PRINCIPLES FOR MORE SUSTAINABLE CROPPED FARMING ON DRAINED LOWLAND PEAT

A Framework for Practice, Research, and Policy

WWF-UK & Fenland SOIL

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INTRODUCTION

UK lowland drained peatlands, such as those found in the Fens of East Anglia and parts of Lancashire and Yorkshire, represent some of the most fertile and intensively farmed landscapes in the country. These areas have been drained over centuries to support high-value agricultural production, including the production of salad crops, root vegetables (such as carrots and onions), and potatoes. The combination of deep, organic-rich soils and intensive land use has made these regions central to the UK's fresh produce sector. The East Anglian Fens alone support approximately 40% of the nation's vegetable production.[1]

However, drainage coupled with intensive agricultural practices have resulted in the rapid oxidation of organic soils, leading to high greenhouse gas (GHG) emissions from the peat as it decomposes, soil subsidence, and biodiversity loss. In England, 85% of total peatland GHG emissions originate from lowland peatlands that have been drained for agriculture.[2] Vegetable production on drained lowland peat presents a particularly acute 'triple challenge' – with the need to balance climate mitigation, food security, and environmental stewardship. While fully rewetting peat is the most effective intervention for halting carbon (C) loss and restoring peat integrity, its feasibility needs to be carefully considered at landscape scale and a mosaic land use approach is most likely to be needed.[2] With nearly half of fresh vegetables and 85% of fruit already imported,[3] displacing production from lowland peat could increase the UK's reliance on imports and offshore environmental impacts to regions already facing water and soil stress. To maintain the UK's capacity for domestic vegetable production, it is likely that drained peatland landscapes will continue to produce some vegetable crops.

It is in this context that WWF-UK and Fenland SOIL have partnered to co-develop principles for sustainable lowland peat farming. The principles and recommendations presented here were developed following a discussion session with over 150 attendees at the Fenland Soil conference (2025), then refined by a panel of agronomists, scientists and farmers and were further tested with a focus group of farmers from drained lowland peat areas.[4] The emerging farming principles must not distract us from the fact that around 31% of the UK's lowland peatlands will need to be fully re- restored by 2040 to meet national climate targets.[5] However, where full restoration is not feasible, adapting farming systems to protect peat soils can play a vital role in slowing degradation and reducing emissions while continuing food production.

This paper sets out a set of pragmatic, outcome-oriented principles for more sustainable cropped farming on lowland peat soils. Rather than offering a prescriptive blueprint, the aim is to provide guidance to farmers, food retailers, and policymakers on how to reduce climate and environmental impacts while supporting viable agricultural livelihoods on peat. Recognising the many uncertainties that remain – particularly regarding soil processes, crop systems, and economic feasibility – this paper should be viewed as a foundation for dialogue and experimentation. It includes a set of research priorities to guide future enquiry and innovation.

This discussion paper is a step toward addressing the complex, intersecting challenges that lowland peat agriculture presents. It offers a pathway for action – informed by research, shaped by practice, and committed to balancing climate, nature, and food security outcomes.

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A more sustainable farming on lowland peat must serve three key outcomes: **reducing carbon emissions while enhancing biodiversity and sustaining productivity.** WWF worked with a panel of farmers, agronomists and academics to consider how principles for regenerative farming on mineral soils might apply in a lowland peat context. Five core principles emerge:

1. Proactive water management
2. Protecting the soil surface
3. Diversity in space and time
4. Evidence-based cultivation
5. Targeted inputs

