Lowland Agricultural Peat Task Force Chair's Report

Contents

Foreword

The science is clear: catastrophic climate events across the globe will get worse if we do not reduce our carbon emissions. Weather events expected to happen once in a generation are fast becoming the new normal. As a Lincolnshire farmer for over 40 years, I know too well the vulnerabilities of the farming sector to extremes of flooding and drought.

But the farming sector is also powerful. As farmers and growers, we have vast potential to protect the carbon in our soils. Where these soils contain peat, our potential is far greater. To protect our climate and ensure that our peat soils can continue to provide for future generations, we must transition to more sustainable management regimes.

Arguably, the greatest threat to food security is climate change. For centuries, our lowland peat soils have supported the growth of fresh vegetables, salads, grains, meat and dairy products which continue to feed our nation today. Now the existence of peat soils is time-limited, it is the collective responsibility of all those who have a stake in the land, the food it provides and the water levels which preserve it to secure for peat a more promising future.

For 18 months during 2021 and 2022, the task force was united around one common goal: to extend useable life of lowland agricultural peatlands, both to slow the loss of soil carbon and to support continued profitable agriculture. I have been delighted to see the journey of the task force bring together individuals, stakeholders and organisations around this ambition. I have been humbled by the enthusiasm of all parties to engage and I hope those involved feel my report does justice to their views.

In the aftermath of the task force, I hope the many great examples of collaboration and innovation I have seen will be supported to thrive. To deliver meaningful change, at the scale required to see lowland peatlands make a significant contribution to our nation's Net Zero by 2050 target, will require strong backing from government. Both our farming community and those responsible for managing our water will require positive leadership and financial support to deliver results on the ground.

This report sets out what I believe will be the key steps required to secure a more sustainable future for lowland agricultural peat soils. I hope Ministers will agree this is a constructive aid for considering how best to progress with recommendations on lowland peat as made by the Climate Change Committee. Whilst my report will now be for the UK government to consider, I hope it can provide a positive force for change by all parties.

I would like to close with thanks to all those involved in the journey of the task force, including national members, regional farming champions and everyone who joined me in regional discussions and visits. I am also grateful for the support of Defra officials.

Robert Caudwell, Chair of the Lowland Agricultural Peat Task Force

Executive summary

England's carbon rich, lowland peat soils provide some of our most productive farmland[1]. Following centuries of land drainage for agricultural use and food production, these naturally wet peat soils are fast degrading. When peat degrades, the landscape subsides, and the carbon once stored in the soil is lost to the atmosphere primarily as carbon dioxide; so much so that the process of peat degradation places England's lowland peat soils amongst the largest sources of greenhouse gas emissions in the UK's land use sector[2]. Both to preserve peat soil carbon, and to support continued profitable agriculture, the government has declared it timely to develop more sustainable management regimes[3].

In 2021, Defra established the Lowland Agricultural Peat Task Force to shape these more sustainable management regimes. The task force provided a way to build consensus amongst farmers, conservationists, academics and other delivery partners, particularly those with responsibility for managing water. Based on task force discussions, this chairman's report provides an expert and independent view on what needs to change in order for new regimes to become reality.

The report makes 14 recommendations to ensure lowland peat soils can be managed more sustainably. Some of the recommendations may be delivered in the short- term, whilst others will need further development over the mid- to long term: a summary of the recommendations is presented overleaf, followed by a plot of the recommendations over time (see figure 1). As climate change itself will force a change in the use of peat soils, it will be wise to tailor these recommendations towards achieving change at scale to deliver broader benefits for the environment, climate and nature, as well as providing ongoing economic prosperity for those whose livelihoods are tied to the land.

The report is being published to drive collective thinking and ambition by all. It will now be for the UK government to set out how it intends to support change on the ground.

[1] Approximately 20% of lowland peat in England is grade 1 agricultural land and a further 19% is grade 2

[2] Evans, C, Morrison, R, Burden, A and others (2017). 'Final report on project SP1210: Lowland peatland systems in England and Wales – evaluating greenhouse gas fluxes and carbon balances'

[3] Defra (2021) 'England Peat Action Plan'

Recommendations summary

Chapter 1: Water for peat and more water-level management control

Recommendation 1 – A place for peat in planning more strategically about water:

- factoring peat into regional water resource planning
- new-look Water Level Management Plans, expanded to apply to all significant expanses of lowland peat, docked into Local Nature Recovery Strategies (LNRSs)

Recommendation 2 – New investment in water storage, management and control:

- new investment in infrastructure to store, release and retain more water in lowland peat landscapes, and in telemetry and water-level management controls
- UK government to create a new 'Water Fund for Carbon' to test and trial new approaches, transitioning to a blend of public and private finance over time
- water companies to invest in peat preservation as a source of carbon credits

Recommendation 3 – Legal protection and powers for managing water for carbon:

- UK government to assess in full the legal implications of asking responsible authorities to raise water levels in the interests of preserving peat soil carbon
- if a change in the law is deemed necessary, UK government to take a stronger position on the need to manage water levels in the interests of climate mitigation
- new powers for relevant authorities to manage water levels more optimally for peat

Chapter 2: Enabling more sustainable ways of farming on peat soils

Recommendation 4 – Public money for wetter modes of farming on peat soils:

- UK government to incentivise raising water levels under its new environmental land management schemes, based on activities which can evidentially reduce peat-related emissions to provide climate mitigation and improved soils as public goods
- Defra to work with experts in farming, land and water management to develop workable incentives for more sustainable management techniques on lowland peat, using a new and expanded definition as to which soils are classified as 'peaty'
- incentives to be made available on a long-term basis, with the capacity to transfer long-term agreements between tenants

Recommendation 5 – Viable opportunities in private finance:

- improved monitoring, reporting and verification of different lowland peat management techniques, focusing on carbon emissions and removals for different crop and water management systems
- an update to the Peatland Code, or the development of a robust and credible system of assurance akin to it, applying to a lowland agricultural peat setting

Recommendation 6 – Technical advice on keeping peat soils wetter:

- expanding the regenerative farming toolkit to encompass wetter ways of farming
- introduction of Peat Sensitive Farming Advisers to all expansive areas of lowland peat to improve understanding for the value of keeping peat soils wetter
- roll-out of low-cost measurement methods to enable farmers and investors to measure and verify emission reductions resulting from changes in management

Chapter 3: Supporting people, partnerships and economies

Recommendation 7 – Building on bonds already formed:

- ongoing support for partnerships under the Nature for Climate Discovery Grant
- support for bottom-up partnerships emerging and for the creation of new ones
- creation of a new national forum for lowland agricultural peat
- UK government to engage with partnerships to shape its emerging policies

Recommendation 8 – Ensuring policy and legislation supports regulators:

- thorough assessment of current policy and legal frameworks relevant to water-level management on lowland peat, particularly rules on abstraction

Recommendation 9 – Raising the profile of lowland agricultural peat soils:

- food producers and consumers made aware of emissions from farming on peat within the supply chain and encouraged to support ways of reducing emissions
- environmental groups, together with farmers, to rally behind a public outreach campaign to raise public awareness of the lowland agricultural peat challenge
- early innovators leading wetter farming trials to host open days for the public
- new ways of helping the public to see the visual impact of wetter farming

Recommendation 10 – Undertaking a socio-economic assessment of new measures:

- UK government to commission a socio-economic assessment of wetter farming

Chapter 4: Driving forward science and innovation

Recommendation 11 – Understanding the depth and condition of lowland peat:

- Defra to draw on ground-truthing exercises to inform its mapping products
- greater emphasis on understanding and mitigating emissions from wasted peat

Recommendation 12 – More large-scale field-trials and modelling:

- field trials to explore targeted questions on different peat preservation techniques

Recommendation 13 – Advancing new technologies:

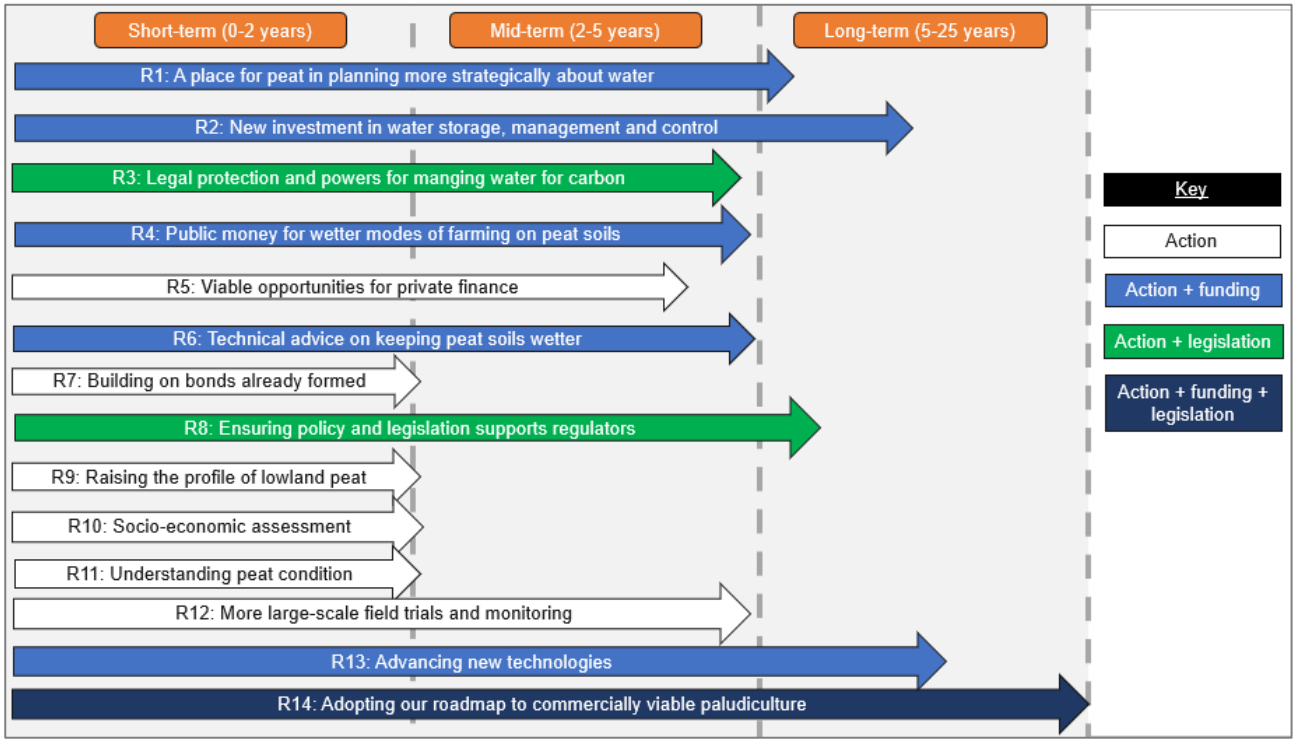
- expansion of lower ground pressure machinery to manage the risk of compaction
- support for vertical farming alongside more sustainable farming on peat
- new research into the breeding of more water tolerant, low carbon food crops

Recommendation 14 – Adopting the roadmap to commercially viable paludiculture:

- adopt our targeted programme of investigation, development and reform to pro-actively develop paludiculture as a commercial reality over the next 10 years

Time horizons

Figure 1: A timeline of the 14 recommendations split by the short-term (0 to 2 years), mid-term (2 to 5 years) and long-term (5 to 25 years), with a key to demonstrate which actions may require funding or legislation.



The Lowland Agricultural Peat Task Force

Context

Lowland peatlands drained for agricultural use are fast degrading. When peatlands degrade, their soil is lost, the land subsides and the carbon they preserve is released primarily as carbon dioxide to the atmosphere. This process is bad both for farmers and for the climate.

Greenhouse gas emissions in England released by lowland agricultural peatlands were estimated to be around 6.5 million tonnes of carbon dioxide equivalents in 2021; this equates to around 1.5% of UK total emissions.

With more sustainable management measures, the science suggests that lowland peat soils can be retained, and emissions reduced, without having to halt their productive use. In January 2021, Defra established the Lowland Agricultural Peat Task Force to explore how this might be done.

This report is the chairman's summary of what he believes needs to change in order for lowland peat soils to be more sustainably managed. The chairman has come to his recommendations based on discussions with task force members and stakeholders based across the country, following meetings and visits with individuals and organisations in England's most expansive areas of lowland peat.

For the duration of the task force, regional sub-groups convened by Defra have welcomed individuals and organisations from, but not limited to, four key regions (broadly mapped out in figure 2):

- East England (East Anglia and Lincolnshire)
- South-West England (Somerset Levels)
- North-East England (Yorkshire, Humber and Durham)
- North-West England (Cumbria, Lancashire, Manchester, Cheshire and Merseyside)

Accompanying this report is a long-term roadmap to commercially viable paludiculture. Paludiculture is a new farming system modelled on the profitable production of wetland crops. Paludiculture has the most potential to slow peat soil loss and, in some instances, could even lead to carbon sequestration and net greenhouse gas removal.

The package of measures required to make a reality of paludiculture has been developed based on separate meetings of a paludiculture sub-group. These step-changes go above and beyond the system changes recommended in this report and have therefore been presented as an annex.

