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Transition to peat-free horticulture in Scotland

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1 Executive summary

Scotland's peatlands store large amounts of carbon and play a key role in climate regulation and biodiversity conservation. However, extracting peat for use in horticultural growing media – materials used to grow plants in containers or controlled systems – damages these ecosystems and releases greenhouse gas emissions.

The Scottish Government has committed to ending the use of peat in horticulture, while recognising the sector's economic importance. In 2024, potatoes, fruit and vegetables, and ornamental plants such as flowers and shrubs together contributed £831 million to Scottish crop output, representing over half of the total value.

This report assesses whether it is possible to move to peat-free growing materials in Scottish horticulture. It draws on published studies, industry reports and extensive engagement with the sector, including workshops and interviews with growers, growing media manufacturers, retailers and researchers. Stakeholders provided practical insight into how peat-free systems are working in practice, the challenges businesses face, and the solutions currently being trialled across the industry.

1.1 Key findings

- **Scotland can achieve peat-free horticulture.** Businesses across the horticulture sector are already using a range of alternative growing materials.
- **The main challenge is system coordination.** For a successful transition to peat free horticulture, infrastructure, standards, supply chains and technical growing practice are best aligned.

- **Parts of the sector have already made progress.** Retail growing media are now largely peat-free, while some tree growers and producers of ornamental plants have significantly reduced their use of peat
- **Some growing approaches face greater challenges in a peat-free transition.** Growers must test propagation systems and production of seed potatos and ericaceous crops – acid-loving plants such as blueberries – over a longer period to ensure peat-free methods work reliably.
- Cost, supply chain capacity and consistency of materials remain key barriers.
- With **coordinated implementation** and realistic timelines, Scotland has the resources and industry capability to support a peat-free transition.

1.2 Conclusions

This report finds that the principal challenge for Scotland's peat-free transition is the coordination of infrastructure, standards, supply chains and technical growing practice – rather than a lack of alternatives or willingness in the sector.

Evidence from trials, real business use and stakeholder experience shows that growing without peat can be successful when materials are reliable, standards are clear, and the appropriate support is provided. Where these conditions are uncertain or developing, growers and manufacturers reported that technical uncertainty can translate into commercial risk.

The transition should therefore be understood as a process of system redesign rather than simple material substitution. With coordinated implementation and investment, and continued collaboration across the sector, Scotland can phase out horticultural peat while keeping plant growing productive and reliable.

Overall, the evidence indicates that Scotland can achieve transition to a peat-free horticulture sector. Scotland has the resources, industry capability and emerging technical knowledge needed to support this transition. The pace of this change will depend on clear policy direction, realistic timescales, and continued support for infrastructure, standards, and shared trials.

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3 Glossary

Term	Definition
Air-filled porosity	A basic measure of how well soil or growing media allows air to reach plant roots. Refers to the proportion of the material's volume that is filled with air after the growing medium has been fully watered and excess water has drained away. Expressed as a percentage, with higher values indicating more air space and lower bulk density.
Amateur grower	Individuals growing plants, typically in a home or community setting, for personal enjoyment. May sell plants face-to-face at local events for charitable purposes e.g. National Gardening Scheme. Not making a regular profit.
Bare-root plants	Plants that are sold with their roots exposed, without soil or growing medium.
Biochar	A highly porous, carbon-rich material produced by heating organic biomass (e.g. wood, crop residues or manure) in a low-oxygen environment through pyrolysis.
Biosecurity	Practices that prevent the introduction and spread of plant diseases and pests.
Black peat	Found in the lower, older layers of a peat bog. Composed of plant matter which is in more advanced stages of decomposition than in upper layers. Dark brown to black in colour, with dense, compacted structure.
Blonde peat	Sometimes referred to as white peat. Youngest form of peat, extracted from the uppermost layers of peat bogs. Less decomposed than black peat, with a more fibrous and open structure.
Bulk density	A measure of how heavy a growing medium is for a given volume. It reflects how compact the material is, with higher bulk density indicating a heavier, more compact medium with fewer air spaces, and lower bulk density indicating a lighter, more open structure. Bulk density affects handling, transport costs, plant stability, and root aeration, and is therefore an important factor when comparing peat-based and peat-free growing media.
Carbon sequestration	The process by which carbon dioxide is captured and stored in natural sinks such as peatlands, forests and soils.
Cation exchange capacity (CEC)	The ability of a growing media or soil to hold and exchange positively charged ions (cations), including key nutrients. High CEC media retains and supplies cations more effectively.

