Bioenergy Review (2018) - Call for evidence : Entry # 1316

The Centre for Ecology & Hydrology (CEH) is a component of the Natural Environment Research Council (NERC) and is the UK's Centre of Excellence for integrated research in terrestrial and freshwater ecosystems and their interaction with the atmosphere. For 10 years the Plant-Soil Interactions Group at CEH Lancaster have led research studying the impacts of land-use change to 2nd generation bioenergy crops on soil carbon stocks and greenhouse gas emissions, and ecosystem services more broadly. We have coordinated (McNamara PI) large consortium projects such as the £4M Energy Technologies Institute Ecosystem Land Use Project (ELUM) and NERC Carbo-Biocrop projects (McNamara, Whitaker, Co-Is). Here we have translated detailed soil C and GHG measurements across multiple field sites into improvements in process based soil models for agricultural systems. More recently the EPSRC project MAGLUE is addressing nitrous oxide hotspots after land use change (McNamara, Whitaker co-I's). We also have expertise in the impacts of 2nd generation bioenergy crops on biodiversity (Rowe).

This submission has been compiled by Dr Jeanette Whitaker (Senior Research Scientist and NERC Knowledge Exchange Fellow on Bioenergy), Dr Niall McNamara (Head of the Plant-Soil Interactions group and Principal Scientist) and Dr Rebecca Rowe (Bioenergy Research Scientist).

10. Please highlight any further measures you feel are required to ensure bioenergy feedstocks used in the UK are sustainable and deliver significant life-cycle GHG emissions savings. Why are these measures needed?

Evidence from the Energy Technologies (ETI) ELUM project (www.elum.ac.uk; Rowe et al 2016; Richards et al 2017) in the UK and other similar research internationally (Whitaker et al 2017; Qin et al 2015) has demonstrated that planting perennial energy crops onto low carbon soils will minimize soil carbon losses in the short-term and promote soil carbon sequestration in the long-term. However, the converse is also true that planting perennial bioenergy crops onto high carbon mineral soils leads to a greater risk of soil carbon loss, the magnitude of which can significantly influence the life-cycle GHG balance (Whitaker et al 2017; Richards et al 2017). Incorporating direct land-use change impacts on soil carbon stocks and protecting high carbon mineral soils, in addition to the current protections for high carbon peat soils should therefore be a priority. This could be incorporated into any criteria for scaling up domestic supply in the UK.

In the case of perennial crops such as Miscanthus and Short Rotation Coppice (SRC) it also accepted that adopting best practices in management is likely to improve yields and deliver further GHG benefits through enhanced soil carbon sequestration and GHG mitigation (Davis et al 2013). The longevity and yield of the crops are also key factors in the overall GHG balance achieved. Soil C sequestration is slow process thus to maximize sequestration criteria must encourages the longevity of plantation while they remain productive (15-20 yrs.) (Rowe et al., 2016, Whitaker et al., 2017).

Evidence from numerous studies in the UK and Europe have shown the incorporation into the farming landscape of the second generation bioenergy crops Miscanthus (Bourke et al., 2013, Petrovan et al., 2007) and Willow SRC (Rowe et al., 2009, 2011, 2013) generally has positive impacts on farmland biodiversity (Rowe et al., 2009). Impacts however depend on the location and scale of planting, large mono cultures of any crop can be detrimental to diversity, therefore to ensure long term benefits for farmland biodiversity criteria for planting must consider the scale and location of planting (Dauber & Miyake 2016, Bourke et al., 2013, Rowe et al., 2011).

Rowe RL, Keith AM, Elias D, Dondini M, Sith P, Oxley J and McNamara NP (2016)

Initial soil C and land-use history determine soil C sequestration under perennial bioenergy crops. GCB Bioenergy, 8 1046-1060. doi: 10.1111/gcbb.12311.

Richards M, Pogson M, Dondini M, Jones EO, Hastings A, Henner DN, Tallis MJ, Casella E, Matthews RW, Henshall PA, Milner S, Taylor G, McNamara NP, Smith JU, Smith P (2017) High-resolution spatial modelling of greenhouse gas emissions from land-use change to energy crops in the United Kingdom. Global Change Biology Bioenergy 9, 627-644.

Whitaker, J. Field, JL. Bernacchi CJ, Ceulemans R., Davies CA., DeLucia EH., Donnison IS., McCalmont JP., Paustian K., Rowe RL., Smith P., Thornley P., McNamara NP. (2017) Consensus, uncertainties and challenges for perennial bioenergy crops and land-use. GCB Bioenergy. doi: 10.1111/gcbb.12488

Qin Z, Dunn JB, Kwon H, Mueller S, Wander MM (2016) Soil carbon sequestration and land use change associated with biofuel production: empirical evidence. GCB Bioenergy, 8, 66–80. Doi: 10.1111/gcbb.12237

Sarah C Davis, Robert M Boddey, Bruno JR Alves, Annette L Cowie, Brendan H George, Stephen M Ogle, Pete Smith, Meine Noordwijk, Mark T Wijk (2013) Management swing potential for bioenergy crops. GCB Bioenergy, doi. 10.1111/gcbb.12042

Bourke D, Stanley D, O'Rourke E et al. (2014) Response of farmland biodiversity to the introduction of bioenergy crops: effects of local factors and surrounding landscape context. GCB Bioenergy, 6, 275–289.