Membership

National Task Force

Chaired by Robert Caudwell, the task force has brought together:

- Andrea Kelly, Broads Authority
- Charles Shropshire, G's Global
- Chris Evans, UK Centre For Ecology & Hydrology (UKCEH)
- Daniel Johns, Water Resources East (formerly Anglian Water)
- Deborah Land, Natural England
- Ian Moodie, Association of Drainage Authorities (ADA)
- Julie Foley, Environment Agency
- Olly Watts, Royal Society for the Protection of Birds (RSPB)
- Philippa Arnold followed by Diane Mitchell, National Farmers Union (NFU)
- Richard Lindsay, University of East London (UEL)
- Stephen Briggs, Innovation for Agriculture

Aims

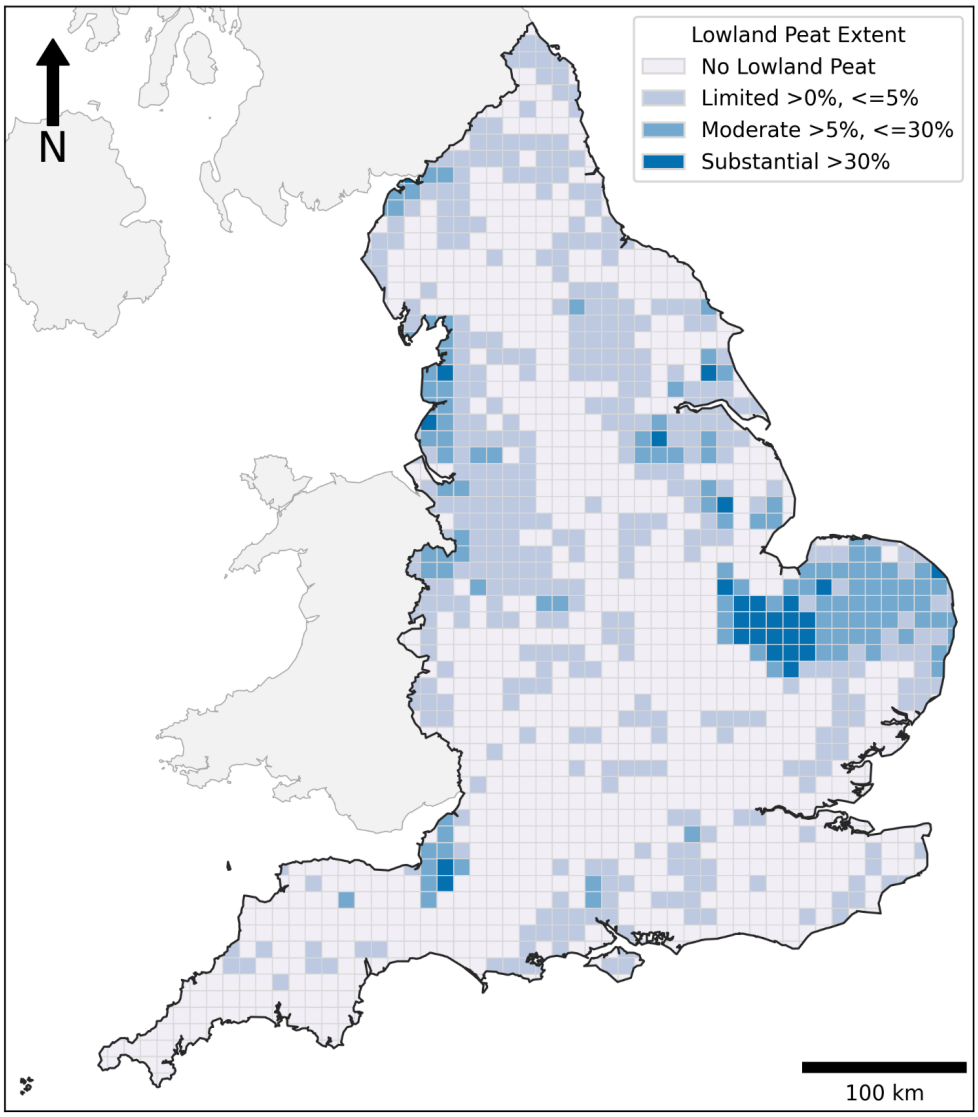
The task force has worked to the overarching aim to extend the useable life of lowland agricultural peat soils, both to preserve their soil carbon and to support continued profitable farming. Drawing on the advice of the sub-groups, it has also aimed to:

- identify new management practices for lowland agricultural peat soils which reduce the rate of loss of peatland soils, reduce greenhouse gas emissions from drained peat soils and support continued profitable agricultural production
- consider the unique conditions of different peat regions (for example, differences and commonalities of peat soils, topographic and climatic conditions, local market constraints and community priorities)
- consider different peat soil types (deep, shallow and skirt), their relative emissions and management
- identify existing opportunities, potential barriers and trade-offs to adopting more responsible management practices, by building on existing best practice and proactively suggesting ways to overcome issues
- be bold and ambitious about what can be achieved by when, delivering recommendations which support the government's commitment to reach Net Zero

emissions by 2050, the government's target to have all of England's soils sustainably managed by 2030, and the 2030 agenda for sustainable development

Lowland Peat Extent in England

Figure 2: A classified map of peat in England, gridded at 10km, excluding peat above and within 2km of the moorland line. There is no universal definition of lowland peat: this map offers a proxy. The map highlights substantial deposits of peat in the South-West, North-West, North-East and East of England, for which regional sub-groups to the task force were created. The map is based on 2008 England peat soils data for deep and shallow peat.



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BGS, Cranfield University (NSRI) and OS acknowledged for Peaty Soils Location (England) data.

Regional overviews

The task force has focused its discussions on England's four most expansive areas of lowland peat, the majority of which have been drained and cultivated for agricultural use (see figure 2). These regions include the:

North-West

The North-West is home to the peat soils of Cheshire, Cumbria, Lancashire and Merseyside, this region is thought to have once housed the UK's second largest area of lowland raised bog. Today peat in the North-West supports a mix of arable, horticultural and livestock farming systems, providing us with crops including salad leaves, potatoes, wheat and barley. The area contains some of the wettest places in the country. Of the four regions the task force has discussed, this is the only one not serviced by Internal Drainage Boards (IDBs).

South-West

In the South-West there is a focus on the Somerset Moors and Levels. This is one of the UK's lowest and flattest areas and a region where water is intrinsically managed. Soils in the Levels are reported to be majority peat, in some places up to 4m thick[4]. Arable farming is practiced in the region but is less common than livestock: peat under grassland supports extensive dairy and beef herds and the growth of maize and wheat. Much of Somerset is protected for biodiversity.

North-East

In the North-East, the majority of lowland peat spans the Humberhead Levels, which is a flat plain straddling the borders of Yorkshire, Lincolnshire and Nottinghamshire, with small peaty pockets also found in County Durham. Much of the peat has been artificially warped[5], more so than in other regions, to improve the fertility of acidic peat for agriculture. Wheat, barley and oilseed rape are widely grown on the region's peat soils today. Some of

[4] Somerset County Council 2013. Minerals and Waste Development Framework

[5] Smart, PJ, Wheeler, BD, Willis, AJ. 'Plants and Peat Cuttings: Historical Ecology of a Much Exploited Peatland – Thorne Waste, Yorkshire, UK'. New Phytologist 1986: volume 104, pages 731-748

the peat is grazed by dairy cows and beef cattle. The last remnants of raised bogs in the area (Thorne, Crowle and Hatfield Moors) have been safeguarded for nature conservation.

East

Often dubbed the breadbasket of Britain, the Fens in the East of England provide one third of our fresh vegetables and one fifth of our potatoes[6]. Maize is widely grown on the drained peat for biogas production. The Fens are the UK's most contiguous area of lowland peat, though large parts have wasted to become skirtland. To the east of the Fens is Broadland, which is an area home to much of the UK's fen and reed bed. The Broads supports all farming systems, though livestock farming for beef is particularly common on peat. Taken as a whole region, the East comprises some of the driest parts of the country.

Regional perspectives

The task force included five 'regional farming champions,' local to England's four most significant expanses of lowland farmed peat (two for the East of England: one for Fenland and one for Broadland.) Each region needs its own set of changes in order for lowland peat to be farmed more sustainably.

North-West

Lisa Edwards, tenant farmer in South Lancashire and NFU Lancashire County Chair

"I farm on 900 acres of mainly peat soils. I find the North-West unique in that it averages twice the amount of rainfall (averaging 1000mm per year) compared to the East of the country: this brings both advantages and challenges. Water management is key to this valuable area of food production which includes cereals, vegetables and salad crops.

There are a number of farmers looking at ways of integrating paludiculture alongside their existing farming operations, but I believe what is required is a statutory body to put in place the right water management strategies to enable farmers and growers to achieve a balance between preserving the peat alongside efficient food production. Managing water levels will be essential to achieving this, both to ensure we can maintain a vibrant and

[6] NFU 2019. 'Delivering for Britain – Food and farming in the Fens'

productive agricultural and horticultural sector whilst implementing new ways of managing the land."

South-West

Charlie Ainge, arable and livestock farmer and CLA Member

"The unique nature of the Somerset Levels leads it to needing a unique approach to its management. I believe this area has the ability to produce both meat and milk in a highly sustainable manner, whilst at the same time protecting the carbon locked up in the peat soils that make this area so special. To continue to be an area that can achieve food production and preserve our peat, we need protocols to encourage and maintain sustainable agricultural systems, with a clear view to supporting agriculture both economically and environmentally.

The tools to make this work are already in place, those being the farmers/land managers, livestock and grass swards. I believe what is now needed is structural support to encourage livestock production that can operate in a sustainable manner, using, for example, low-input techniques such as rotational grazing. I would also like to see funding to encourage independent research into the wider aspects of peat soil management, including the relationship between peat soil and plants and the benefits that can be gained from a sward management and grazing system, where all three aspects can benefit from each other.

We need to work to a clear vision to see sustainable agricultural practices thrive – practices that can protect and support the needs of our peat, regardless of the changing weather conditions that are proving so challenging in so many places."

East

Nick Allpress, fourth generation farmer and Lead for the Fenland SOIL7 Farmers' Dialogue Group

"A mosaic of management practices has been discussed and can be introduced to reduce emissions whilst still producing our crops and maintaining food security. I believe a peaty

[7] SOIL stands for Sustainability, Opportunity, Innovation, Learning. Fenland Soil

soils standard as part of the new schemes for Environmental Land Management would support these practices.

More significant emission reductions will be achieved if deep peat soils can be rewetted. But agriculture has poor resilience due to the lack of water as demonstrated these past couple of years. Government needs a strategic approach for water capture and availability and to empower Internal Drainage Boards (IDBs), as the required water is not currently available. The UK government will also need to support the very significant capital investment required if water is to be held at higher levels, either in agricultural or paludiculture systems or wetland restoration.

All future recommendations for local solutions need to be based on evidence and data. I recommend that we continue to expand our evidence base in conjunction with Fenland SOIL. Fenland SOIL is now well established with local farmers and the supply chain and is working with farmers and the academic community to collect the data needed to implement these approaches. Flux towers are measuring greenhouse gas emissions and farmers are updating soil maps. It is their ambition to implement local solutions based on data collected over the next few years with the collaboration of all academic parties."

Robin Buxton, Chair of the Broads IDB and Chair of the British Reed Growers Association

"I manage land in the north-east of the Norfolk Broads, between Horsey Mere and the sea. The area is low-lying with arable leading to grassland, with water boundaries (dykes) and reed bed adjoining the river.

I have retained high water levels over the years, much to the benefit of local wildlife, drawing on the support of Higher Level Stewardship and the earlier Environmentally Sensitive Areas scheme. For me, these schemes have removed the financial incentive to turn to arable or more intensive grazing. Where this has happened in neighbouring parishes, one can see where the peat has shrunk and the land has noticeably lowered.

I am now being sponsored by the Broads Authority to trial paludiculture on one grass field, growing reed and reed mace (also known as bulrush, and by its scientific name Typha).

Having seen how paludiculture can change the land, I am concerned that without proper funding, over a lengthy period, it will not be adopted in the Broads. Paludiculture is seen by most as land lost to farming; currently reed growing is only sustained by environmental payments and commercial reed growth is cost neutral at best.

My primary ask now, as former payment schemes end, is that there needs to be a suitable environmental scheme going forwards. Without this, I am concerned that the landscape,

‘waterscape’ and wildlife of the Broads is at risk. To save and or enhance peat within the Broads, we need a scheme that rewards peat maintenance as well as peat restoration.”

North-East

James Brown, organic farmer and CEO of Reverse Coal

James runs a family-owned, diverse, organic farming business. The farm covers 5,000 acres crossing the three county borders of Nottinghamshire, Lincolnshire and South Yorkshire and much of it sits on degraded peat. It has a renewable energy and a retail division and houses three Sites of Special Scientific Interest (SSSI).

James believes that the effect we have on the environment around us is at the centre of everything we do and strives to enhance the land we live and work on for future generations to come. He has already invested in green technology to help make the farm’s cereal, vegetable and livestock farming more sustainable and is pioneering a scheme to make renewable heat, electricity and biochar, capturing and burying CO2 as solid carbon.

James believes the future of farming on lowland peat lies in climate-resilient, controlled-environment agriculture.

The area has a well-defined natural floodplain, which is flooded regularly. The limited development on the floodplain means that the impact of the flooding is largely dominated by agricultural land. There have been calls in the North-East for flood-alleviation measures and also for a regulatory framework covering water resources. Additionally, there is appetite to run more trials but a feeling that the process of securing permissions to do so could be made easier.

Key findings

Peatlands are wetland landscapes, made up of partially decomposed plant and animal remains. The wet conditions of a healthy peatland slow the decomposition of organic material and gradually allow for new matter to accumulate over timescales of centuries to millennia. In a good condition, peat will contain around 90% water[8].

Since the 1600s, land drainage mostly for agricultural improvement and food production has dried out our peat. Our collective approach to managing water out of the landscape has resulted in the widespread decomposition of peat in the lowlands, releasing stored carbon to the atmosphere. The land has visibly subsided where the peat used to be. In England, only 13% of our peatlands remain in a near-natural state and, in the lowlands, this figure drops to less than 1%[9], which provides a clear indication that the vast majority of lowland peat has degraded.

If this degraded lowland peat could be partially or fully 'rewetted', then rates of peat decomposition could be significantly reduced. Subsidence could be lessened, and greenhouse emissions cut to achieve faster reductions to the UK's greenhouse gas emissions than could be achieved by tree planting. The effectiveness of any rewetting would of course depend on many things, but it is the crux of this report that if we are to preserve lowland peat, then we must implement changes which revolve around water.