Term	Definition
Circular economy	A circular economy is one that reduces demand for raw materials, designs products to last, and encourages reuse, repair, and recycling. It aims to keep materials in use for as long as possible, extract maximum value from them while in use, and recover and regenerate products and materials at the end of their service life.
Carbon dioxide equivalent (CO2e)	A standard metric for measuring the total climate change impact of different greenhouse gases (GHGs). It converts the emissions of various GHGs, such as methane and nitrous oxide, into a single unit representing the amount of CO2 that would cause the same amount of warming.
Coir	A natural fibre extracted from the outer layer of coconut husks, commonly used as a peat alternative in growing media.
Composted bark	The outermost part of woody plants (usually softwoods) which are crushed and screened before fermenting in heaps. Used in growing media chiefly to improve drainage and increase air capacity. May increase CEC and pH buffering of media.
Composted green waste (CGW)	Biodegradable organic waste, primarily composed of plant material, that has been decomposed and recycled as a soil amendment or growing media component. Production, quality control and lab testing for CGW is covered by The British Standard Institution PAS 100 across the UK.
Environmental horticulture	Defined by the Horticultural Trades Association (HTA) as encompassing '*a wide range of activities—including companies that cultivate ornamental plants, manufacturers of garden equipment, wholesalers and retailers such as garden centres, and specialists in landscape and arboriculture who maintain home gardens and expansive parks.'*
Ericaceous plants	Group of plants in the family Ericaceae, which thrive in acid (low pH) soil environments. Includes economically important genera such as *Vaccinium* (blueberry, cranberry), *Rhododendron* and *Camellia.*
Greenhouse Gas (GHG) emissions	GHG's – including carbon dioxide, methane, nitrous oxide and fluorinated gases – which trap heat when released into the atmosphere, contributing to global warming and climate change.
Horticulture	The science and art of cultivating plants. The horticulture industry can broadly be broken down into two main sectors – environmental and production.
Hydroponics	A method of growing plants without soil or growing media, using nutrient-rich water solutions.

Term	Definition
Life Cycle Assessment (LCA)	A method used to evaluate the environmental impact of a product, including carbon footprint, resource use and emissions.
Liner	Young plants grown individually from cuttings in modular trays ready to be potted-up or planted-out. The term ‘liner’ is often used interchangeably with ‘plug’.
Loam	A type of soil composed of roughly equal proportions of sand, silt and clay particles.
Microbial activity	The presence and function of microorganisms in soil or growing media, impacting plant health and nutrient availability.
Oomycetes	A group of fungus-like microorganisms, commonly known as ‘water-moulds’, which often act as decomposers. Thrive in moist environments and include damaging pathogens such as *Phytophthora* spp.
Plant pathogen	Biological agents which cause disease in plants, negatively impacting plant health, quality and crop yield. Includes microorganisms such as bacteria, fungi and viruses.
Pathogen screening	The process of testing growing media for harmful microorganisms.
Peat	Organic material formed when dead plant matter collects and breaks down slowly in cool, waterlogged, oxygen deficient conditions. Introduced into UK horticultural use in the 1930’s and renowned for its water retentive properties and favourable structure.
Peat-free growing media	Growing media composed of non-peat components, including coir, wood fibre, composted bark and composted green waste. Peat-free media is typically made up of a combination of ingredients to achieve the desired growing properties.
Peat soils	Soil with a surface peat layer with more than 60% organic matter and of at least 50cm thickness.
Peaty soils	Soil with a shallower peat layer at the surface less than 50cm thickness over mineral layers.
Perlite	Formed from a naturally occurring volcanic glass, which is mined and heated to produce a lightweight, porous material. Commonly used to improve aeration and drainage in growing media.
pH buffering capacity	Describes how well a growing medium can resist changes in pH when fertilisers or other inputs are added. A medium with good buffering