Dauber J, Miyake S (2016) To integrate or to segregate food crop and energy crop cultivation at the landscape scale? Perspectives on biodiversity conservation in agriculture in Europe. Energy, Sustainability and Society, 6, 25.

Petrovan SO, Dixie J, Yapp E, Wheeler PM (2017) Bioenergy crops and farmland biodiversity: benefits and limitations are scale-dependant for a declining mammal, the brown hare. European Journal of Wildlife Research, 63, 49

Rowe RL, Street NR, Taylor G (2009) Identifying potential environmental impacts of large-scale deployment of dedicated bioenergy crops in the UK. Renewable and Sustainable Energy Reviews, 13, 271–290.

Rowe RL, Hanley ME, Goulson D, Clarke DJ, Doncaster CP, Taylor G (2011) Potential benefits of commercial willow Short Rotation Coppice (SRC) for farm-scale plant and invertebrate communities in the agri-environment. Biomass and Bioenergy, 35, 325–336.

Rowe RL, Goulson D, Doncaster CP, Clarke DJ, Taylor G, Hanley ME (2013) Evaluating ecosystem processes in willow short rotation coppice bioenergy plantations. GCB Bioenergy, 5, 257–266.

13. What is the latest evidence relating to the availability of 'marginal' and abandoned agricultural land for growing bioenergy crops (where possible, reflecting broader sustainability requirements e.g. water stress, biodiversity, social issues)? Is this evidence adequately reflected in global resource estimates?

While limiting energy crops to marginal or abandoned land reduces competition with food production a greater land area is required due to potentially decreased yields. Such an approach may overlook additional benefits which might be achieved by integrating bioenergy into the landscape in a more structured way. For example, greatest biodiversity benefits may occur by incorporating second generation crops into productive arable cropping systems where landscape heterogeneity is most limited (Petrovan et al 2017, Rowe et al., 2011, Sage 1998).

Latest information on land availability for the UK is available in the ETI ADAS report on Refining estimates of land for biomass (Wynne et al 2016)

S Wynn, L Alves, R Carter (2016) Refining Estimates of land for Biomass: Route map to 1.4M ha of bioenergy crop, ETI : http://www.eti.co.uk/library/refining-estimates-of-land-for-biomass

Petrovan SO, Dixie J, Yapp E, Wheeler PM (2017) Bioenergy crops and farmland biodiversity: benefits and limitations are scale-dependant for a declining mammal, the brown hare. European Journal of Wildlife Research, 63, 49

Rowe RL, Hanley ME, Goulson D, Clarke DJ, Doncaster CP, Taylor G (2011) Potential benefits of commercial willow Short Rotation Coppice (SRC) for farm-scale plant and invertebrate communities in the agri-environment. Biomass and Bioenergy, 35, 325–336.

Sage R. (1998) Short rotation coppice for energy: towards ecological guidelines. Biomass and Bioenergy, 15, 39–47.

18. What are the main opportunities to scale-up the supply of sustainably-produced domestic bioenergy supply in the UK?

Business models such as those used by Iggesund (for SRC willow) and Terravesta (for Miscanthus) in supporting farmers to diversify and providing guaranteed long-term contracts have been successful in encouraging farmers to maintain current plantations or develop on new areas of land. Both companies are actively expanding and seeking to recruit new growers (www.terravesta.com, http://biofuel.iggesund.co.uk/). This echoes bioenergy deployment in other counties where success is at least in part built on a strong business case supported by coordinated policy that links biomass supply and demand (Silveira and Johnson 2016).

The land available for bioenergy expansion within the UK has been estimated to be as great as 1.4 Mha (Wynn et al., 2016) although reaching such levels will require co-coordination to link levels of supply and demand to ensure long term market stability (Silveira & Johnson 2016). Ensuring such a roll out requires careful consideration around the available supply of planting material stock, the provision of mechanisation and tools for delivery and in the training of workers along the supply chain.

S Wynn, L Alves, R Carter (2016) Refining Estimates of land for Biomass: Route map to 1.4M ha of bioenergy crop, ETI : http://www.eti.co.uk/library/refining-estimates-of-land-for-biomass

S Silveira, FX Johnson (2016) Navigating the transition to sustainable bioenergy in Sweden and Brazil: Lessons learned in a European and International context, Energy Research & Social Science, 13, 180-193.