The science

The storage of water in peat soil can be defined relative to three levels:

1. **Saturation**: the soil water content when all pores are filled with water
2. **Field capacity**: the soil water content of a saturated soil once gravity has freely drained out some water
3. **Permanent wilting point**: the soil water content when all possible water but that most tightly bound has been extracted, be that naturally or artificially by plants or land drainage

In most areas, the soil water content of our lowland peat is, for most times of the year, far below saturation, and therefore below the soil water content at which low oxygen conditions will support peat formation. Water levels held at or below field capacity can

[8] ONS, UK natural capital: peatlands 2019

[9] Approximately 1% of lowland peatlands are in a near-natural condition - mainly those in protected sites.

allow for oxygen to penetrate the soil, which can in-turn feed the aerobic decomposition of existing peat deposits by microbes in the soil. When this process takes hold, the soil is lost, the land subsides, and the carbon stored in the peat is lost to the atmosphere primarily as carbon dioxide. To significantly slow the rate at which peat is being lost, the science suggests we need to provide for peat a soil water content somewhere between saturation and field capacity. Maintaining water levels closer to saturation could limit peat loss, and under optimal conditions, may support the formation of new peat deposits.

This is not to suggest that we should be flooding peat soils, given that saturated peatlands with standing water can pose other problems for the climate. Indeed, when a large amount of standing vegetation becomes inundated, particularly for extended time periods, peatlands can release methane. Methane is a greenhouse gas known to have a much shorter lifespan, but a far higher climate warming potential, than carbon dioxide. Figure 3 aims to demonstrate the complex relationship between water-table depth and different greenhouse gas emissions known to come from peat.

Emissions according to water table depth

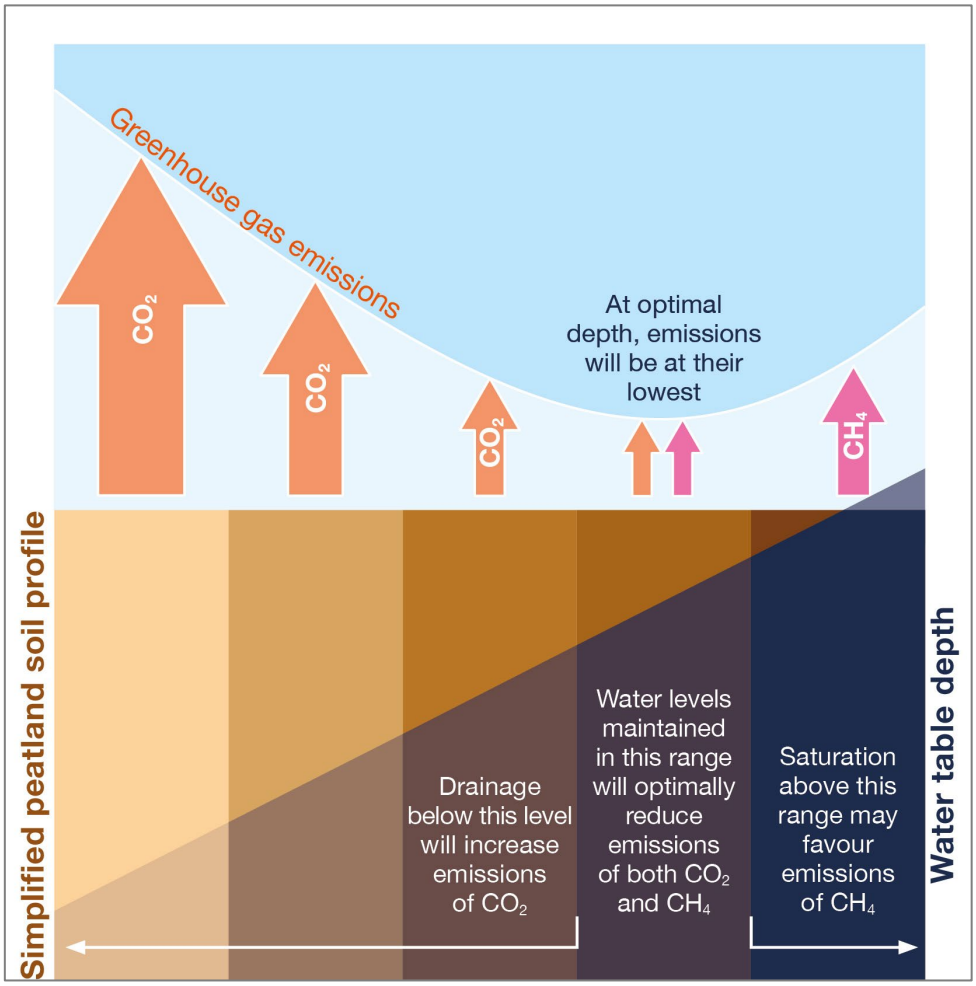

Figure 3*:* A demonstration of the relationship between water table depth and emissions from peat, where CO_2 is carbon dioxide and CH_4 is methane. Nitrous oxide is excluded due to uncertainties.

The UK's evidence base on emissions from agriculturally managed peatlands is world-leading. To best preserve the carbon stored in peat, the science indicates that in most cases we will need to raise water levels above where they are penned currently, without creating conditions so wet that we spur the release of methane. With even small changes in water management, experts believe the loss-rate of peat can be slowed significantly.

For every 10cm reduction in water-table depth, until a depth of 30cm below ground surface has been reached, field evidence indicates that each year we could save the equivalent of 3 tonnes of carbon dioxide per hectare[10]. As emissions reduce, so would subsidence.

The challenge, therefore, is finding a more accommodating water balance for lowland peat soils whilst maintaining profitable use of the land. This report makes recommendations for how this might be achieved, both by raising peat water tables and through other interventions which can lead to an increase in soil moisture content.

Though the evidence base draws a clear link between emissions from peat and the presence of water, the broader impact of farming at higher than current water levels is less understood. There is valid concern that raising water levels, either temporarily or continuously, could have detrimental impacts on crop yield, nutritional quality and disease risk, and present broader challenges such as water availability and the use of farm machinery on wetter soils. This is why, underlying the changes I have recommended in my first three chapters, I have included a final chapter dedicated to science and research to tackle the fundamental questions we still need answers to.

The science should not be interpreted as meaning that water levels can and should be raised wherever peat is still present in the landscape. Variations in rainfall, topography and soil composition will make it more or less practical to raise levels in certain places. This teamed with the importance of high-grade agricultural peatlands for food and farming, and the interplay of new measures on flood risk management, will make some areas more or less attractive for raised water levels. For environmental, social and economic reasons, the decision to raise water levels beneath peat soils must be one that is taken locally.

[10] Evans, CD, Peacock, M, Baird, AJ, and others. 'Overriding water table control on managed peatland greenhouse gas emissions' Nature 2021: issue 593, pages 548-552

The system

To rise to the challenge, I believe we need to retain more water in lowland peat landscapes and drive forward demand for wetter modes of farming on peat.

Retaining more water in lowland peat landscapes

Everyone has a role to play in managing our water environment. A number of organisations (summarised in the box titled 'Management of the water environment – which authority does what?') are required by statute to perform specific functions. These organisations exist primarily to manage our public water supply, to protect people and property from flooding, and/or to drain the land for food production.

Recently their remits have widened. Most appear to have responded well to new government policy on conserving and improving the environment and adapting to climate change, though as the task force has found, one fundamental gap remains. Still today there is a lack of strategic direction on managing water in the landscape in the interests of climate mitigation.

Management of the water environment – which authority does what?

Defra has responsibility for developing policy in England on water resources, water quality and on the management of flood risk and coastal erosion. The following authorities each have a key role in implementing its policies:

Environment Agency: which is responsible for water quality and resources, fisheries, inland river, estuary and harbour navigations, conservation and ecology and for managing the risk of flooding from main rivers, reservoirs, estuaries and the sea. The Environment Agency has priorities to work with others to manage the use of resources, increase resilience to the risks of flooding and coastal erosion and to protect and improve water, land and biodiversity.

District Councils: which manage flood risk from ordinary watercourses and carry out work, often in partnership with others, to manage flood risk including from the sea. District councils also have powers for water works and drainage.

Drinking Water Inspectorate: which provides independent reassurance on the quality of drinking water in England and Wales.

Highways Authorities: National Highways and unitary or county councils have lead responsibility for providing and managing highway drainage and roadside ditches.

Internal Drainage Boards (IDBs): which are independent public bodies responsible for managing water levels in low-lying areas. IDBs work in partnership with other

authorities to carry out water management works to support land management for farming productivity and to actively manage and reduce flood risk.

Lead Local Flood Authorities (LLFAs): Unitary authorities and county councils have the lead responsibility for managing risk of flooding from surface water, groundwater and ordinary watercourses in their area.

Riparian landowners: those whose land adjoins a watercourse have legal duties and responsibilities to manage the watercourses that run or under their land. They must maintain them, let water flow naturally, prevent pollution and protect wildlife.

The Water Services Regulation Authority (Ofwat): Ofwat is responsible for regulating the customer service and price afforded by the water and sewerage companies in England and Wales.

Water and sewerage companies: these companies provide clean (drinking) water and services for wastewater (sewerage). In England, they work in collaboration with other agencies to protect and improve the environment.

This is not an exhaustive list. See the National Flood and Coastal Erosion Risk Management Strategy for England for details of organisations involved in flooding.

Return to Recommendation 3

I consider the water industry to be at the forefront of the peat restoration agenda. Over recent years, and particularly in the uplands, water companies have invested heavily in peat restoration projects to unlock benefits for climate, nature, water quality and flood risk management. The focus so far has been on peat restoration, and there is an opportunity now to bring sustainable lowland agricultural peat management into scope. For this to happen, the UK government must set new strategic direction for managing water in the interests of preserving peat soil carbon. This new strategic direction must be matched with new investment and resource, as supported by changes in policy, regulation and potentially in legislation, in order to support authorities to deliver change on the ground.

Intuitively I believe our country, which once held vast areas of natural wetland, receives enough rainfall to keep peat wetter: I believe our problem is how this water is managed. From extensive climate modelling, we know that our country is on track to experience more rainfall during winter and less rainfall during summer, which is both projected to increase our likelihood of flooding and periods of water scarcity[11]. By 2050, the impact of climate change alone will require us to find an additional 400 million litres of water each day, and this is before we factor in far greater drivers of water scarcity such as population

[11] Climate Change Committee 'Independent Assessment of UK Climate Risk' 2021, page 13

growth[12]. If collectively, we do not find a way to better manage our water, then adding a new requirement to keep peat soils wetter will only exacerbate pressure on supply. Not only for peat, but especially for peat, we need to future-proof how water is managed.

To rise to the challenge, I believe we need to increase our capacity to store, retain and release more water in lowland peat landscapes. New storage will be the key to holding back more water during times of peak flow, helping both to improve our resilience to drought and to manage local flood risk, whilst making new stores of water available for keeping peat wetter. To raise water levels safely and sustainably, new storage must be distributed across lowland catchments and matched with new investment in water management infrastructure, telemetry and controls for reasons I come to later. Year round, instead of pumping excess water out to sea, I believe we need to be providing water with a local place to go, from which it can be released and utilised to ease water scarcity.

Demand for wetter modes of farming on peat

Hand-in-hand with water-level management comes farming. If water levels are to be raised in peat landscapes, then by and large the government must create the right conditions for farmers to want to transition to wetter modes of farming. Above all, new ways of farming on peat must be practically and economically viable, and they and must not drive food production overseas, nor increase emissions arising from food production.

Currently, most farmers share a reluctance to convert to wetter modes of agriculture. Shifting policies through time have paid farmers to pull hedges out only to replant them years later. For some, this has created a sense of mistrust for where the next administration is headed. Compared to such changes, raising water levels may feel like a bigger change still – more of a paradigm shift. Until we can better understand the impacts and economics of lowland peat rewetting, and until we can de-risk the transition to new measures, it is reasonable to expect most farmers to object to raised water levels.

That said, I have heard from numerous farmers who are keen to trial new measures. I have met great innovators whose pioneering farms serve to demonstrate what can be achieved with strong partnerships, permissions granted and financial support. To see more people take-up wetter modes of farming will rest on the success and celebration of these trailblazers. Later in this report, I showcase what our early innovators have achieved and provide a plan to build confidence and security to upscale demand.

I strongly believe the success of new measures will rest on cooperation between farmers, land-managers, their agencies and communities, drawing on government support. At the

[12] GOV.UK, 2020 Meeting our future water needs: a national framework for water resources

start of this process, I stressed the importance of having each region create their own vision and I am pleased to see strong partnerships starting to take effect. The changes recommended in this report will be far more effective, and easier to facilitate, if they are developed with local catchments in mind.

To carry on as we are currently will only compound the adaptation challenge for future generations (as depicted in figure 4). By continuing to intensively drain water away from low-lying peat landscapes, we should only expect more peat soil loss and, in turn, subsidence. In effect, we will continue to carve out an ever-deeper bowl in peatland landscapes, making it more and more difficult to protect drained peat landscapes from flooding. The societal and infrastructural costs of peat-related subsidence are severe[13], as is the damage being done to our climate. To secure resilience, not least for those who work and live on peat soils, I believe now is the right time to seek out a new approach.

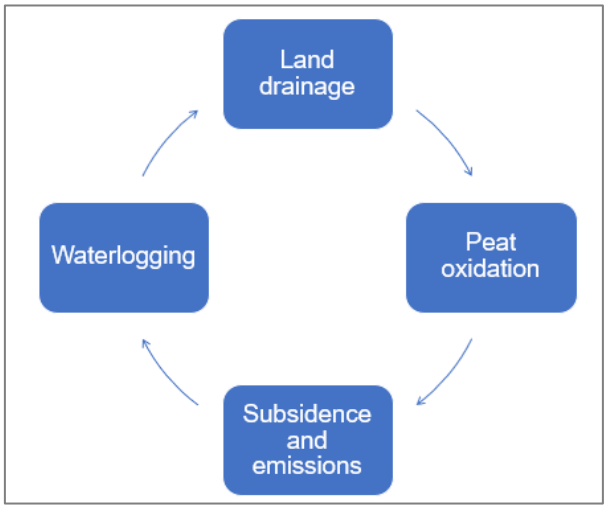

Figure 4: The positive feedback loop happening currently in drained lowland peat landscapes.

[13] University of Leicester and UK Centre for Ecology and Hydrology. Infrastructural and societal impacts of water level management on lowland peatlands in England and Wales Policy Briefing Note 2021

Vision

I want this report to unlock opportunities for all those farming on lowland peat to do so in a more sustainable way. The science suggests that even a small change in water-level management can significantly slow the loss-rate of peat soils, and so, in some landscapes, I want to make it possible to raise water levels above where they are penned currently to farm in a more climate resilient way. In some places, particularly on marginal farmland, I want to encourage some farmers to go further so as to transition to paludiculture. I hope this report, together with its annex, can unlock a matrix of opportunities across England's different farming systems (see figure 5) to better preserve peat in every region.