Term	Definition
	capacity maintains a more stable pH, helping to ensure nutrients remain available for healthy development.
Phytotoxicity	Adverse effects on plant growth and development caused by phytotoxins (substances which are toxic or poisonous to plants). In the context of growing media, excessive fertiliser may result in phytotoxicity.
Plug plants	Young plants grown individually from seed in modular trays ready to be potted-up or planted-out.
Professional grower	Individuals or groups regularly growing and selling plants with a view to making a profit.
Propagation	The process of growing new plants from seeds, cuttings, or tissue culture through both sexual and asexual means.
Responsible sourcing	The ethical procurement of raw materials that ensures environmental sustainability and fair labour practices.
Responsible Sourcing Scheme (RSS)	A framework that assesses the environmental, economic, and social sustainability of growing media components.
Soft fruit	Soft, juicy fruit borne on low growing plants (not trees) such as strawberries, raspberries and blueberries.
Sphagnum moss	A plant species that grows on peatlands and other wet habitats, often harvested for horticultural use as a water-retentive substrate.
Standardisation and quality Control	Efforts to ensure consistency, safety, and performance across the growing media production sector.
Supply chain reliability	The ability to ensure consistent availability and quality of growing media materials.
SWOT Analysis	A strategic planning tool that evaluates: Strengths, Weaknesses, Opportunities, and Threats.
Vermiculite	A naturally occurring mineral, which is mined and heated to produce an expanded, lightweight material. Primarily used in horticulture to retain moisture and nutrients, can also improve aeration, although not to the same degree as perlite.
Wood fibre	Fibres extracted mechanically/thermally from wood and wood waste, used in peat-free growing media for high air capacity, good drainage and low bulk density.

4 Context for transition to peat-free horticulture

4.1 Research purpose

The Scottish Government has committed to phasing out the use of peat in horticulture. This commitment is reflected in policy measures including National Planning Framework 4 (NPF4) (Scottish Government, 2023a) and the consultation Ending the Sale of Peat in Scotland (Scottish Government, 2023b), which together restrict new commercial peat extraction licences and set out the basis for stakeholder engagement on the transition. Scottish Ministers have also written to UK counterparts to advocate for coordinated UK-wide legislation and a clear roadmap for ending horticultural peat use, underscoring inter-governmental support for a structured transition (Scottish Government, 2026).

This research (October 2024 to September 2025; Appendix A) examined the transition to peat-free growing media from a Scottish perspective and focussed on:

- The level of confidence in available peat alternatives, including their performance, supply reliability, sustainability and cost.
- The preparedness of the horticulture sector to reduce and eliminate peat use.
- The main barriers to transition across Scottish horticulture.
- Challenges associated with peat-dependent crops and growth stages, particularly ericaceous plants and propagation.
- The scope for industry collaboration through coordinated grower trials.
- The role and practicality of peat-free standards.
- The overall feasibility of a sector-wide transition.

4.2 Background

Peat emerged as a key growing media component in UK horticulture in the 1970s, having first been commercialised as a constituent in loam-based media for container planting in the 1930s (Alexander et al., 2008; Prasad et al., 2024; Waller, 2012). Its combination of high water-holding capacity, good air porosity and structural stability ensures optimal conditions for healthy root development, while its low bulk density and friable texture make it easy to handle (Schmilewski, 2008). The inherently low nutrient content of peat allows growers to tailor treatments to suit specific crops, making it a versatile growing medium (National Institute of Agricultural Botany, 2024). Traditionally peat has been regarded as free from pathogens, pests, and weed seeds both at point of extraction and during controlled production. Its processing and grading are considered straightforward, and its pricing has historically been highly competitive (Barrett et al., 2016), making it a preferred choice in both professional and amateur horticulture.