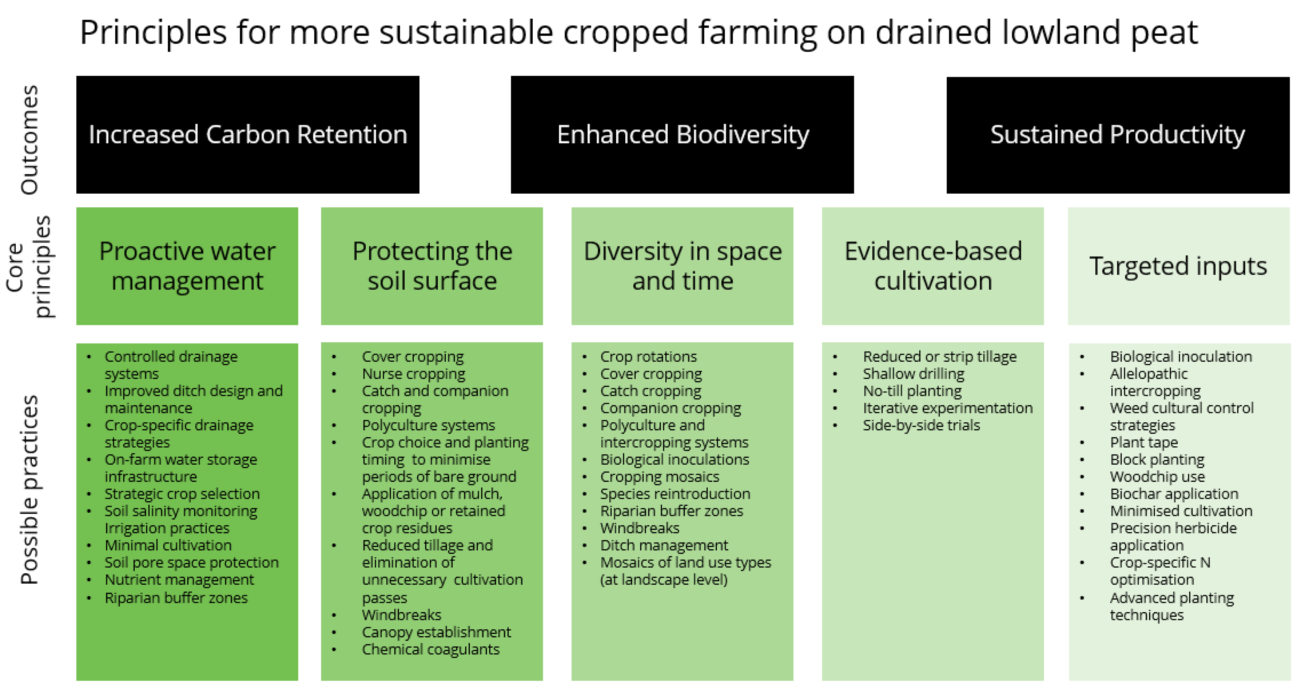

Figure 1: Principles for Sustainable Lowland Peat Farming, highlighting the 3 major outcomes, the associated 5 principles, and an array of practices grouped by principle.

Mapping Outcomes to Practices
This framework rests on three core outcomes – carbon emissions reduction, biodiversity enhancement, and sustained productivity. Each principle contributes to these outcomes in different ways. For example, proactive water management directly reduces peat oxidation, protecting C stores while indirectly supporting wetland biodiversity, and the longevity of productivity. Targeted inputs reduce nutrient losses and GHG emissions while improving soil microbiome health and crop yields. Protecting the soil surface curtails erosion and supports invertebrate habitat, while practices like polyculture enhance structural and species diversity. Evidence-based cultivation underpins all these core outcomes, ensuring that decisions surrounding cultivation are data-driven and locally adapted to reduce C emissions, nurture biodiversity and improve productivity.

Each of the principles contributes to the key outcomes to varying degrees and in different ways and can be put into practice using a variety of farming practices discussed in detail below.[6] Although the framework can be adapted to suit different local contexts, it is important to understand that all five principles are connected. To make cropping on peat more sustainable, actions should aim to achieve all the outcomes together, not just focus on one or two.

1. **Proactive Water Management**

Proactive water management is the cornerstone of sustainable peatland agriculture. Without consistently high WT, peat soils oxidise, subsidence accelerates, and carbon is lost to the atmosphere.[7] Therefore, minimising the aeration of the peat profile through effective water table control is essential to maintaining peat integrity.

A combination of **controlled drainage systems** tailored to peatland hydrology, **improved ditch design and maintenance**, and **crop-specific drainage strategies** can sustain productivity while minimising peat drying.[8] **On-farm water storage infrastructure** plays a critical role in buffering seasonal water fluctuations, ensuring water availability during dry periods, and reducing reliance on external irrigation.

Strategic crop selection is also vital. Reducing reliance on species with high evapotranspiration (ET) rates mitigates unnecessary water loss, while decreasing bare ground helps maintain soil moisture and reduces erosion risk. **Soil salinity monitoring** is crucial to balancing water retention with crop requirements, particularly in drained peat environments where salt accumulation can impair plant growth.