I believe all farmers should have the choice to implement the actions they see fit, recognising that no two peat landscapes are the same. In areas where deep peat remains, I see scope to achieve the biggest gains by raising the water table partially or temporarily. Where peat has wasted, it may be that other interventions could be more effectively applied. Rather than prescribe solutions nationally, I want to enable farmers and land-managers to adopt those interventions best suited to their soil, topography and climate.

I hope decision-makers will begin by focusing on delivery in England's most expansive areas of lowland farmed peat. In these four regions, I believe the focus should be on preserving peat at scale by helping farmers and land-managers take up new opportunities en masse. Over time, I want to make it possible for famers to transition to more significant measures to realise wider benefits for the catchment and climate, which may come with broader benefits for the environment and nature. To realise this long-term vision will require systemic changes in policy, funding, science and innovation, matched with new ways of working – I see this report as just the start.

This report should be read as complementary to Defra's broader agenda for peat, as set out in the England Peat Action Plan. The government has set ambitious targets to restore peat which will be the best way to deliver for the climate, environment and nature. Where restoration is not possible or desirable, I believe the recommendations in this report can be implemented to see farming on peat continue in a more sustainable way. Though restoration is beyond my remit, I see restoration and sustainable management as intrinsically linked, given that both will rely on our capacity to better manage water. As such, I believe that opportunities for restoration and more sustainable management should be explored in parallel to drive the best results for peat at a landscape scale.

Before I move into my recommendations, I must explain how all 14 of them come as a package. My recommendations do not flow in priority order. They are interlinked and must not be cherry picked.

All 14 recommendations should be considered in the context of broader changes ongoing. Climate change, biodiversity loss and population growth will force changes in water

resource, flood risk management and food and farming policy in landscapes including (but not limited to) those containing peat.

Lowland peat soils play a vital role in producing food for our nation and supporting our rural economies. To see this continue, I set out the changes I see as necessary to future-proof how they are farmed.

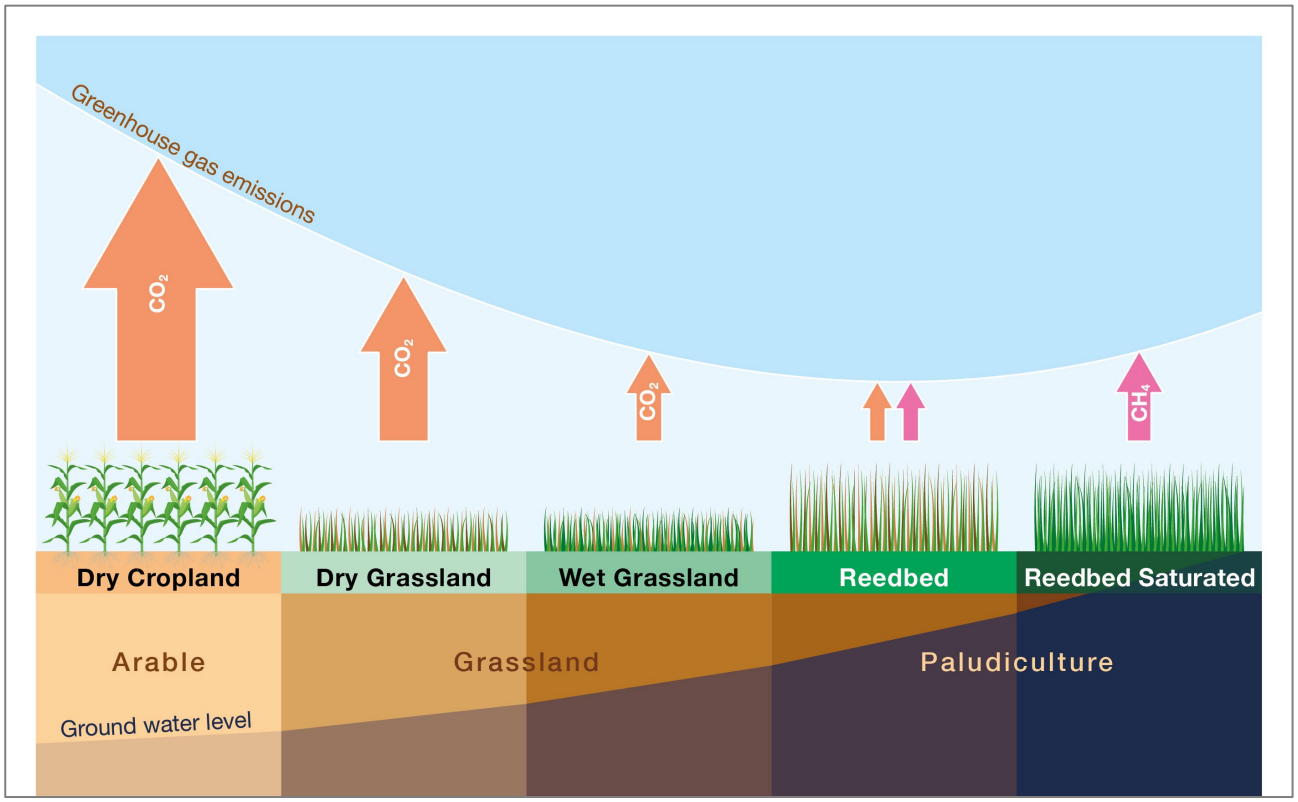

Figure 5: A matrix of opportunities, demonstrating the different farming systems across which the Task Force wants to bring about positive change. The matrix demonstrates how different emissions range from system to system, where CO2 is for carbon dioxide and CH4 is for methane. Again, nitrous oxide is excluded due to uncertainties.

Recommendations

Chapter 1: Water for peat and more water level management control

The largest expanses of lowland agricultural peat are based in some of the driest and wettest parts of the country. Given water is the answer to preserving peat soils, we must make new stores of water available for peat preservation and improve our water level management control.

Recommendation 1: A place for peat in planning more strategically about water

Peat preservation will require us to take a more integrated approach to water level management. The NFU has already put this approach into words in its strategy to build resilience in the farming sector to episodes of flooding, water deficit and drought[14], which are set to become more frequent and intense with climate change[15].

Water resources are already of concern, with most farmers concerned that their share of existing reserves will continue to reduce as pressure mounts on public water supply. If the direction of travel is to keep peat wetter, then finding water for peat could add to this pressure. This need not be the case, if we can take a more strategic approach to retaining water in the landscape.

I cannot say how much water peat will require. What I can do is offer constructive ways to better manage our water so that decision-makers are not forced to allocate peat a share of our diminishing supply. Fundamentally, I believe we should radically reduce the extent to which we flush to sea vast quantities of freshwater and store more water on land for use during times of short supply.

Having new multi-functional water stores available could both make new reserves of water available for peat preservation and unlock significant benefits for the public, environment and agriculture. For the benefit of all sectors, I believe we need to plan for water more holistically and embed lowland peat within our plans for water.

To factor peat into decisions about how water is allocated and managed, **I recommend England's five regional water resource groups start factoring peat into their emerging regional plans**. Delivering on the Environment Agency's National Framework

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[14] NFU 2021, Integrated Water Management

[15] Climate Change Committee 2021, Independent Assessment of UK Climate Risk, page 35

for Water Resources[16], each of the 5 groups is currently finalising a draft plan for how it will supply enough water to meet demand in its region until 2050.

The framework requires each group to plan for the combined challenges of supplying water to a growing population, improving resilience to drought and minimising disruptions to supply, all whilst adapting to climate change and leaving the environment in a better state than it is now.

Earlier this year, I wrote to each of the five groups to recommend they start considering water requirements for peat as part of their efforts to improve the environment and I echo this advice here. Though I recognise that detailed hydrological estimates will be constrained by the limited data we currently have available on peat, I believe now is the time to secure for peat a place in the planning process.

Peat also needs to be placed on the agenda for local decision-making. To achieve this, **I recommend the improvement and expansion of our existing model of Water Level Management Plans (WLMPs).**

Developed some 30 years ago, WLMPs were first introduced to balance the interests of agriculture, flood risk management and conservation in areas where water level management may have had a particular impact on wildlife. Now considering the effects of water level management on our climate, I recommend the application of WLMPs is strengthened and their remit is expanded to apply to peat. Arguably, the process and guidance for producing and maintaining WLMPs is due a refresh, hence now is the right time to bring in the consideration of peat carbon stores.

I want these 'new-look' WLMPs to give structure and focus to discussions between local convenors, and to help them balance water levels for all outcomes including peat. I am acutely aware how many plans exist already, and I am keen not to introduce new plans unnecessarily, which is why I think they should work with plans which are already a requirement or will soon be introduced.

I therefore recommend that Defra designs these new-look WLMPs to align with its Local Nature Recovery Strategies.

At the catchment scale, LNRSs could be used to identify England's most significant expanses of lowland peat for which new plans should be created. Each WLMP could be used to identify local priorities for feeding into the LNRS and to map areas where change is most needed. The lead authorities responsible for LNRSs could help to identify a suitable lead for new-look WLMPs in different places: this could be the Environment Agency, local IDB or another agency.

[16] Environment Agency 2020, Meeting our future water needs: a national framework for water resources

Those involved in governing LNRSs could also play a role in reviewing the consistency of WLMPs for peat carbon stores between places. The time and resource invested by these parties in producing and maintaining these new look plans would need additional funding.

The amount of water required to keep peat soils wetter will vary greatly between the unique conditions of each site, hence better planning for peat locally will be key to understanding the water requirements for peat at scale. Some lowland peat landscapes, particularly those in natural dips or bowls, may require little or no additional water input to significantly reduce emissions, whereas sites elevated in the landscape may need a higher volume of water to be inputted more frequently, particularly during the driest times of the year.

In some instances, bunding may be required to pen water. Some farmers may find it beneficial to either reduce field sizes or water management zones (or both) to support a more localised management of water across smaller drainage units. These types of decisions are ones best made locally.

Recommendation 2: New investment in water storage, management and control

Key to making new water available for peat preservation will be investing in water storage, retention and release. To raise water levels safely and sustainably, new storage must be matched with new investment in the technologies and controls we use to manage water.

In some cases, investing in new water storage could mean significant infrastructural change and the need to compensate farmers for land taken out of production.

To prevent new water storage from eating into the banks of high value land, I recommend we grow our national network of water stores and reservoirs offline and across drainage districts.

Storing water this way could support a more global sharing of water for where and when demand outstrips supply. It could also help to reduce the frequency of pumping and in-turn cut fuel-related emissions, particularly if new storage could be created at river level or elevation to promote drainage by gravity. When creating new storage, the benefits of integrating new and existing wetlands in the farmed landscape should be considered.

I recommend we also invest in advancing our water level management technologies to help us retain and recycle more water within the landscape.

Learning from the Dutch, I see scope to invest in a combination of both soft and hard engineering solutions. One cheap and effective tool could be the installation of simple u-bends in farm drainage systems to keep more water in the soil: as and when deemed necessary, farmers could simply downturn the u-bends to see the same water released.

More expensive solutions include the installation of greener, more efficient pumps to recycle freshwater within drained catchments. I have been impressed with the evolution of

the Felixstowe Hydrocycle (see Case Study 1) and the roll-out of Archimedes screw pumps by the Water Management Alliance in East Anglia (see Case Study 2).

To make safe and sound decisions about if, where, when and for how long to pen raised water levels in lowland peat landscapes, **we should also invest in improving our telemetry and water level management controls.**

By telemetry, I mean we need to invest in providing local decision-makers with more accurate information about changing weather conditions. By controls, I mean we need to invest in certain procedures such as the opening and closing of weirs and sluices, so that operators can react faster to intense downpours where and when water levels have been raised, and freeboard has been reduced.

Only with these three layers of investment do I believe it will be possible, in some landscapes, to raise water levels safely and sustainably whilst supporting flood risk management: this is a point I expand upon further in the box 'Mitigating flood risk under raised water levels in lowland peat landscapes'.

As to where this new money for investment will come from, **I recommend government creates a new dedicated 'water fund for carbon'.**

The fund should unlock new ways of managing water in lowland peat landscapes to achieve 'win-win' scenarios including reduced peat loss, emissions and subsidence, and increased resilience to drought and flooding.

Building on the success of early funding introduced for natural flood risk management techniques, I believe the fund should be first introduced as a standalone pot and spent on collecting evidence through tests and trials. The fund should consist of both capital and revenue and should be made available to farmers, growers and other consortia.

In time, the UK government should decide how the fund can be most appropriately resourced. If private investors can be empowered, I would recommend a blend of public and private finance streams pay for the fund in future.

Rightfully, this decision should be influenced by the degree to which lowland peat management can be funded by new opportunities emerging from the carbon market (which is a topic I come to in my next chapter).

New investment by water companies could provide another investment stream. There may be several motivations for this, particularly as a source of good quality, local carbon credits to support the industry's collective commitment to reach Net Zero emissions by 2030[17]. Investing in peat preservation could provide co-benefits for water resources, water quality,

[17] Water UK 2020, Net Zero 2030 Roadmap

biodiversity and flood risk management and therefore be made a part of water company plans and requirements[18].

In the short-term, I recommend that regulators of the water sector (including Ofwat, the Environment Agency and the Drinking Water Inspectorate) find ways through the 2024 Price Review to support and incentivise water companies to invest in the multiple benefits that could be unlocked through keeping lowland peat wetter.

Though new funding must be found upfront, I would urge decision-makers to consider the long-term cost savings of preserving peat.

In the Great Ouse Fens, experts have forecast it will cost at least £1.8 billion to maintain the current standard of flood risk protection for the next 100 years[19], and I would expect similarly significant costs to maintain the current standard of service in other lowland peat settings.

Rather than system improvements being seen as costing more money, I think they should be seen as investments for the long term. By investing in the infrastructure required to prevent peat loss, we can limit the extent to which peat landscapes subside and slow down the cycle of decline explained earlier (see figure 4). To reduce emissions, manage flood risk and build resilience to drought, we should invest heavily and upfront to tackle peat loss and subsidence.