Peatlands play a crucial role in carbon sequestration but, when degraded, become significant sources of greenhouse gas emissions (International Union for Conservation of Nature and Natural Resources, 2021). Analysis by The Wildlife Trusts (2022) estimates that up to 31 million tonnes of carbon dioxide have been released since 1990 as a result of peat extraction for UK horticulture. Although peatlands cover only about 3-4% of the Earth's land surface, they store more carbon than any other terrestrial ecosystem, holding roughly twice as much as all the world's forest biomass combined (United Nations Environment Programme, 2022).

Around 20% (c.1.8 million hectares) of Scotland's land area is peatland (Bruneau and Johnson, 2014). Approximately 80% of UK peatlands are degraded, the majority located in Scotland, with 90% of raised bogs and 70% of blanket bogs in damaged condition (NatureScot, 2015). Although only around 1,000 hectares (0.05%) are harvested annually for horticulture – producing roughly 270,000 m³ of peat (Scottish Government, 2025, pers. comm.) – extraction disproportionately affects lowland raised bogs, one of the most threatened peatland habitats (UK Centre for Ecology and Hydrology, n.d.). Peat extracted in Scotland accounted for 18% of the total volume used in UK growing media in 2022 (Horticultural Trades Association, 2022a).

Concerns about the carbon emissions and biodiversity loss resulting from peat extraction were first raised in the 1980s and 1990s (Waller, 2012), prompting the formation of the Peat Working Group in 1992 and the introduction of stricter harvesting regulations. The UK Government's first formal reduction goal appeared in *Minerals Planning Guidance 13* (Department for Environment, Food and Rural Affairs, 1995), which aimed for 40% of growing media materials in England to be non-peat by 2005 (Alexander et al., 2008). This trajectory was reinforced in the 2011 Natural Environment White Paper (*The Natural Choice*), which set voluntary targets to phase out peat use in amateur gardening by 2020 and in professional horticulture by 2030 (HM Government, 2011).

Subsequent national and UK policy has sought to progress this transition. The phasing out of peat-based horticultural products is a devolved matter, with each nation developing its own approach within the context of an intended UK-wide ban. In England, the Department for Environment, Food and Rural Affairs (2023) previously set out a series of proposed phase-out dates under the former UK Government, including a statutory ban on the retail sale of peat-based products for amateur use by 2024, a phased reduction for professional growers by 2026, and a full prohibition by 2030. The current UK Government has reiterated its intention to legislate for a ban on the sale of peat and peat-containing products, although implementation remains contingent on parliamentary time and no specific timetable has yet been confirmed (Defra, 2025a). A Private Members' Bill seeking to give legislative effect to a ban in England and Wales has been introduced to the UK Parliament and is awaiting a second reading (UK Parliament, 2025).

In Scotland, the Government has committed to ending the sale of peat-based horticultural products. The 2021–22 Programme for Government (Scottish Government, 2021) included a pledge to develop and consult on a ban as part of a wider strategy to transition away from peat. This commitment was progressed in February 2023 through a public consultation seeking stakeholder views on prohibiting sales, initially in the retail market and subsequently for professional growers (Scottish Government, 2023b).

4.3 Current use of peat in the horticulture industry

Figures released by the HTA (2022) and Defra (2025b) reveal that total peat use in UK horticulture declined slowly between 2011 and 2019, remaining close to 2 million m³ per year (Figure 1). In 2020, peat use increased temporarily, coinciding with a surge in home gardening and plant production during national COVID-19 lockdowns (White et al., 2021). From 2021 onwards, peat use fell rapidly; total volumes declined by around two-thirds between 2020 and 2023, associated with a sharp reduction in retail peat use; professional peat use also declined, but at a slower pace. By 2023, retail and professional use had converged at similar levels, each accounting for around half of remaining peat consumption.

