POLICY BRIEFING NOTE

An Assessment of the Potential for Paludiculture in England And Wales

April 2021

Lowland Peat

Figure 1: Horticulture on deep peat, the Fens, eastern England (Photo: S.Page)

Key Findings

There is considerable potential and a range of options for paludiculture to contribute to reducing high GHG emissions from cultivated lowland peats. It does not yet offer an economically viable large-scale alternative to conventional agriculture, but could become a significant component of lower-emitting lowland peat landscapes in the future.

Until continued research and development can find solutions for increased potential for upscaling, it remains essential that efforts are made to mitigate emissions from UK peatlands remaining under drainage-based arable and horticulture cultivation.

Project Background

This briefing note summarises the findings of a desk-based study undertaken for Defra as part of Project SP1218: Managing agricultural systems on lowland peat for reduced GHG emissions.

A literature review was carried out for both UK and international work to assess the potential for diversification of unproductive land for 'paludiculture'. Paludiculture was defined as farming and agroforestry systems designed to generate a commercial crop from wetland conditions using species that are typical of (or tolerant of) wetland habitats. Wetland potential for greenhouse gas (GHG) mitigation, environmental co-benefits and the identification of barriers to the uptake of land use change provide a contextual framework for agri-environment-climate protection schemes and potential adoption by farmers.

Figure 2: Sphagnum farm trial: a potential paludiculture crop (Photo: J. Clough)

What are the issues?

In England, there are approximately 325,000 ha of lowland peatlands, with 240,000 ha (74%) used for farming and food production.

Much of this has been drained to maximise yields of high value fresh produce crops (Figure 1). 69% of the cropped peatlands in England are in regular use for horticulture crop production, with the remainder being used for arable/cereal rotation. Peat wastage under cropland is typically 10 to 30 mm yr^{-1}, and this use of peat soils has the highest GHG emissions of any form of UK land-use (>10 times higher than emissions from modified upland peat on a per hectare basis). The UK Government 25 Year Environment Plan identifies this as inherently unsustainable.

When peatlands are utilised to increase their provisioning services (e.g. through drainage to enable cultivation, forestry, livestock grazing, peat extraction) there will be trade-offs with other co-benefits. Whilst drainage and modification of the original vegetation cover may increase direct provisioning services (e.g. in terms of food production, employment and business revenues) there will be an inevitable and concomitant reduction in other services. For UK lowland peatlands, these typically include a loss of carbon storage, and an increase in greenhouse gas emissions, as well as gradual loss of the peat soil (peat subsidence). This may further negatively impact microclimate, biodiversity, peat archaeological and historical archives, water storage and flood regulation, and recreational and other cultural services.

Land subsidence resulting from long-term drainage of peat is a widespread problem in many regions including the UK, Netherlands, Germany and Southeast Asia, due to a combination of peat compaction and oxidation. Subsidence can cause damage to buildings and linear infrastructure such as roads, lead to the land surface falling below river or sea-levels, and therefore increase requirements for expensive pumped drainage. In the worst case, subsidence can ultimately lead to the degradation and loss of land from agricultural production (this is discussed further in a separate briefing note).

What are the benefits of paludiculture?

As a consequence of these issues, there is a growing interest in ameliorating peat and associated CO_2 loss through paludiculture.

The prospect of raising water levels to reduce emissions in peatlands managed for production demands new ways of growing existing crops, or new crops capable of thriving with elevated water tables. Where trials have been undertaken, findings suggest that paludiculture has the potential to reduce CO_2 (and overall GHG) emissions relative to conventional drainage-based agriculture or peat extraction. This mitigation potential largely takes the form of avoided present-day CO_2 emissions from deep-drained peat cropland, which can be as high as 25-30 $tCO_2e\ ha^{-1}\ y^{-1}$. A number of studies suggest that paludiculture sites could become net CO_2 sinks, thereby helping to sequester GHGs from the atmosphere. Capturing CO_2 by adoption and uptake of paludiculture techniques has the potential to make an important contribution to achieving the UK's commitment to net zero GHG emissions by 2050. However, it is also important to consider methane (CH_4) emissions, which are typically higher from wetlands (including sites managed by paludiculture) compared to drained cropland, and may therefore partly offset the climate mitigation benefits of reducing CO_2 emissions. The highest CH_4 emissions occur when water levels are above the peat surface. Some potential crops (such as *Sphagnum* bog moss; Figure 2) have the capacity to oxidise CH_4 before it is released while others may facilitate its transport from depth. With careful crop selection and water management it should therefore be possible to minimise CH_4 emissions, whilst also sequestering CO_2.