As for mineral soils, **irrigation practices, minimal cultivation**, and **soil pore space protection** contribute to optimising water use and maintaining soil structure of peat soils as well.[9] Additionally, **crop-specific nutrient management** ensures that fertiliser inputs match crop demand, limiting nutrient losses and improving overall efficiency and watercourse health.

At the landscape scale, the establishment of **riparian buffer zones (RBZs)** not only reduces nutrient runoff but enhances hydrological resilience and biodiversity.[10] Together, these interventions offer a holistic framework for sustainable, economically viable farming that preserves peat soil function and supports long-term climate and environmental goals.

2. Protecting the Soil Surface

The soil surface is a critical interface for peatland stability, where rainfall and water table play a central role in regulating moisture, temperature, and oxidative processes. When bare, peat soils undergo accelerated desiccation, aeolian erosion, and oxidation, accelerating C loss and structural degradation.[11] Maintaining continuous ground cover where possible is therefore essential to protecting peat from wind erosion and improving soil moisture.

This can be achieved through a suite of agronomic practices that actively reduce bare ground exposure and enhance soil protection. These include **cover cropping, nurse cropping, catch and companion cropping**, and **polyculture systems**, all of which support continuous vegetative cover while contributing to biological function and system resilience.[12] However, scope to research, and produce peat specific cover crop mixes is important, with large proportions of cover crops favouring productivity over cover, due to nutrient return, which may further dry peat. **Thoughtful crop choice** and **planting timing** can further minimise periods of bare ground, helping to safeguard soil during vulnerable transitions between production cycles.

Residue management practices, such as the **application of mulch**, **woodchip**, or **retained crop residues**, serve to insulate the soil surface, retain moisture, and suppress weed pressure.[13] These materials also contribute to the development of surface organic layers that buffer against temperature fluctuations and rainfall impact. **Reduced tillage** and the elimination of unnecessary cultivation passes are key to maintaining aggregate stability and avoiding compaction in sensitive peat soils.[14]

Windbreaks, particularly trees or those formed from non-woody species like *Miscanthus* or rushes, are highly effective at reducing wind-driven desiccation and erosion. These vegetative barriers are well-suited to the open landscapes typical of peatlands and can be integrated without compromising field operations, within RBZs or on field margins.[15]

Moreover, planting techniques that ensure rapid **canopy establishment** – such as dense sowing patterns or staggered plantings – can close the ground canopy faster, further reducing the window of vulnerability. Emerging technologies and research directions, such as the use of **chemical coagulants** to stabilise surface aggregates (under exploration by Cranfield University), also offer promising avenues to enhance peat surface protection and deserve further investigation.[16]

These protective measures are far more than conservation tactics – they are foundational to the long-term viability of productive, climate-aligned peatland agriculture. By preserving the soil surface, we minimise surface loss, which when combined with higher water table management protects the entire peat profile, enabling sustained use of these landscapes within planetary boundaries.

3. **Diversity in Space and Time**

Biological and temporal diversity is a foundational strategy for enhancing resilience and reducing environmental risks in peatland agriculture. Moving beyond monocultures toward more multifunctional farming systems offers a pathway to more sustainable production that aligns with the ecological sensitivities of organic soils.

Crop rotations that include fibrous and deep-rooted species are instrumental in improving soil structure and stability, while **cover cropping, catch cropping**, and **companion cropping** reduce nutrient leaching, suppress weeds, and extend the period of active ground cover. These practices support both short-term productivity and long-term peat conservation by maintaining a living root network within the soil profile.[17]

Polyculture and **intercropping** systems, paired with **biological inoculations**, create synergistic interactions between plant and microbial communities, bolstering disease resistance, nutrient cycling, and overall ecosystem function through more effective rhizosphere interactions. At a broader scale, **cropping mosaics** and **species reintroduction** – including select uses of livestock to reduce mechanical intervention – can restore ecological processes, reduce input dependency, and re-establish functional biodiversity in intensively managed landscapes.[18]

Riparian Buffer Zones, and **windbreaks** provide microclimatic stability, reduce wind-driven desiccation, and serve as habitat corridors. In peatland settings, **ditch management** is a particularly critical component of land system diversity, supporting both water regulation and habitat connectivity

At the landscape level, creating **mosaics of land use types** – integrating wetlands, productive plots, and semi-natural habitats – enhances biodiversity, carbon retention, and climate resilience. These multifunctional designs echo lessons from tropical peat systems, where integrated land use has demonstrated success in balancing environmental performance with livelihood outcomes.