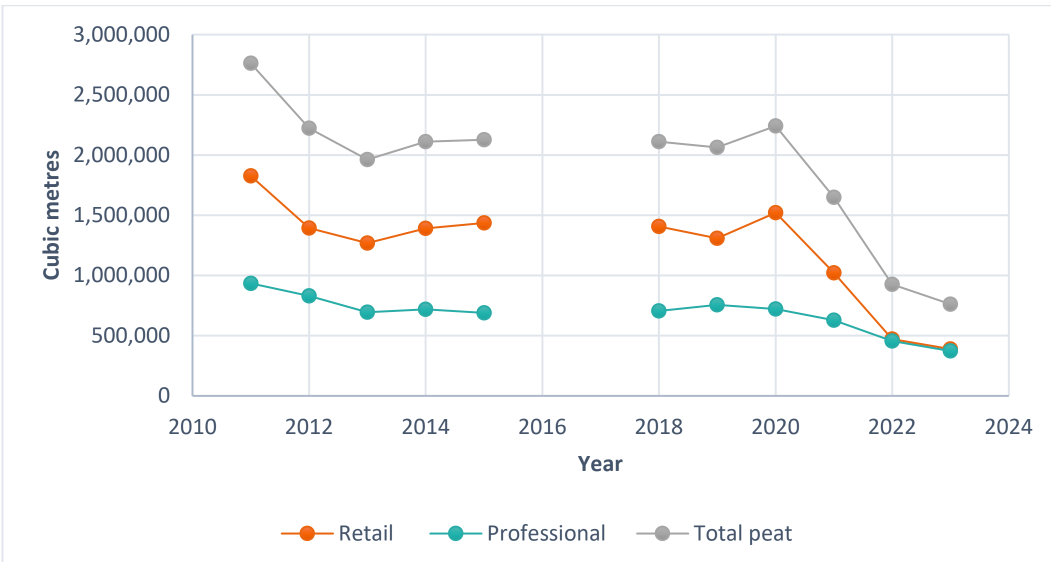

Figure 1: Total peat usage across retail and professional sectors 2011-2023 (Defra, 2025b; HTA, 2022)

Between 2011 and 2023, the retail horticulture sector consistently used more growing media than the professional sector, typically between two and four times as much (Figure 2). Retail volumes fluctuated, but remained high overall, at 2.34 million m³ in 2023, compared with 0.81 million m³ used by professional growers. This reflects the much larger scale of the consumer growing-media market relative to commercial plant production. This highlights an important dynamic in the transition to peat-free media. Although the retail sector has reduced its peat use more rapidly, it remains the largest user of growing media overall. As a result, changes in the composition of retail products continue to exert a strong influence on total peat demand.

Figure 2: Total growing media usage across retail and professional sectors 2011-2023 (Defra, 2025b; HTA, 2022)

5 What are the alternatives to horticultural peat in growing media?

5.1 Current alternatives

Ongoing research and commercial trials have led to the development of several viable alternatives to peat, either individually or through the blending of more than one constituent material. Table 1 summarises a range of materials currently used, trialled, or proposed as alternatives to peat in horticultural growing media. It provides a high-level overview of each material's origin, current level of commercial adoption, and primary functional role within growing-media blends.

The table is intended as an orientation tool for policymakers and practitioners, supported by full SWOT and detailed analyses of performance, constraints and sustainability considerations presented in Appendix F and Appendix G respectively. Currently, the most widely adopted materials across both professional and amateur horticultural sectors are wood fibre, coir and composted bark (Defra, 2025b; HTA, 2022).

