultural land and temporary grassland are the area, which is considered as viable in relation to land use for PGC in this research.

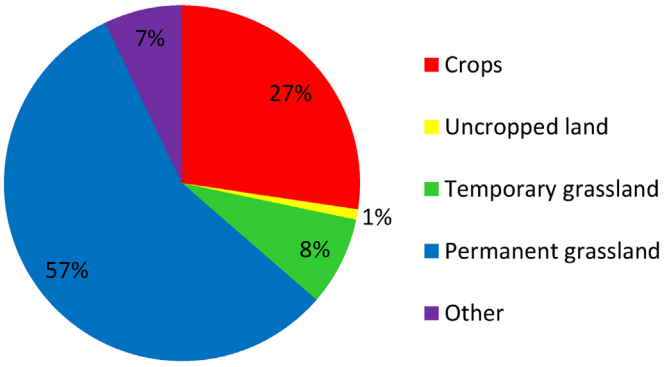

Fig. 1. Agricultural land use in the UK in 2014, generated from Defra data (Defra, 2014).

Fig. 2 shows the split of the arable crop area with wheat and barley dominating the production and maize, which is partly used as AD feedstock grown on about 4% (183,000 ha) of the crop area (Defra, 2014). Fig. 2 also shows that historically maize is not a main crop in the UK. Even though the share of area utilised for maize production is small compared to other crops such as cereals and oilseed rape, the land maize is grown on has increased steadily over the last 3 decades from 16,000 ha in 1984 to 183,000 ha in 2014 (Defra, 2014). The main share of maize grown in England is for animal feed (132,000 ha of 173,000 ha) (Defra, 2015b). There are claims that maize production for AD has little impact on changes of agricultural practices and land use in the UK (ADAS, 2016; ADBA, 2012; Defra, 2011); nevertheless, land used to grow maize for AD increased between 2014 and 2015 from 29,000 ha to 34,000 ha (Defra, 2015b).

2.2. AD Industry in the UK and Outlook

The UK's on-farm AD sector is still in development and compared to countries such as Germany or Italy relatively small (EBA, 2015). Currently 185 CE plants are operational (NNFCC, 2015). This does not include wastewater and municipal solid and commercial waste. 102 of these plants are farm-fed, and 83 are waste-fed, all totalling to a capacity of about 168 MWe (NNFCC, 2015). 18 of these plants are biomethane-to-grid plants of which 2 are industrial (brewery waste), 3 community (food waste) and 13 agricultural (8 PGC, 4 PGC-waste mix, 1 waste) facilities (NNFCC, 2015).

The mix of feedstock types and requirements of the UK's AD sector is shown in Table 1. Waste and residue feedstock are dominant with about 4 Mt while PGC make up less than one quarter (about 23% of feedstock requirements). Apart from crop residues, the feedstock requirements for all categories are projected to double by 2020 (NNFCC, 2015). This also means that the role of PGC will increase and are projected to cover about 27% of the feedstock requirements (NNFCC, 2015).

2.3. Land use change implication from the AD sector in the UK

In terms of land, currently about 0.5% of UK's total arable crop land is used for PGC for AD (NNFCC, 2015). With the increasing demand from the AD sector, the area is expected to expand to about 60,000 ha by 2020 (NNFCC, 2015). This appears to be a small amount of land used for AD crops compared to other countries such as Germany where about 1.27 Mha are utilised to grow AD feedstocks (FNR, 2015). Nonetheless, an increasing utilisation of agricultural land for PGC is taking place but the future patterns and to which extent land use is changing is unclear. Recent research evaluate the possible impact of PGC for AD (with focus on maize) and agricultural land rental prices in the UK and if this