Nevertheless, the requirement for commercial viability remains central. The challenge is not only to diversify ecologically, but to design systems that are economically sustainable, scalable, and practical for implementation across temperate peatland regions. The retail sector has a vital role to play in supporting this transition.

4. **Evidence-Based Cultivation**

Evidence-based cultivation is essential for transitioning peatland agriculture from tradition-bound practices to adaptive, scientifically grounded systems. Many historical approaches to cultivation – such as intensive tillage, fixed crop rotations, and blanket nutrient applications – were developed with mineral soils in mind and often prove counterproductive or even harmful on peat. These methods are increasingly being called into question on mineral soils as well as on peat, signifying the importance of change.

In contrast, evidence-based cultivation calls for context-specific decision-making guided by empirical research, local monitoring, and continuous learning. Central to this approach is the rigorous testing of cultivation methods under varying WT conditions and crop regimes to determine what works best under real-world conditions. It involves critically evaluating the timing, depth, and method of tillage, the use of machinery suited to wet or semi-wet soils, and strategies for minimising compaction and structural damage. Practices **like reduced or strip tillage, shallow drilling**, and **no-till planting** should be explored systematically for their potential to preserve soil integrity and reduce emissions.

Crucially, evidence-based cultivation also means abandoning one-size-fits-all solutions in favour of **iterative experimentation**, including side-by-side trials that compare conventional methods with innovative techniques. Such trials should be embedded in farm systems and supported through collaborative research networks and demonstration sites. This principle positions farmers not just as practitioners but as co-creators of knowledge, essential for refining sustainable methods through observation, measurement, and feedback.

5. **Targeted Inputs**

Conventional fertilisation regimes, designed for mineral soils, often prove ineffective or environmentally detrimental when applied to organic soils, leading to nutrient imbalances, elevated greenhouse gas (GHG) emissions, and impaired soil function.

A paradigm shift in agronomic guidance is essential. This includes targeted re-education of the agricultural workforce and advisors (both agricultural and hydrological), equipping them to work with the distinct needs of peat soils and to critically assess dominant frameworks such as the Groundswell principles, which do not always align with peatland-specific sustainability goals.

Biological inoculation, allelopathic intercropping, and **weed cultural control strategies** offer significant promise for reducing chemical inputs while fostering healthy, functional soil microbial communities. These approaches not only suppress weed burdens naturally but contribute to improved nutrient cycling and long-term soil resilience.

Innovative practices such as **plant tape** or **block planting**, the use of **woodchip** to moderate nitrogen (N) availability, and strategic **biochar application** can stabilise nutrients, enhance soil structure, and optimise microbial interactions.[19] These interventions reduce nutrient losses and can diminish dependency on synthetic inputs, thereby contributing to climate-smart agriculture.

Beyond peat-specific strategies, broader practices such as **minimised cultivation**, **precision herbicide application** for increased efficiency, and **crop-specific N optimisation** further support sustainability goals. Integrating **advanced planting techniques** with input-use efficiency principles ensures better establishment, improved weed suppression, and reduced resource wastage.

CURRENT BARRIERS AND OPPORTUNITIES

The transition toward sustainable lowland peatland farming is limited not by a lack of interest but rather a lack of guiding principles, and persistent structural, technical, and cultural barriers. To unlock the full potential of peat soils while safeguarding their ecological integrity, it is essential to revisit embedded assumptions and explore alternative practices in a systematic, trial-based manner. Several key areas offer both opportunities for progress and clear evidence gaps that warrant targeted investigation.

Water Management

Water is arguably the most powerful lever in peatland management, yet it remains one of the least controlled. Full rewetting and paludiculture dominate restoration rhetoric, but these approaches can be seen as binary and unattainable for many commercial farmers. In contrast, moderate adjustments – such as raising the water table (WT) to around 40–50 cm below ground level – represent a more accessible step toward reducing peat oxidation.