[18] Including company-level water resource management plans, drainage and wastewater management plans and nature-based approaches to meeting Water Industry National Environment Programme requirements.

[19] ADA 2021, Future Fens – Flood Risk Management

Case Study 1: Water Storage at Felixstowe Hydrocycle

Water shortages on the Felixstowe Peninsula are particularly acute. Even during the winter months, it has been reported that the rivers can flow so low that at times abstraction cannot be supported. To increase supply, farmers on the peninsula have established the Felixstowe Hydrocycle to bring inland new supplies of fresh water.

The Hydrocycle is a coalition of farmers and representatives from the Environment Agency, East Suffolk IDB, the University of East Anglia and Suffolk County Council. In 2018, project partners saw €969,000 of EU funding invested in 14km of new pipes and infrastructure to bring water inland.

So far, the new piping has been used to successfully pump 800,000m^3 of water into reservoirs. The project should eventually be able to recharge natural groundwater reservoirs and to supplement irrigation supplies: early trials have demonstrated promising results.

By investing in similarly innovative solutions to store more water in lowland peat landscapes, we could be capturing water which would otherwise be flushed to sea.

A pumphouse on the Felixstowe Hydrocycle

Case Study 2: Water Management Alliance

A group of 6 IDBs in East Anglia, collectively referred to as the Water Management Alliance, has invested £48 million in new infrastructure to improve outcomes for environmental protection and flood risk management. The investment has funded the replacement of 13 pumping stations with state-of-the-art Archimedes screw pumps.

Inspired by Dutch engineering, the Archimedes screw pump features a conventional open screw, fully enclosed and welded to a pipe to see it rotate as a single unit. Each pump can be operated at variable speeds, with lower spin rates using less electricity.

The pumps are designed to be fish and eel friendly, and to make it possible to lift water to the top of the embankment to replenish reservoirs and to recirculate water upstream and across low-lying catchments. By moving water more slowly throughout the network, the pumps can help to improve water quality in support of local nutrient neutrality goals.

Investment in similar pumps across the country could help us respond more quickly to changes in catchment conditions and to better manage water resources upstream.

Archimedes screw pump at Thorne Moors

Mitigating flood risk under raised water levels in lowland peat landscapes

Return to Recommendation 2

The Environment Agency has undertaken initial assessments to determine the number of properties at risk of flooding in areas of lowland of particular interest. Housing and buildings have been mapped given they are the key criteria for investment in floods funding.

Based on its assessments, the Environment Agency is confident that the effects of raising water levels on flood risk to people and property can be managed and do not present a significant barrier to raising water levels in lowland peat landscapes.

Whilst there are some properties currently at risk, the Environment Agency finds that the actual and relative number of properties at risk is relatively low [20]. If water levels were to be raised to better preserve peat, the Environment Agency has found that the risk to properties nationally is unlikely to change significantly.

As a task force, we have discussed how even the smallest increase in flood risk can be hugely significant when it is felt by persons locally. This is why I am calling for new investment in water storage, water management infrastructure, telemetry and controls to mitigate flood risk.

I believe these investments should make it possible to take more water out the system during peak flow events, to raise and lower water levels apace, and to more accurately predict downpours so that authorities can continue to manage flood risk. So long as these improvements are delivered in tandem, I would expect them to improve our resilience to managing both peak flow and low flow events.

To understand the flood risk posed to sectors broader than property, **I recommend that flood risk is considered based on local conditions. I recommend a new model of WLMPs to achieve this**, seeking to provide a platform to balance the shared needs of people, agriculture and the environment locally (as covered in recommendation 1).

[20] As a proportion of total property numbers at risk in each Lead Local Flood Authority

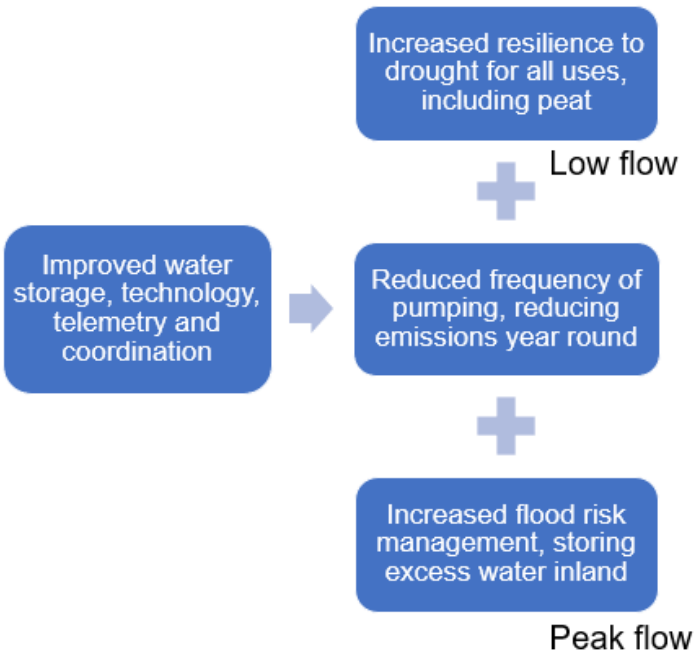

Figure 6: This diagram shows how improved water storage, technology, telemetry and coordination can lead to improved resilience to both peak flow and low flow events

Return to Recommendation 2

Recommendation 3: Legal protection and powers for managing water for carbon

Responsibility for managing water levels in our most expansive areas of lowland peat sits primarily with IDBs. IDBs cover approximately 10% of England and are concentrated mostly in the East, North-East and South-West of the country. If we are to empower IDBs to play a part in peat preservation, then we must give them the legal protection and powers to manage water differently.

IDBs are required to manage water levels to meet their district's agricultural and environmental needs and to manage flood risk from watercourses in their district. To deliver on environmental terms, each IDB is required to further the conservation and enhancement of natural beauty and the conservation of flora, fauna, geological and physiological features in their drainage district.

In view of how they are mostly for nature conservation, I find these environmental duties lack specific reference to carbon. I am mindful, therefore, that IDBs may face risk of legal challenge if they are asked to raise water levels in the interests of peat preservation, should this be perceived as contrary to their primary responsibility to drain the land.

To understand if this risk of legal challenge is real or perceived **I recommend the government assesses in full the legal implications of asking responsible authorities to raise water levels in the interests of preserving peat soil carbon**. This assessment should include both the short-term and long-term risks of penning more water in lowland

peat landscapes. **If a change in the law is deemed necessary, I believe the UK government must take a stronger position on the need to manage water levels in the interests of conserving our climate, as it has done for nature**.

Ultimately, where it is deemed possible to safely manage higher water levels to preserve peat, we will need the UK government to signal that doing so is in-keeping with national policy on climate.

I also recommend the government considers giving IDBs new powers.

Currently IDBs only have the power to charge drainage rates: in other words, IDBs only have the right to receive payment for the act of water removal. If their remit is to be formally expanded to include managing water for peat preservation, then IDBs will also need the power to charge for supplying water locally. Changes to one part of their funding programmes may prompt the need for wider reforms.

The UK government should also consider giving IDBs the power to own and operate infrastructure for irrigation and reservoirs locally, and access to capital funding for investment in waterworks beyond flood risk management, including for water storage and water management.

Currently such funds tend to be ringfenced mostly for agricultural businesses and therefore exclude IDBs as public authorities. Despite having 'drainage' in their name, some IDBs are already starting to describe their modern function as water level management[21]. With the right support, I strongly believe IDBs – where present in lowland peat landscapes – can be a part of the solution.

Where IDBs are not present, I recommend that the authorities responsible for watercourses in those areas are similarly empowered to manage water levels more optimally for peat. This may mean giving legal protections and powers to the kinds of authorities outlined in the box titled 'Management of the water environment – which authority does what?' As above, a thorough assessment should first be done.

Whilst I have focused on changes in the lowlands, I support the need for nature-based solutions in the upper catchment too. Here solutions can help to reduce run-off, increase soil infiltration and thereby help to maintain a more consistent flow of water from catchment to sea. Storing more water throughout the system in natural places may unlock holistic benefits for farming and conservation and promote ambient cooling[22].

And as well as finding new ways to store and manage water in lowland landscapes, I recommend a greater concerted effort by all sectors for using water resources more

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[21] ADA, Environment Agency 2012, Establishing New Internal Drainage Boards – Guidance

[22] Zhang, Z, Chen, F, Barlage, M, and others, Cooling Effects Revealed by Modelling of Wetlands and Land-Atmosphere Interactions Advancing Earth and Space Science 2022, Volume 58, Issue 3

effectively. If we can all find ways to improve efficiency, we can leave more water in the environment to meet the UK government's existing ambitions and have water available to keep lowland peat wetter.

Chapter 2: Enabling more sustainable ways of farming on peat soils

A new approach to water level management will be the key to preserving peat, but for change to be successful, it must have the support of farmers. New measures for peat can only be deployed if farm businesses are to remain viable.

I firmly believe that no farmer on peat soil should be left financially worse-off for better managing our carbon stores, and that farmers should have the opportunity to access technical advice on wetter modes of farming.

Recommendation 4: Public money for wetter modes of farming on lowland peat

Let me begin by reviewing the current position regarding the Defra's roll-out of its new schemes for environmental land management. These schemes include the:

- Sustainable Farming Incentive: which will focus on making agricultural activities more sustainable and will pay for actions that all farmers can choose to take. This scheme will pay for standard actions that can be taken at scale across the farmed landscape.

- Countryside Stewardship: which will pay farmers and land managers to look after the environment at a local scale, paying for actions that protect and improve habitats and features of the land they manage. The scheme is set be updated and expanded through Countryside Stewardship Plus in 2023 and 2024.

- Landscape Recovery scheme: which will pay landowners and managers who want to take a more radical and large-scale approach to producing environmental and climate outcomes through land-use change and habitat and ecosystem restoration.

Through one scheme or another, all farmers and land managers will be able to enter into voluntary agreements to get paid for delivering positive environmental outcomes.

To deliver sustainable soils and climate change mitigation, I recommend Defra uses these schemes to incentivise activities which can evidently preserve peat and reduce emission.

Roll-out of the Sustainable Farming Incentive has already begun. For its first year (2022 to 2023), the government introduced a standard for arable and horticultural soils and a standard for improved grassland soils.

Those farming on peaty soils are eligible to apply to either standard, subject to them following some targeted advice:

- under the arable and horticultural soils standard: applicants are advised to not add organic matter to their peat soils given the risk of accelerating peat decomposition
- under the improved grassland soils standard: applicants are advised to not introduce herbal leys into their rotation as ploughing can lead to peat disturbance and aeration

For these initial standards, Defra has defined peaty soils as soils with an organic matter content of 20% or more to a depth of 40cm or more.

Moving forward, I recommend that Defra expands this definition to include soils with an organic matter content of 12% or more within the top 40cm of the soil[23], at least within our most significant expanses of lowland peat.

This way, 'peaty' incentives can be made to apply not just to deep peat but also to areas of wasted peat which remain important carbon stores, as well as continued sources of emissions. To constrain use of this definition nationally, I would think it possible that our current peat maps could be used to support a high-level identification of our most 'peaty' areas.

Looking ahead, I urge Defra to use this updated definition to create content for the sustainable management of lowland peat as its three schemes develop. Officials should work with the farming, land and water management community to develop workable solutions supported by the science. I have covered already the evidence on emission reductions associated with raised water levels.

To raise water levels, I believe Defra should use its schemes to at least pay for the capital infrastructure required to raise water levels, for the platforms required to bring local convenors together, and for the provision of technical advice to the farming and land management community. Countryside Stewardship might provide a neat fit for these three things.

I note that Defra has signalled its intention to develop offers for lowland peat under Countryside Stewardship: to create attractive offers, I recommend stakeholders across the country engage with its development.

As an alternative or additional option to raised water levels, I am pleased to see evidence starting to emerge from early trials to suggest that irrigation can provide another peat preservation technique (see Case Study 3). The same cannot yet be said for mulching, but intuitively experts believe that it could provide another way to retain more moisture in peat.

[23] As per the FAO 2006 World Reference Base for Soil Resources

I therefore recommend that scientists, policy-makers and interest groups work more closely together to realise the potential of irrigation and mulching to preserve lowland peat.

Mulching trials should focus on peat under cropland, given caution aired in Somerset that mulching on grassland could trigger unintended consequences for sward species.

If the benefits of irrigation, mulching and indeed other interventions can be robustly evidenced to preserve peat, so as to reduce emissions and subsidence, then the government should facilitate their uptake.

I recognise there are significant cost and water implications associated with irrigation, and that mulching might cease to be effective when conditions are extremely dry. I would therefore expect these types of options to mostly appeal to those farmers who may struggle to raise their water-tables, including those farming on wasted peat.

Overall, I believe Defra should develop realistic and inclusive incentives across its three schemes, especially during its early phases of scheme roll-out. I say this based on what I have seen of the Countryside Stewardship options announced in 2022 for raised water levels on cropped or arable land on peat[24]. Currently, these new options will only reward farmers who can raise their water levels to within 10 to 30cm of the surface. Whilst these options may be attractive to some, I believe they should be expanded to include those who can raise their water levels less substantially. Under all its schemes and initiatives, I believe Defra should focus on incentivising results on a sliding scale, accounting for differences in topography, soil and climate.

I do not disagree that those more challenging options, capable of delivering more environmental benefit, should attract the highest reward: payments should increase to the right of my matrix (see figure 5), but Defra must reward positive step changes across all farming systems to achieve optimal results. Incentives should drive modest results where more significant results are not yet attainable.

As new schemes replace old, Defra must stay cognisant to the risk of incentivising perverse outcomes for peat: by this I mean, the risk that new incentives introduced to make peat farming more sustainable could end up causing more damage to peat than good. I am especially concerned that without financial support for extensive livestock farmers, some farmers may feel forced financially to convert their grassland to cropland to ensure a viable farm business.

This should not be the case.

I must also stress the need to lengthen agreements where they involve lowland peat, given that to raise water levels may not be a change quickly reversed.