In the context of paludiculture, it would be expected that raising water levels in former agricultural land should slow or halt oxidative peat loss, and similarly reduce compaction. It is also possible that currently compacted peat may to some extent 'rebound', as the refilling of pore spaces with water increases peat buoyancy and raises the ground surface level, while steady in-situ accumulation of paludiculture crop residues has the potential to reverse the effects of subsidence over longer time periods.

Figure 3 Fen biomass harvesting
(Photo: J. Clough)

What options exist for diversifying through paludiculture?

Bioenergy

Wide scale production of paludiculture bioenergy crops, such as *Phragmites australis* (Common Reed; Figure 3) can sequester in the region of 4–13 $tCO_2e\ ha^{-1}\ y^{-1}$. As these crops will be used to produce energy, sequestered CO_2 will be re-emitted, resulting (if all sequestered CO_2 is removed from the site as biomass) in a neutral carbon balance at the stand scale. If the bioenergy crops produced substitute for fossil fuel use, however, the overall impact will be a reduction in CO_2 emissions. Other uses of harvested biomass, including incorporation into building materials or the return of biomass carbon to the soil in unreactive forms (such as biochar), have the potential to contribute directly to long-term CO_2 sequestration.

Sphagnum Farming

The majority of peat used in containerised horticulture production systems consists of decomposed *Sphagnum* moss. One proposed form of paludiculture is the production of *Sphagnum* crops which can be harvested and processed to create growing media. *Sphagnum* grown at high water tables (e.g. on former peat extraction sites) could be potentially utilised in blended growing media products. Preliminary work suggests that *Sphagnum* can be grown and processed for use as a raw material for containerised plant raising. (Figure 2). However significant further research and development are needed to turn this potential into a commercially viable product with the required physical, chemical and biological properties, and at the scales needed, to reduce the UK's current reliance on extracted peat as a growing medium.

Food Production

Changing land-use to the production of fibre or bioenergy crops has the potential to negatively impact on national food security, whilst also displacing GHG emissions from food production in the UK to other countries. Consequently, the possibility of growing food crops on high water table peatland holds considerable appeal as a means of avoiding having to trade-off GHG emissions and food production. Some wetland plants are already food staples, albeit in cultivated form, such as celery and water cress, while some novel food crops may have the potential to be grown on wet peatland soils. Again, further research is needed to develop viable and economic wetland-based food crops for UK conditions.

Construction Materials

Perennial reed grasses, particularly *Phragmites* spp., have been used for millennia as a construction material. The best-known example is the use of reeds for thatched roofing; in Europe reed is almost exclusively used for thatching. Thatching requires reed with specific qualities, so the efficiency from harvested biomass to final product varies, and unsuitable material can make up to 50% of standing biomass. In 1989, the UK imported 1.5-1.8 million bundles (75-85% of usage) to meet shortfalls and until 2013 an import share of 75% was maintained; while exact figures are not available, the market situation is similar today. This level of import indicates there is strong market demand for reed thatch and a lack of domestic supply. However, it has been suggested that high labour costs and nature conservation policy limit the availability of UK-grown thatching reed. The low density of wetland plant material also provides potential for novel uses in construction, including lightweight construction boards, insulation and lightweight aggregate. These uses would have the additional benefit that the carbon contained in long-lived construction materials would be sequestered over the lifetime of the building, effectively contributing to the greenhouse gas removal by managed wetlands.