Controlled drainage infrastructure, ditch design innovations, and on-farm water storage all offer relatively low-cost interventions that could help bridge this gap, yet these tools remain under-researched and under-deployed. The potential for Internal Drainage Boards (IDBs) to assist within the implementation of more effective water management is vast, since controlled drainage at drainage board and landscape level have the biggest potential for positive change at scale.

Reconsidering Livestock in Rotational Systems

Leys are often credited with improving soil structure, boosting soil biology, and breaking pest and disease cycles. However, the specific contribution of grazing animals – especially under peatland conditions – remains ambiguous. On mineral soils, there is stronger evidence linking grazing to enhanced nutrient cycling and soil aggregation, but these effects may not translate directly to organic soils that behave differently under saturation and compaction pressures.

Moreover, the economic and logistical challenges of incorporating livestock are significant. Retailer standards that favour continuous arable production, concerns around biosecurity, and infrastructure limitations tend to discourage mixed systems. There is a need to decouple the agronomic effects of the ley period itself from those of grazing, through well-designed field trials. Such work could provide evidence to either support or reframe the role of livestock on peat soils, potentially validating grass-only leys or alternative cover strategies that deliver comparable benefits without livestock integration.

Rethinking Cultivation Practices

A significant opportunity lies in revisiting how crops are cultivated on peat. In the Fens, highly intensive systems – particularly those geared toward potato production – have evolved toward methods involving repeated deep tillage, prolonged soil exposure, and minimal organic matter return. These practices contribute heavily to peat degradation but persist due to short-term economic pressures and entrenched supply chain expectations.

Alternative methods exist, such as strip tillage, controlled traffic farming, and continuous soil cover through catch crops or mulches. However, comparative trials between high- and low-disturbance systems on peat are rare. Agronomic innovation in this domain could benefit from cross-sector collaboration, involving growers, researchers, and supply chain actors. Establishing benchmark trials and quantifying outcomes in terms of yield, soil condition, and C balance would provide the evidence base needed to support transitions to “clever”, conservation-focused cultivation.

Learning from Tropical Peatland Analogues

In other parts of the world, particularly Southeast Asia, peatland systems are managed under very different climatic and socio-economic conditions – but some offer instructive lessons. In regions like Borneo and Sumatra, multi-strata agroforestry systems that integrate tree crops, groundcover species, and minimal soil disturbance have shown potential for reducing erosion, maintaining hydrological function, and slowing subsidence.

While direct replication of these systems to the UK is not feasible, they expand the realm of what is considered possible. Importantly, they demonstrate the value of diversity, integration, and perennial cropping on peat soils. Trials of temperate analogues – such as short-rotation coppice, perennial vegetables, or mixed horticultural systems – on rewetted or semi-wet peatlands could yield insights into more stable, multifunctional land uses that balance production with restoration, polyculture systems, and commercial viability.

RESEARCH PRIORITIES

A transition to sustainable lowland peat farming depends on addressing key knowledge gaps that currently constrain implementation. Among the highest priorities is a better understanding of the interactions between WT depth, crop type, and management intensity. Specific questions include the GHG trade-offs of shallow versus deep drainage, the potential for cover crops and biological amendments on peat, and the seasonal impacts of rotational wetting and drying. Trials are also needed to compare traditional monoculture approaches with diversified systems, including polycultures, intercropping and integrated livestock systems. The role of biological inoculations in peatland soils, and their contribution to nutrient cycling and aggregate stability, warrants focused study. Research should also explore novel techniques such as the use of allelopathic species to manage weeds and reduce chemical inputs. Strategic monitoring of farms and living laboratories can play a pivotal role in testing these approaches under real farming conditions. Finally, interdisciplinary work is needed to link soil C dynamics with socio-economic outcomes, supporting a more holistic view of what sustainable peat farming looks like in practice.

Farmer-led innovation networks, participatory trials, and flexible agri-environmental schemes could help overcome the inertia that currently hampers transition. In this sense, the path forward is not only scientific but social and political, requiring trust, dialogue, and shared vision across sectors, with multi-stakeholder engagement likely to produce the most significant positive outcomes.