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[24] GOV.UK 2022, SW17: Raised water level on cropped or arable land on peat soils

Case Study 3: Reduced Peat Subsidence with Surface-Level Irrigation, Central Kalimantan, Indonesia

A study looking at rates of tropical peat soil loss in Central Kalimantan, Indonesia, has concluded that surface irrigation merits further attention as a climate change mitigation technique[25].

The study, which has used cameras to measure rates of subsidence across forested, burned and agricultural peatlands, found lower rates of subsidence from peat soils where borehole irrigation was used to maintain soil moisture. These results suggest that irrigation could be used to reduce subsidence and in turn emissions from dry and degraded peat soils.

Experts see no reason why these results should be unique to Indonesia because the fundamental processes that govern peat decomposition are universal. I therefore recommend that the potential for targeted irrigation is further explored as a way to reduce emissions from peat soils here in England, and that lessons learnt are clearly communicated to the farming community.

Drone picture of the study site in Central Kalimantan, Indonesia

[25] Evans, CD, Callaghan, N, Jaya, A, and others: A Novel Low-Cost, High-Resolution Camera System for Measuring Peat Subsidence and Water Table Dynamics. Frontiers in Environmental Science 2021, Volume 9

Sluices may be operated where present, but the lasting effects of raised water levels on the land remain largely unknown. For tenant farmers, the effects of some measures could outlast the lifespan of most Farm Business Tenancies. Without long-term payment agreements, few tenants or landlords could agree to changes which may risk a permanent devaluation of their land or a breaking of their contractual agreements, as few would want to invest in costly equipment such as water control structures.

To ease constraints, **I recommend that Defra supports the transfer of long-term agreements between tenants.** I also suggest that UK government considers who in the tenancy agreement owns the peat soil carbon and who is responsible for maximising, in so far as possible, the permanence of any climate mitigation secured.

Recommendation 5: Viable opportunities for private finance

The government has set out its commitment to drive private investment in the sale of ecosystem services and, where possible, for its environmental land management schemes to support the crowding-in of such finance. I am keen to ensure that land managers who farm their land more responsibly can access potential opportunities for green investment.

As a crucial first step to developing viable opportunities in private finance, I believe we need to improve our monitoring, reporting and verification of different lowland peat management techniques. Gathering data on carbon flux should be an essential place to start. Drawing on expert advice, I believe new data should be collected on the potential of different farming systems and different crops to unlock emission reductions relative to an agreed baseline.

Over time, this data should be captured in carbon assessments and used to reward farmers and land-managers appropriately. Improving our monitoring, reporting and verification will be a significant undertaking.

To get started, experts should prioritise the development of emission factors for those crops and farming systems which promise the most significantly reduced emissions, and for which demand exists already.

I recognise the existing demand for reed for thatch and, having engaged with growing media manufacturers across the country, I have found there to be a rising demand for farmed sphagnum too.

Depending on the extent to which altered peatland management can reduce carbon loss, or even reinstate carbon sequestration, there may be opportunities to ‘farm’ land for carbon as a marketable product, providing financial support for more sustainable peatland management.

Due mainly to a lack of robust data on carbon flux, the voluntary carbon market does not yet have agreed standards for lowland agricultural peat.

To remedy this, **I suggest Defra takes action to signal investment in wetter modes of farming on peat and to develop the infrastructure required to support safe and verified transactions.** The Peatland Code (see 'The Peatland Code' below) is starting to have significant success in attracting voluntary carbon investment into peat restoration.

Either through an update to the Peatland Code, or via a robust and credible new system of assurance akin to it, I would like to replicate the code's success in a lowland agricultural peat setting. I am aware of the challenges in applying the Code's existing principles to a farm setting, such as permanence, which may become an issue where more sustainable management interventions are changed or reversed. Such challenges, along with other big challenges, will need to be worked through.

The Peatland Code

The Peatland Code is a voluntary certification standard for UK peatland restoration projects. Alongside the Woodland Carbon Code, it is one of only two nature-based carbon codes which is endorsed by the UK government. It facilitates the sale of real, quantifiable and permanent climate benefits achieved through peatland restoration. Currently, the code provides assurance for carbon benefits only and, until recently, was limited to restoration projects on blanket or raised bog in the eroding or drained categories.

The Code provides a consistent approach for projects wishing to attract carbon finance. It also provides validation and verification to the market to reassure buyers that each project will deliver the benefits it claims. Defra has been working with the International Union for Conservation of Nature (IUCN), UK Centre for Ecology & Hydrology (UKCEH) and the James Hutton Institute to expand the code to lowland fen.

The development of a model akin to the code, or a new module within it, made to apply to broader lowland agricultural peatlands, could have the potential to unlock new and significant investment in more climate resilient farming techniques. To drive this ambition, more data is needed on the response of different peat soils to different farming techniques.

NB: Since this report was first prepared, more data has been collected and an update to the Peatland Code has been published. For the first time, projects raising the water table on lowland fen peatland (without habitat restoration) are eligible to attract private finance through the Code.

Insetting could provide a quicker alternative to carbon markets, so long as the cost of emission reductions is not passed directly to the farmer. For companies such as retailers and food producers looking to reduce emissions throughout their supply chain, insetting may provide a route to reduce their indirect emissions (often called 'scope 3 emissions') by supporting peat farmers and land-managers to produce their goods in a more climate resilient way.

I see scope for insetting to be part of the solution, but only if farmers can be fairly compensated for their actions, both for cost recovery and for value added. The long-term

benefits of the farmers' actions must be recognised, and the farmer should retain the carbon benefit for their new management style: money – not carbon – should be all that is exchanged. With expenses rising, I recognise that most parts of the supply chain will struggle to bear the additional cost.

Until the UK government can introduce new standards for soil carbon trading, I would recommend that most farmers proceed with caution. Above all, I want farmers to consider the potential risk of having to buy back their carbon credits at a higher rate in future, should carbon accounting requirements one day be introduced, after they have already sold 100% of their on-farm carbon upfront. I want farmers to approach live opportunities fully aware of this and other risks, and of ambiguities linked to claims of carbon neutrality.

Despite my focus on carbon, I see scope for investment in wider benefits attached to nature-based solutions too. I am excited by the potential for stackable benefits linked to nutrient neutrality and biodiversity net gain, though these and other opportunities will need to be signposted more clearly for farmers to make use of them.

In addition to climate mitigation, I can also see how keeping peat soils wetter could unlock wider benefits for water quality and/or water storage capacity. Certainly, for our water companies and insurance bodies, these extra benefits could provide another reason to invest in wetter ways of farming.

Currently these important outcomes are harder to measure, and unlike carbon, are not yet widely traded via established codes or markets. To better understand their potential, I use my final chapter to call for more large-scale field trials and research.

Recommendation 6: Technical advice on keeping peat soils wetter

Financing new measures can only be one part of the solution. For farmers to take-up new measures, some will need access to technical advice on how to keep peat soils wetter.

I have found most farmers and land-managers to be well-versed in 'regenerative farming'. Example techniques include minimum tillage, the application of cover crops, and the introduction of herbal leys, which can all have significant benefits for the structure of mineral soils and for environmental outcomes including biodiversity and water quality. **To now see regenerative farming benefit the structure of organic soils, I believe we need to encompass within regenerative farming ways of keeping peat soils wetter.**

In some circumstances, the farming community may benefit from having access to new technical advice on practical ways to keep peat soils wetter. **I therefore recommend the introduction of new Peat Sensitive Farming Advisers (PSFAs) to build trust and understanding in new wet farming techniques.**

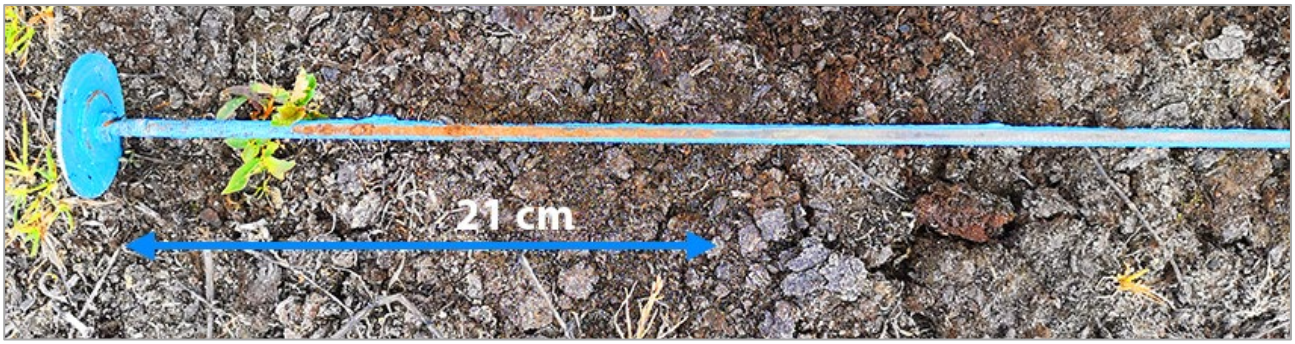
Much like the current model of Catchment Sensitive Farming Officers, I recommend PSFAs are linked to the new schemes for environmental land management. Rolled out across our most expansive areas of lowland peat, one or several advisers (depending on local need) could be resourced by central government to provide technical advice on the

impact of current management techniques upon peat soil hydrology, thinking particularly of the nuances around windbreaks, shelterbelts and agroforestry on peat.

Equipped with the best available science, our PSFAs could spend time out on local farms speaking to farmers in a way that empowers them to encompass positive changes for peat into their existing regimes. PSFAs would need to have a strong understanding of both farming and water management, as is the case with new advisers being financed by water boards in the Netherlands.

To build understanding, I also believe we need to support farmers to monitor the state of their peat using low-cost, simple and effective tools. Rust rods could provide one way forward, knowing that rust will only form on metal where it has been exposed to both oxygen and water. After a few months of a rust rod being placed in the ground, the task force has seen how it can provide a useful gauge for where local water tables have been sitting (see figure 6).

Following a series of simple steps, experts believe farmers could be supported to use rust-rods to map their water-table management zones, to associate their zones to known rates of emissions, and in-turn to calculate a reasonable estimate of emissions from their peat. To instil confidence in results, PSFAs could be supported by a programme of rust-rod roll-out.



A rust rod

Overall, I want sustainable methods of farming on peat to have a long-term future. The value of wetter land must be protected and farmers and land-managers must have new financial and technical support to adapt their regimes: I see this as fundamental to building confidence in more sustainable ways of farming on peat.

Chapter 3: Supporting people, partnerships and economies

Local partnerships will be vital for delivery, given that it will be far more effective to raise water levels at a catchment or drainage board scale than at the scale of individual fields. Some individuals and partnerships are already striving to manage their peat under wetter conditions.

To support their transition, I want to ensure that wet farming is enabled by our policy and legal frameworks and raise public awareness for more sustainable farming techniques.

More so in this chapter, I make recommendations that can be delivered by those outside of government.

Recommendation 7: Building on bonds already formed

For our most extensive areas of lowland peat, I believe constructive conversations have already begun. In all four regions for which I have hosted targeted discussions, I am pleased to see local stakeholders developing new bonds with peat preservation in mind.

I welcome the formation of new partnerships through Defra's Nature for Climate Discovery Grant (see Case Study 4)**.** Successful applications to the fund in Somerset, Fenland, Lincolnshire and the Broads National Park are spurring partnerships amongst farmers, landowners, IDBs and conservationists. Albeit focused mainly on peat restoration, some partnerships are exploring a mosaic approach to managing lowland peatlands in a more climate resilient way. **I recommend these existing partnerships continue to receive support and that new applicants to the fund are helped to develop.**

I highly commend the evolution of other groups starting to emerge from the bottom-up in response to the localised needs of their area. I have found the formation of the Fenland Farmers Dialogue Group to be particularly impressive. The Dialogue Group was formed in 2021 as a sub-group of the wider Fenland SOIL committee.

Now active across my broad spectrum of recommendations, I find the Dialogue Group is acting both as a facilitator and forum for learning and collaboration between local farmers and as a conduit for feeding advice into Defra.

Pump primed with £50,000 funding from Cambridgeshire and Peterborough Combined Authority, I am encouraged to see the group seeking match funding from farming and commercial members to support its long-term future.

Similarly, I think the formation of the Somerset lowland peat test and trial deserves credit. Led by the Farming and Wildlife Advisory Group (FWAG), the project has got stakeholders in the Somerset Moors and Levels working on a new model for collaboration amongst IDBs, farmers, land managers, local partners and delivery bodies.

Mobilised by a Defra funded working group, the project is aiming to shape a new platform for lowland peat preservation at a landscape scale.

I believe this type of project is precisely what we need to better understand and encourage effective modes of collaboration between different stakeholders, especially those who may be seeking different outcomes from the land. Findings should be shared, tested and verified elsewhere so we can find out if this learning is transferrable to other settings.

Case study 4: Nature for Climate Fund Discovery Grants

The Discovery Grant formed part of the Nature for Climate Fund Peatland Capital Grant Scheme. Launched in April 2021, the Discovery Grant has focused on enabling projects to begin the foundation work required to unlock barriers to peatland restoration and prepare to apply for restoration grants in future years.

This includes developing a detailed understanding of project sites (through undertaking hydrology, topography and species surveys using adaptive and novel techniques as well as mapping and modelling), investigating the potential of private investment opportunities and building constructive and effective relationships between partners.

Fifteen projects were awarded over £5 million through the Discovery Grant. At least seven of these projects have been working towards the restoration of peat in the lowlands, with at least 12,000 hectares under investigation across sites including the Humberhead Levels, the Norfolk Broads and the Dorset mires.

Projects in the East of England have been investigating sites with potential for both restoration and responsible management. For example, in the Norfolk Broads, the Discovery Grant is being used to rewet degraded peat to restore up to 1,382 hectares of lowland fen across the Broads National Park, alongside adopting paludiculture and gathering evidence to develop water-level-management approaches.

For projects like this, the Discovery Grant has driven a joined-up approach to lowland peat restoration and sustainable management by supporting collaboration between organisations at a landscape-scale, and knowledge-sharing between projects.

Shapwick Heath in the Somerset Discovery Grant

I am also seeing encouraging partnerships start to evolve in the North. I am pleased to see that the Northern Lowland Peat Coalition has been established to work with local partners

and landowners towards peat restoration and more sustainable land management practices.