19. What risks are associated with scaling-up domestic supply and how can these risks be managed?

One risk for conversion of land to perennial bioenergy crop cultivation is the length of time the crops will stay in the ground. To accrue the maximum GHG benefits crops need to be cultivated for the maximum productive lifetime approx. 15 years. If crops are taken out of the ground after only a few years the GHG benefits will be minimized (Rowe et al., 2016). Any government support should therefore require a minimum lifetime for perennial crops, indeed it may be advantageous for any monetary support of energy crop planting to either have a staged payment system or to be linked to additional longer-term bonus payments at future dates.

Ensuring longevity of the bioenergy crops also requires consideration of long-term demand, including consideration of the types of biomass that will be required by future conversion technologies (Williams et al., 2016; Kan et al., 2016). To manage this any policy development designed to increase domestic supply must draw on evidence from research into conversion technologies.

Kan T., Strezov V., Evans TJ., (2016) Lignocellulosic biomass pyrolysis: A review of product properties and effects of pyrolysis parameters, Renewable and Sustainable Energy Reviews. 57, 1126-1140

Rowe RL, Keith AM, Elias D, Dondini M, Smith P, Oxley J and McNamara NP (2016)

Initial soil C and land-use history determine soil C sequestration under perennial bioenergy crops. GCB Bioenergy, 8 1046-1060. doi: 10.1111/gcbb.12311.

Williams, CL., Westover, TL., Emerson, RM., Tumuluru JS., Li C., Sources of Biomass Feedstock Variability and the Potential Impact on Biofuels Production, Bioenergy Research, 9: 1. https://doi.org/10.1007/s12155-015-9694-y

22. What policy measures should be considered by Government to help scale-up domestic supply?

To facilitate scale-up of domestic planting of 2nd generation bioenergy crops, policy will need to provide a degree of risk reduction for land owners to overcome issues of extended payback times compared to annual cropping. In addition the evidence given in previous sections highlights that the location within the landscape, scale and longevity of perennial bioenergy plantations are critical components in ensuring and or maximizing sustainability. Policy therefore needs to reflect these factors as well as ensuring that supply is linked to demand, this requires facility for; regional based tailoring of support, the application of sustainability criteria, longevity of support over numerous years, and a mechanism to allow monitoring. Therefore it would be expedient and potentially most cost effective to use policy mechanisms already developed within agri-environment schemes as a bases. The development of specific criteria for the support of bioenergy crops within this should be relatively straight forwarded given the considerable depth of research that has been conducted in this area (Whitaker et al., 2017; Rowe et al., 2009; Sage 1998).

Whitaker, J. Field, JL. Bernacchi CJ, Ceulemans R., Davies CA., DeLucia EH., Donnison IS., McCalmont JP., Paustian K., Rowe RL., Smith P., Thornley P., McNamara NP. (2017) Consensus, uncertainties and challenges for perennial bioenergy crops and land-use. GCB Bioenergy. doi: 10.1111/gcbb.12488

Sage R. (1998) Short rotation coppice for energy: towards ecological guidelines. Biomass and Bioenergy, 15, 39–47.

Rowe RL, Street NR, Taylor G (2009) Identifying potential environmental impacts of large-scale deployment of dedicated bioenergy crops in the UK. Renewable and Sustainable Energy Reviews, 13, 271–290.

30. What are the strengths and weaknesses of the current approach to GHG emissions accounting for bioenergy in the UK and internationally? Specifically, what are the main gaps in the current land use emissions accounting rules?

Nitrous oxide emissions from 1st and 2nd generation bioenergy crops are highly uncertain and highly variable. In current GHG emissions reporting and accounting soil N2O emissions are typically calculated using tier 1 emission factors based on fertiliser application rates. These methods are likely to overestimate N2O emissions from 2nd generation bioenergy crops as these crops are often not fertilised, and perennial grasses in particular are highly efficient in their nitrogen use. Evidence shows that when considering life-cycle GHG emissions from 2nd generation bioenergy crops, N2O emissions are likely to be a small but significant contributor to overall emissions. However, there can be high emissions during crop establishment or reversion (dLUC effects) which could be mitigated by using cover crops to mop up nitrogen released due to tillage and mineralisation of the previous crop (Whitaker et al 2017; McCalmont et al 2017).

Whitaker, J. Field, JL. Bernacchi CJ, Ceulemans R., Davies CA., DeLucia EH., Donnison IS., McCalmont JP., Paustian K., Rowe RL., Smith P., Thornley P., McNamara NP. (2017) Consensus, uncertainties and challenges for perennial bioenergy crops and land-use. GCB Bioenergy. doi: 10.1111/gcbb.12488

McCalmont, J. P., Hastings, A., McNamara, N. P., Richter, G. M., Robson, P., Donnison, I. S. and Clifton-Brown, J. (2017), Environmental costs and benefits of growing Miscanthus for bioenergy in the UK. GCB Bioenergy, 9: 489–507. doi:10.1111/gcbb.12294