CONCLUSION

This discussion paper outlines a research-informed, practice-oriented framework for transitioning lowland peat agriculture toward greater sustainability. Grounded in five core principles, the approach acknowledges the complexity and locality of peat systems, while offering a flexible toolkit of practices that can be tailored to diverse contexts. However, implementation cannot rest on farmers alone. Supportive policies, adaptive funding models, and well-resourced research partnerships are essential to drive this change. Food retailers have a vital role to play in enabling and incentivising the transition to more sustainable agricultural practices on peat soils.[20] Through collaborative action, it is possible to chart a path that delivers food, climate, and nature outcomes from some of our most challenging – and important – agricultural landscapes.

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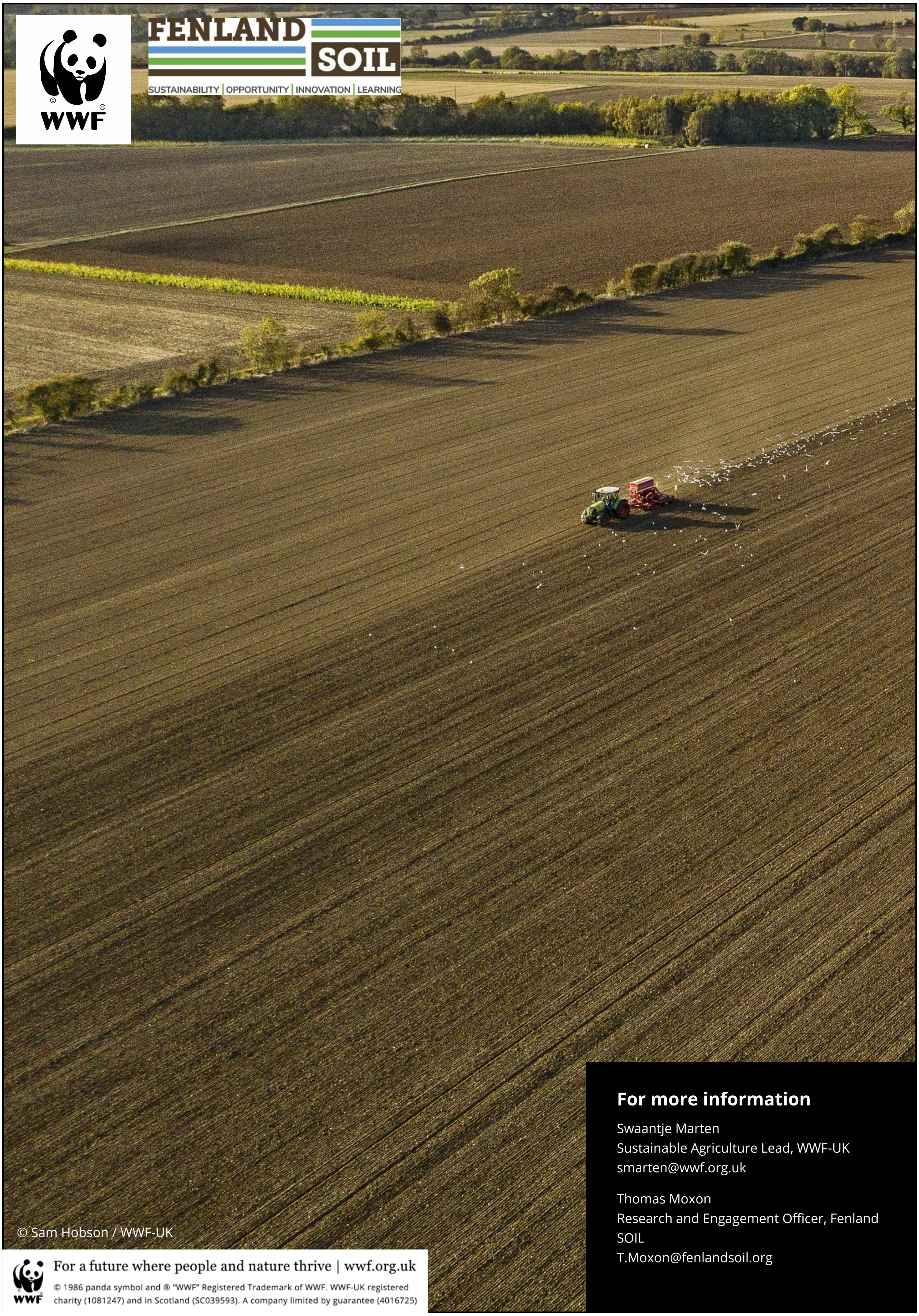

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