In the North-West, the Winmarleigh Carbon Farm has become somewhat of a hub for sharing knowledge and information about wetter modes of farming, as has the Lincolnshire Wildlife Trust reserve to the East. I hope people engaged in these visits will maintain their curiosity to learn about wetter ways of managing peat.

I would encourage all of these groups and partnerships to work constructively on next steps arising from this report. The groups I have listed stand to learn a lot from one another and I encourage them to make links across the country. Certain groups may find it useful to bring new voices to the table, such as abstractor groups.

I also recommend that Defra continues to seek the advice of these partnerships as it develops its new and emerging policies. This will be particularly important for the development of the new schemes for environmental land management and changes afoot in the space of private finance. Input should be sought early and often and from a mixed array of interest groups, particularly from those with practical knowledge of farming, land and water management.

To maintain momentum for peat preservation nationally, I would like to see a new national forum established for lowland farmed peat. The forum could hold a conference once or twice a year to provide a platform for exchanging new data, information and advice on peat management trials and techniques. Defra Ministers should have an interest in the forum, though I believe it would work best if hosted independently of the UK government.

The forum should be open and accessible to people from all regions and applicable to farmers and land-managers across our different farming systems, bringing together members knowledgeable about water and land management, science and peat. To maximise opportunities for paludiculture as a new farming system, the forum should provide a route in for potential growers: their role is detailed further in the annex.

The Environment Agency regularly reviews its maintenance activities and its operation of assets such as pumping stations to ensure they offer the best value for money in meeting the government's priorities for flood and coastal risk management[26].

For those parts of the North-West where the Environment Agency has announced its intention to cease operating pumps and maintaining ditches, I would urge stakeholders to bring peat preservation more actively into scope of discussions ongoing.

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[26] The Environment Agency's Asset Maintenance Protocol (England) sets out the criteria by which assets are accessed and how it will work with those affected.

In the North-West, the Environment Agency has formally notified local people that it plans to cease operation of a number of land drainage pumping stations in three lowland agricultural areas (Alt Crossens, Lyth Valley and Waver Wampool) and that watercourse maintenance will reduce.

The Environment Agency has been working with locally affected farmers and landowners together with the councils and other interested organisations to identify options for future maintenance and the operation of these assets.

There are a number of groups already exploring how best to level-up water management in the area and, rather than create a new group, I recommend these same groups consider how their choices may lead to better outcomes for peat.

Whilst I maintain the importance of people finding and funding a way forward locally, **I also recommend that government takes a more active position in helping local persons address the issue of a new water management authority to help people move forward.**

Recommendation 8: Ensuring policy and legislation supports regulators

Some early innovators are already navigating better outcomes for peat. From discussions with individuals and organisations based across the country, I have heard how the regulatory framework can be hard to navigate. The processes, guidance and regulation used to safeguard our water environment are multifaceted and complex.

Acts founded in abstraction, reservoirs, mining and planning all have crucial implications for how we manage the water balance in lowland peat landscapes.

To introduce into this equation peat preservation, I believe we need to be clearer on what our regulations are driving and on how different regulations come together.

I therefore call on experts to conduct a thorough assessment of how the current system might enable or obstruct wetter ways of farming on peat. What is needed is a timely assessment to map out the approvals process to new measures which are both-top down (surface-level irrigation) and bottom-up (raised water tables).

The aim is to identify matters in both policy and legislation which may hinder the delivery of raising water levels on peat, and any appropriate updates in policy and/or legislation which may be required to secure more balanced outcomes for peat under current decision-making.

Certainly, under some circumstances, I see scope to ease rules on abstraction to deliver multi-sector benefits. I consider it irrational that we place a sweeping ban on abstracting water which is so often headed for the sea when that same water could be stored on land for use during times of short supply. I understand the direction of travel is to further limit abstraction, and I agree there will be times and places where this is necessary to protect and enhance the environment: what I want is for the government to think more holistically.

During flash flooding events, especially in summer, I believe abstraction could be harnessed to pull excess water out of main rivers, into on-land water stores, and used to help keep dry peat soils wetter. Easing abstraction rules in this way could pose benefits for the climate and boost our resilience to flood risk and drought.

I recommend the UK government assesses these and other rules and regulations as a priority. There is much we can learn from previous applicants to the Environment Agency, as the core regulator of decisions on water resources and water quality. A simple desktop survey, perhaps conducted by an independent third party, could explore the challenges encountered by modern-day innovators to understand the customer journey of those to come.

Rather than waiting for more real-life innovators to encounter pressure points already identified in the system (see Case Study 5), I believe we should be proactively exploring the enabling changes required to see regulation better deliver for peat.

As part of this proposal, I recommend the government considers how peat is safeguarded through the planning process. In addition to water storage, planning can have crucial implications for on-farm processing plants, and so change may be required to ensure that planning is sympathetic to wetter ways of farming. Though the impact of development on peat goes beyond the remit of the task force, I believe protections on this and peat extraction should be strengthened.

Recommendation 9: Raising the profile of lowland agricultural peat soils

I want to see more people engaged in the preservation of lowland peat. Key to this will be raising the profile of lowland peat soils to help society understand their value as a part of our biggest terrestrial carbon store.

I see numerous references in the media to the challenges faced by upland peat, but few references to the decline of lowland peat. I find this surprising, given that emissions from lowland peat account for 88% of all emissions from peat in England, and because peat loss in the lowlands is, in effect, sinking lowland peat landscapes further below sea-level. It is right to raise public awareness of these issues.

Environmentalists have been successful in publicising the damaging impact of peat excavation: largely because of their approach, horticulturists now recognise the benefits to our climate of using peat-free growing media. I believe we should now seek to replicate this success in a lowland agricultural peat setting.

I believe it is right to make society aware of the significant carbon footprint of vegetables, grains, meat, sugar and dairy products produced in drained lowland peat landscapes and, whenever opportunities arise, of the positive interventions being introduced by lowland peat farmers to more sustainably manage their soils.

Whilst I am hugely sympathetic about the cost-of-living crisis, if we do not do more to tackle the climate crisis, then I would only expect costs to continue to soar long-term. Crucially**, I want more people to understand that damaged peat soils are a major source of emissions and that raising water levels is our best line of defence**. This way, I believe that local communities will be more open to discussing wetter modes of farming.

To mobilise society**, I recommend our environmental groups rally behind a public outreach campaign**. I want to see the power of peatlands disseminated through social media and news outlets to bring new people into the discussion. The farming community must be actively involved, both to avoid the risk that new climate science is perceived as ruinous to a way of life that has kept generations well-fed and to avoid the development of adversarial debate.

Early innovators can play a special role here. **By inviting local farmers and members of their community to visit wetter farming trials, I believe our early innovators can give people a tangible way to engage with more sustainable farming practices.** Given new opportunities to learn, I would expect to see open farm days well attended by local people curious to listen and open to debate.

I also want to help local people understand the visual impact of wetter modes of farming. Landscape simulation and virtual reality could provide useful tools to raise awareness, whilst in some landscapes, viewing towers could be used to engage communities in decisions about how their land is managed.

My underlying ask is that we find a way to help communities see what different forms of wet farming could look like, and also what their landscapes might look like in 10-, 20- or 30-years' time under a changing climate if conventional modes of agriculture prevail without change. I explained upfront the benefits linked to even small changes in water level management, and in most cases, I would expect small changes to have a negligible impact on the look of farmland.

I make this recommendation fully expecting some members of society to be resistant to change whilst broader threats to peat are ongoing. I believe this could be a particular issue in Somerset which is home to 79% of extant peat extraction sites .

Whilst the UK government has put an end to the granting of new or extended licences for peat extraction and has committed to ban the sale of peat for use in the amateur gardening sector, I call on the government to take stronger action in this area. Telling a coherent story to the public will be necessary if we are to truly mobilise society behind wetter ways of farming.

Case Study 5: Reverse Coal at the Lapwing Estate

The Lapwing Estate covers 5,000 acres of land near Doncaster, crossing the county borders of Nottinghamshire, Lincolnshire and South Yorkshire. Home to one of the country's leading organic farms, the estate is now being used to re-think how lowland agricultural peat soils can be more responsibly managed.

A project called Reverse Coal is underway to abate emissions, store carbon and produce food. The project received funding from the Department for Business, Energy & Industrial Strategy (BEIS) as part of its Greenhouse Gas Removal project and academic support from the UKCEH and University of Lincoln. Using water from an onsite reservoir, the project is seeing lowland peat fields re-wet to reduce and potentially reverse emissions, whilst also providing biodiversity benefits.

In a move to paludiculture, short willow coppice is set to be grown on the re-wetted peat. It will then be harvested and pyrolyzed to create biochar. The energy released from this reaction will be used to power a vertical farm to house food crops displaced from the peat and the resulting biochar, a solid, stable form of carbon, will then be buried in a contained waterlogged condition to store carbon for the long term, akin to deposits of coal. The project operates on a closed system.

Those leading the project have reported numerous conflicts in policy and legislation around waste and water. These conflicts should be urgently reviewed and, where appropriate, amendments in policy or legislation made to enable more innovators to come forward.

A UKCEH flux tower at the Lapwing Estate

Recommendation 10: Undertaking a socio-economic assessment of new measures

Farming on lowland peat can be highly profitable: just in the Fens, the food chain is worth over £3 billion, and much of this is based on lowland peat[27]. For all our regions, I have heard how farming plays a vital role in supporting local communities and economies.

I understand, therefore, why people are keen to know more about the socio-economic impacts of change. **To make headway, I recommend the government commissions a socio-economic assessment of the profitability of lowland peat landscapes, the level of investment required to safely manage raised water levels, the financial incentives required to make wetter modes of farming an attractive proposition for peat farmers, and of their likely impact to rural economies.** The scope of this assessment should cover both grassland and arable farming systems. To my knowledge, the fullest assessment which has been done so far has focused on peat restoration.

Whilst this study has found the costs of restoring 100% of peatlands to be significant, it finds the costs to be approximately one-tenth to one-fifth of the benefits linked to carbon mitigation: in other words, the climate benefits attached to fully restoring all peatlands in England would pay for the costs associated with restoration 5 to10 times over[28].

I also recommend the UK government considers how much land it has available to deliver its numerous commitments, particularly for food security, climate security and nature recovery. The UK government should be mindful of the trade-offs between its different ambitions.

Key questions for officials include: if vast areas of peat are to be rewetted, then what is the likely impact on our domestic food supply; what is the risk of us needing to import more food from overseas in order to meet demand; and what is the risk of us having to apply more fertiliser to grow the same amount of food on mineral soils?

Both options will come attached to their own carbon emissions, as will the infrastructure required to raise water levels.

Land use at a national scale is a matter too broad for this report, but the government must consider these big questions as it maps out its route to Net Zero by 2050. This type of thinking should be fed into the development of Defra's forthcoming framework for land use change.

Intuitively I do not believe that wetter farming on peat will pose a threat to our national food security; I am more concerned that in future our food security will be threatened by farmers not having access to sufficient water and by the loss of our fertile peat soils.

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[27] NFU 2019, Delivering for Britain Food and farming in the Fens

[28] Office for National Statistics 2019, UK natural capital: peatlands, page 2

Wetter than current farming may favour the growth of different crops, but experts have classified at least a third of all species which may be suited to paludiculture in the UK as food species or potential food species[29].

Furthermore, I believe we should be excited by the potential for using wetter farming to produce more fibre by, for example, helping us to rely less on imports of reed for thatch at a time of market volatility and high shipping costs. When it comes to socio-economics, I urge decision-makers to think holistically and long-term.

I believe it will be possible to reconcile competing demands for land-use in lowland peat landscapes to maintain productive and viable farming systems responsible for slower rates of peat loss. To deliver, we need to maintain the positive engagement between sectors which I have been pleased to see grow and develop over the lifetime of the task force.

Chapter 4: Driving forward science and innovation

At the start of this report, I set out what the science can and cannot yet tell us. I am without doubt that raising water levels will be key to preserving lowland peat, but we do not yet understand the full effects of peat rewetting. To progress new measures with confidence, we need to better understand the condition of our peat, run more large-scale field trials, and be innovative in our response to new challenges and opportunities.

I am clear that a lack of data is not a reason to stall my other proposals: I want to see us taking the steps required to unlock wetter farming whilst improving our evidence base.

Recommendation 11: Understanding the depth and condition of our lowland peat

It feels logical to focus our efforts on those areas which have the most substantial reserves of peat remaining. The problem with taking this approach is that our best available data on lowland peatlands is over thirty-five years old.

The UK government is already working on a new baseline map of England's peatlands. By 2024, a series of open-access maps will come online to guide the prioritisation of action and investment on peat and to support more robust estimates of emissions from peat.

Natural England, as guided by Defra, is currently leading on product development. Defra is also developing a Peat Restoration Register, which will act as a data repository to store information about past and current peat restoration activities and peat condition.

[29] The UK list of the global Database of Potential Paludiculture Plants (DPPP) contains 90 species. At the time of writing this report, 35 of those species represent food species and have been found to have good paludiculture potential.

Defra plans to dock into the map more detailed information from ground truthing exercises: there are excellent examples of ground truthing underway which I would like to see considered.

In the Fens, NIAB is bringing together the outputs from farmer-led peat mapping and ground truthing with farmer-led productivity mapping, water management mapping and catchment habitat mapping, to produce restoration plans and opportunity maps to inform the integration of rewetting regimes into catchment-scale decisions about land-use change.

I believe we need to capitalise on these efforts, both by docking their more detailed maps into Defra's, and by sharing their techniques with stakeholders mapping peat soils in other parts of the country.

The UK government should consider its role in financially and technologically supporting these endeavours.

More specifically, I believe we need to improve our understanding of emissions from wasted peat. Experts predict that the majority of lowland peat soils under agricultural use which were previously mapped as peat have now wasted, ruling in some 75% of peat under cropland and 50% of peat under grassland at the national scale[30]. There is a misconception that wasted peat has stopped emitting, but this is not the case: ongoing research is already demonstrating consistently high emissions from wasted peat, albeit lower than from our deeper peats.