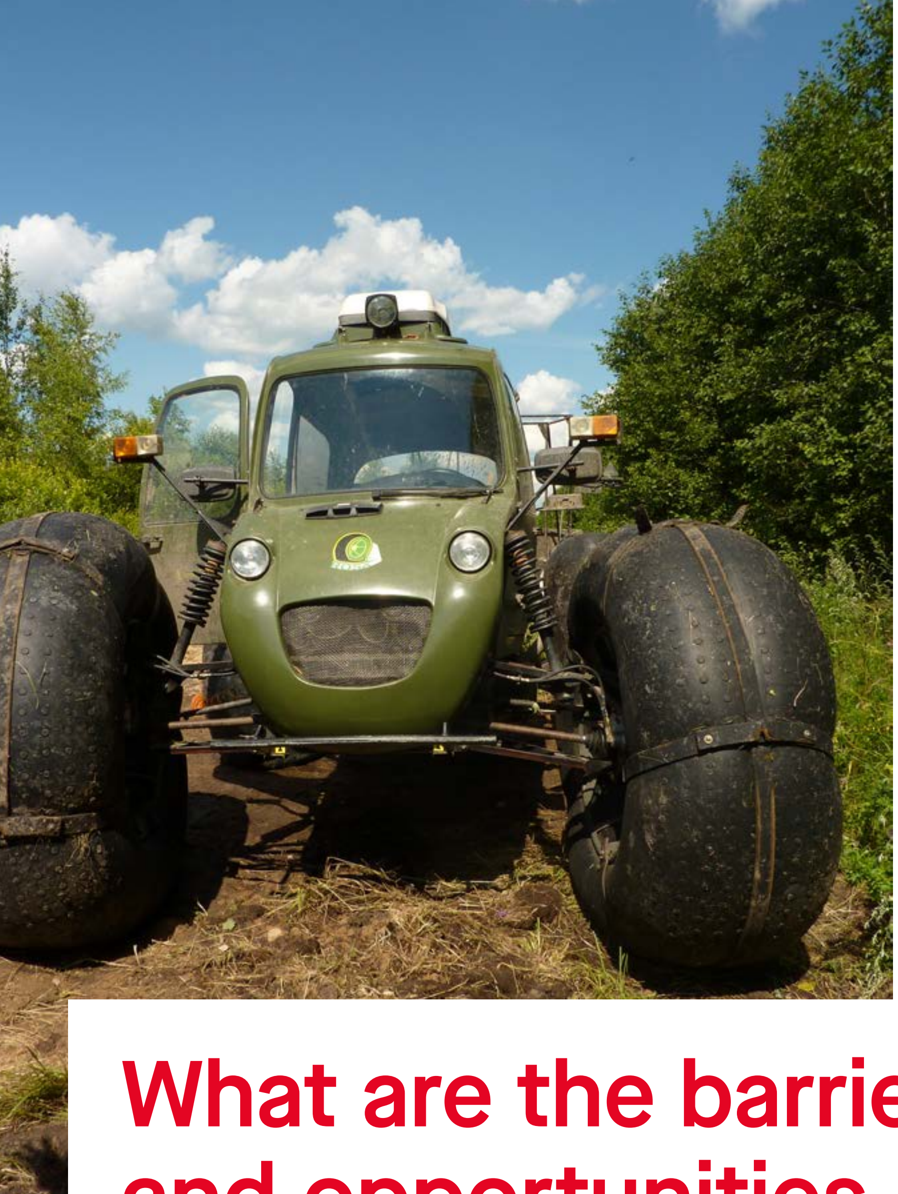

Figure 4 Biomass harvester with balloon tyres to improve trafficability on wet peat soils (Photo: J. Clough)

What are the barriers and opportunities for paludiculture?

Transitioning conventionally managed agricultural landscapes to paludiculture would require large-scale changes in water management and associated investment in new infrastructure.

Conflicts are possible at the boundaries between areas managed for paludiculture and those under drainage-based management. High water use by paludiculture crops could lead to pressures in water-scarce regions such as Eastern England, although it is important to recognise that many wetland and wetland-tolerant species can continue to grow under non-wetland conditions provided competition from other species is controlled during such periods. On the other hand, if land under paludiculture could be managed in order to hold excess water during winter, this could provide flood storage, and act as a water source for adjacent farmland during dry periods.

Scaling up paludiculture will also require innovation to increase efficiency and practicability, as well as to reduce currently high labour costs, for example in relation to weed control, mechanisation and trafficability of wet soils (i.e. development of machinery and practices that enable farming operations to occur on wetter soils; Figure 4), and the development of new markets and supply chains. Overcoming these barriers is likely to require changes to current regulations and agricultural payment schemes. The growth of carbon markets, which provide financial incentives for farmers to reduce or offset emissions, is likely to also favour the growth of paludiculture as an alternative to drainage-based agriculture.

Recommendations

There is a growing body of knowledge to suggest that raising water levels in lowland peat crop production areas to reduce environmental impacts such as GHG emissions and subsidence will not necessarily require the cultivation of economically important fresh produce to cease. There remain significant knowledge gaps on how these adaptations will fully impact upon food supplies and regional economies. Much of the research undertaken to date has involved the replacement of drainage-based food crops with (native) plant species better suited to wetter conditions, primarily for fibre production. This may well represent an appropriate use of peatland, provided that:

- markets for these products exist;
- paludiculture can be made financially viable (or supported via subsidies that reflect the wider societal value of peatland protection);
- and that food crops displaced from organic soils can be grown instead on mineral soils where their environmental impact will be lower. As with many of our existing food crops, there may also be opportunities to develop novel (non-native) wetland food crops in future, particularly as the climate continues to change, and as existing land-management practices in some cases cease to be viable.

Overall, we conclude that, although there is considerable potential, paludiculture does not yet offer an economically viable, large-scale or immediately implementable solution to the challenge of high GHG emissions from cultivated lowland peats. However, this should not preclude continued research and development into the potential of high-water table crops, or to the development and expansion of paludiculture trials with the aim of scaling these up where successful. Until and unless paludiculture becomes a viable large-scale proposition, however, it remains essential that efforts are made to mitigate emissions from UK peatlands remaining under drainage-based arable and horticulture cultivation.

The full report can be downloaded from:
lowlandpeat.ceh.ac.uk

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