Knowing more about where peat has wasted and how it functions will help decision-makers tailor their interventions to unlock the greatest potential. As I said in chapter two, I am minded that wasted peat may be more suitable for top irrigation, whereas deep peat might be more suitable for raising the water table.

Having accurate emission factors for wasted peat is important for the government's greenhouse gas inventory. When emissions from peat were first added to the inventory in 2021, emissions from wasted peat were classified the same as for deep peat. Experts have formalised updated figures for wasted peat which were added to the inventory published on 7 February 2023 . This reduction in emissions from wasted peat should not be interpreted as good news for our climate: it simply means that carbon currently modelled as stored has already been released.[31]

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[30] Evans, C; Artz, R; Moxley, J; and others (2017) Implementation of an Emissions Inventory for UK Peatlands, issue 1

[31] GOV.UK Final UK greenhouse gas emissions national statistics: 1990 to 2021

It is, however, likely to be an important revelation for decision-makers in wasted peat areas as they weigh up the mitigation potential of new management regimes. By further improving estimates in the inventory, decision-makers will be better equipped.

Recommendation 12: More large-scale field trials and modelling

To better understand the effects of raising water levels in lowland peat landscapes, **I recommend more large-scale field trials and modelling.** We should effectively execute more projects like Defra's Lowland Peat Project 2[32] to understand the link between peat soil moisture and greenhouse gas emissions of all kinds, whilst also considering:

The impact of water resource constraints on raising water levels beneath peatlands

This **i**ncludes the water input required to rewet and maintain wetter peat soils and the broader impact of this demand on the water environment, particularly under a changing climate (see Case Study 6). Modelling could be used to understand how much water we pump to sea currently and how much more water we could feasibly store on land. I am pleased to hear that the UKCEH is conducting some early analysis to quantify the relative roles of surface conditions and meteorology on evapotranspiration and its influence on peatland water balance and I encourage more projects of this kind.

The impact of raising water levels on water quality and the water environment

Reed beds are already used to improve water quality and I believe paludicultural systems have the potential to be used in the same way. Though reed and Typha both have the potential to purify water by stripping out nitrates and phosphates, I have heard how, in the Netherlands, the amount of manure required to grow and maintain Typha can lead to water quality issues.

I therefore see a need for trials focused on the impact of farming at a range of higher water levels considering changes in water quality, as well as the potential effects on run-off recovery time and on species which inhabit the water environment (such as water voles).

[32] Lowland Peat 2 Project: https://lowlandpeat.ceh.ac.uk/lowland-peat-2-project

Case Study 6: Fenland Field Trial, Cambridgeshire

In Summer 2022, a Fenland farmer embarked on a trial to increase the water table on a 15-hectare field. Used to grow wheat, this particular field was selected for a trial because of its drains set approximately 10 metres apart which help to move water across the land.

In its early stages, the trial saw water tables successfully raised to within 25cm of the surface. Once conditions of extreme heat and low rainfall took hold in July, the supply of water from the river had to be switched off. The trial has revealed the critical importance of water availability, water control and ease of drainage for farming on peat soils at raised water levels.

Implications for crop nutrients and greenhouse gases have not yet been determined, but an abrupt drop in water levels at the peak of the heatwave seems to have had a negative impact on yields. Further trial experiments based on stable water management are needed to establish whether yields can be maintained with higher water levels.

A raised water level management trial

The potential for using irrigation, mulching and other techniques to preserve peat

In chapter 2, I set out the findings of an Indonesian paper documenting lower rates of peat loss on irrigated soils. Whilst these results have promise, they have come from just one study.

I strongly recommend that trials are replicated, and that robust research is carried out on the effects and practicality of irrigation here in England, looking at the potential benefits of mulching and other techniques. Defra already has one irrigation trial underway which is a positive start. For those techniques which can be robustly evidenced to provide benefits, I would recommend they get government support.

How yields of conventional crops will respond to raised water levels

I would like to establish whether there is a 'sweet-spot' water-table depth for best preserving peat, at which conventional crops can still be viably grown. Field trials should investigate the effect of different water-table depths on a range of yields.

Trials should prioritise food crops over other crops given the government's commitment to broadly maintain the level of food we produce domestically and to sustainably boost production in horticulture[33]. I am pleased to see trials like Case Study 7 and call for more of this kind.

The impact of different management regimes on peatlands under grassland

Trials so far have mostly been run in the Fens. Far fewer studies have focused on the effects of different measures on peat under grassland. Farmers in Somerset are calling for new research into the effect of different grassland management regimes on peat-related emissions covering changes in sward species, stocking densities and livestock removal dates.

I am minded there are likely to be fewer benefits associated with mulching or irrigating on peat under grassland, but to my knowledge, research is yet to be done.

If and how raising water levels closer to the land surface might generate the release of greenhouse gases other than carbon dioxide

Studies have shown that raising the water level to at or above surface level on peat soils can result in short-term pulses of methane, but this is mostly perceived to be an issue where vegetation is subject to standing water for long periods. We need to better understand how this process works and consider ways to block methane release (for example, through the addition of certain substrates).

We also need to understand the risk of nitrous oxide emissions in highly nutrient-enriched soils and the potential to suppress the processes that lead to nitrous oxide formation. The impact of wetter farming on concentrations of Dissolved Organic Carbon (DOC) and Particulate Organic Carbon (POC) should also be considered.

[33] Defra 2022, Government food strategy

The potential for actively storing more carbon in lowland agricultural peat

Early findings show that some paludicultural systems can provide us with a net sink of emissions, but we need to understand for how long, as well as the impact of cropping and of the life-cycles of different paludicultural crops on carbon flux. By this I mean, how would the overall carbon flux be impacted if paludicultural crops were grown to meet our short-term demands for fuel, rather than being grown for insulation in such a way that carbon is ‘locked away’? We need more research both into the sequestration potential of paludiculture and into new ways of boosting peat accumulation, such as through the addition of biochar.

The UKCEH is leading a new UKRI-funded project, as part of the Greenhouse Gas Removal Demonstrator programme, to explore whether optimised water management, the growth of wetland biomass crops, and/or conversion to biochar can enhance rates of carbon dioxide uptake, and supress emissions of methane and nitrous oxide, to see rewetted lowland peat soils become net sinks. If shown to be effective and scalable, this kind of research could unlock new funding for carbon sequestration.

The impact of raised water levels on nature

I would expect raising water levels on lowland peat to have positive impacts for nature, but more evidence is needed in an agricultural setting. Trials should therefore explore changes in biodiversity at sites managed under different raised water levels as well as in adjacent conservation areas.

Case Study 7: Rindle Field Trial, Greater Manchester

Led by Lancashire Wildlife Trust, in collaboration with local farmers, a trial is underway to explore the effects of growing celery under raised water levels. The trial is being monitored in conjunction with Liverpool John Moores University to assess changes in biogeochemistry linked to raised water level management.

Rindle Field is a 5-acre field formerly used to grow potatoes. Recently acquired by the Trust, the field has been bunded to make it watertight and planted with celery sourced from a producer of salads on nearby Tarleton Moss. Water levels will be raised to within 10 to 50cm of the surface and the impact of different conditions on growth rates and emissions will be measured.

I believe more trials such as Rindle Field should be deployed, spanning other terrains and food crops, to explore the potential to profitably farm conventional crops on peat under wetter than current conditions.

Local farmers planting celery plugs

Recommendation 13: Advancing new technologies

Farming at raised water levels is likely to present certain challenges that only advancements in technology can overcome. One particular challenge will be avoiding the risk of compaction when wetter soils are farmed using heavy machinery. With new investment in water management infrastructure (as recommended in chapter one), there may be situations where it is possible to temporarily drop the water level whilst machinery is held on the land: in other circumstances, farming may only continue using lighter machinery.

Lower ground pressure machinery

To adapt to changing conditions, **I recommend we develop and expand the roll-out of lower ground pressure machinery.** I see a role for businesses and researchers to collaborate on the development of smarter, lower carbon and more precise equipment to minimise the time equipment is held on the land. There may be a role for government in pump-priming innovation to make new kit commercially viable and available for mass uptake. The risk of compaction is higher under paludicultural systems, which is why the steps required to bring forward new technology in this area are detailed in the annex.

We will also need to manage any impacts to our domestic food supply as a result of growing crops that favour a higher water level. The impact, of course, will depend on the scale and extent to which water levels are raised, and the reaction of conventional food crops to these changes, as well as the potential for new wetland-adapted food crops; questions to which answers remain largely unknown. What we do know, however, is that some of our most productive peat soils have a limited remaining lifespan and so it makes sense to be exploring broader models of producing food now.

Vertical farming may be one part of the solution

Vertical farms can enable growers to closely control a crop’s environmental conditions. Farming vertically can be an efficient way to produce nutritional food with low inputs where water can be recycled and renewable energies can be deployed. Herbs and leafy salad crops are already being produced vertically and sold in the UK, and some people believe we have the potential to vertically grow more food crops such as strawberries, turnips and radishes, which may one day be mass produced, so long as their production can be made commercially viable.

I am not suggesting that vertical farms are rolled out en masse: a lot of food can be produced from a few vertical farms, especially the production of high-value, low-volume crops. Rather, I want to unlock opportunities for vertical farming as a way for some peat farmers to maintain food production whilst they convert other areas of their farm to wetter management regimes. For vertical farms to play a more significant role in our food supply, I have heard it will be necessary to establish routes to market for vertically grown crops.

Over coming years, I would hope to see the emergence of new food crops which can tolerate higher than current water levels. Currently the potential paludicultural menu is limited in the UK, including mostly watercress, a range of berries, products such as

mozzarella and meat produced from water buffalo grazed on wet peat soils, though other wetland species have been used as food sources in the past.

Given the UK government's focus on science, innovation and technology[34], I would like to see new research into the breeding of low carbon food crops which can tolerate these wetter conditions.

Experts should explore the potential for new food crops to be grown under both wetter, conventional farming systems and under paludicultural systems. As technology progresses, I see scope for these and other technologies to help us produce food more innovatively as part of a whole range of solutions.

Recommendation 14: Adopting the roadmap to commercially viable paludiculture

I want paludiculture to take its place in the matrix of opportunities for farming lowland peat more sustainably (see figure 5). This cannot be true without a targeted programme of intervention which goes above and beyond the package of measures set out in this report: this is because paludiculture also requires the development of a new market for its crops.

To see paludiculture become a commercial reality in England, I recommend the adoption of the accompanying roadmap which plots out a 10-year programme of investigation, development and reform (as set out in the annex).

I want to see paludiculture become a mainstream option for farming on lowland peat, though I am under no illusion that paludiculture will be widely practiced, at least not for this decade. I say this noting great passion from some people already willing to explore paludiculture (see Case Study 8), matched with hesitation from others.

Certainly, for those people who are struggling to keep their land dry and who may feel that the profitability of their land is at risk in future, paludiculture can offer a way forward. There may be more people who feel this way as the climate changes. I want to provide all farmers, particularly those fighting naturally wetter conditions, with a fresh opportunity to work to their conditions and not against them.

In summer 2022, the UK government announced a £5 million grant scheme to promote the uptake of paludiculture[35]. This is a positive step in encouraging trials, but there is plenty more to do. Presented as a separate and significantly more technical annex, the paludiculture sub-group has developed a roadmap to list the steps they see as necessary to make paludiculture a commercial reality on lowland peat in England.

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[34] BEIS 2021, Net Zero Strategy: Build Back Greener

[35] GOV.UK 2022, Sale of horticultural peat to be banned in move to protect England's precious peatlands

I thank the many individuals and organisations involved with the parallel journey of the paludiculture sub-group who have helped bring the accompanying roadmap together. I recommend their work is adopted, and all those interested in paludiculture engage with it.

Case Study 8: Horsey Wetland Project, Broads National Park

A 2 year multi-benefit wetland project is underway in the Upper Thurne area of the Broads National Park, providing an early demonstration of paludiculture in England.

Made possible through a partnership between the Broads Authority, Broads IDB, The Environment Agency, and the land-manager of Horsey Estate, the project is drawing on Interreg funding from Creating a New Approach to Peatland Ecosystems (CANAPE) to test the conversion of a 1.3 hectare field to wetland. It is expected to provide a host of benefits – not least peat preservation and the growth of wetland crops which could be used for bioenergy or building materials, such as thatch or insulation boards.

By maintaining a slower flow of water throughout the landscape, the project is also expected to clean and purify water. The project is already providing a useful platform for raising awareness of paludiculture with other farmers and land-managers: so far, lessons learned include the vulnerability of paludicultural crops to wildlife grazing.

We are excited by the potential of this and similarly innovative projects to inspire more farmers to trial paludiculture. To position paludiculture as a mainstream option in farming, we recommend adopting the step-changes we set out in our accompanying roadmap.

Horsey wetland project

Cows on Halvergate

Glossary

Term	Definition
Deep peat	A thick layer of peat measuring more than 1m in depth.
Freeboard	The additional height above the base flow of a watercourse. Freeboard can provide a buffer zone before water reaches the bank tops.
Local Nature Recovery Strategies	A new system of spatial strategies for England, these strategies will establish priorities and map proposals for specific actions to drive nature's recovery and provide wider environmental benefits.
Mulching	A covering of material laid over the soil, mulching can help to retain moisture.
Offline water storage	Water stored offline is stored in a separate area to the river channel.
Paludiculture	A new farming system modelled on the profitable production of wetland crops.
Raising water levels	A term used to describe either maintaining higher than current water tables or other interventions which can lead to an increase in soil moisture content.
Shallow peat	A moderate layer of peat measuring 40 to 100cm in depth.

Term	Definition
Skirt peat	(See also wasted peat.) A thin layer of peat measuring less than 40 cm in depth and typically comprising a mixture of peat and mineral soils as a result of ploughing.
Sustainable management	A term used to describe actions which are less damaging than current management regimes on drained and cultivated lowland peat. Truly sustainable management would require no further depletion of peat carbon stocks, but it is doubtful whether this could be achieved under any form of agricultural management involving lowered water levels.
Warped peat	Peat which has been covered with silt-laden water to increase fertility.
Wasted peat	A thin layer of peat measuring less than 40 cm in depth and typically comprising a mixture of peat and mineral soils as a result of ploughing.

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