Table 1: Overview of alternatives

Material	Source	Characteristics/uses
Anaerobic digestate (AD) Limited/early commercial adoption	By-product of anaerobic digestion. Consists of nutrient-rich material remaining after organic waste is broken down in oxygen-free conditions during biogas production.	Supplies high levels of essential nutrients. Is used primarily to enhance the fertiliser value of growing-media blends, rather than as a structural base.
Composted bark Widespread commercial adoption	By-product of forestry and wood-processing industries. Bark is composted through piling and turning, screened, and often nitrogen-treated prior to use.	Provides high air-holding capacity and structural openness (particle size dependent). Low inherent nutrient content allows fertilisation to be tailored to crop requirements.
Biochar Limited/early commercial adoption	Carbon-rich, porous material produced by heating organic biomass (e.g. wood, crop residues or manure) under low-oxygen conditions (pyrolysis).	Contributes stable structure, porosity, nutrient retention and water-holding capacity when used as a blended additive.
Composted bracken Limited/early commercial adoption	Harvested from natural/managed areas where bracken grows abundantly. Biomass is composted before use.	Improves structure and aeration, with potential nutrient contribution when composted. Can be suitable for ericaceous crops where composted material is acidic.
Coir and coir pith Widespread commercial adoption	By-product of the coconut industry, consisting of fibres and fine pith derived from the outer husk of coconuts.	Provides a good balance of water retention and aeration, with high re-wetting capacity. Functionality varies depending on blend composition.
Composted green waste (CGW) Widespread commercial adoption	Derived from commercial and public waste streams, including local authority green waste and agricultural residues.	Typically nutrient-rich. Used to enrich peat-free mixes and contribute organic matter.

Material	Source	Characteristics/uses
Composted heather No current commercial market	Upland biomass harvested as part of moorland vegetation management; chopped and composted to produce a fibrous material.	Early trials suggest potential for ericaceous growing media where an acidic product can be produced; evidence base remains under development.
Hemp fibre (*Cannabis sativa)* No current commercial market	Fast-growing fibre crop that can be produced domestically; fibre derived from the woody core (hurds or shiv).	Lightweight material with good air-holding capacity and moderate water retention; may have nitrogen immobilisation effects due to high C:N ratio (similar consideration as wood fibre).
Loam Widespread commercial adoption	Fertile mineral soil composed of a balanced mixture of sand, silt and clay.	Provides mineral content, structure and water-holding capacity; traditionally used as a base component in growing media.
Marine sediment No current commercial market	Dredged material collected from coastal or marine environments and subjected to remediation prior to reuse.	Potential to contribute mineral fraction and influence water/nutrient dynamics when appropriately remediated; suitability is highly dependent on salinity/contaminant control and particle-size distribution.
Reclaimed peat Limited/early commercial adoption	Peat recovered from previously disturbed sources (e.g. construction/dredging spoil, excavation arisings, or other waste streams) and processed for reuse.	Retains some of peat's structural and water-holding properties; typically blended with composted or fibrous materials to improve performance.
Rice husk ash (RHA) No current commercial market	By-product of rice milling, produced by controlled burning and processing of rice husks.	Enhances structure, aeration and water-holding capacity in growing-media blends.
Sheep wool Limited/early commercial adoption	By-product of the wool industry, typically using low-grade fleece unsuitable for textile manufacture.	Retains water, supplies slow-release nitrogen and improves aeration.

Material	Source	Characteristics/uses
Spent mushroom compost (SMC) Limited/early commercial adoption	By-product of commercial mushroom production, following pasteurisation of spent growing substrate.	Nutrient-rich organic material used primarily as a conditioner or minor component in growing media to enhance fertility and structure.
Farmed *Sphagnum* No current commercial market	Harvested from cultivated peatland systems using propagated *Sphagnum* moss, not wild-harvested.	Highly effective water retention and structure that improves aeration; particularly suited to propagation and sensitive crops.
Wood fibre Widespread commercial adoption	Derived from primary and secondary wood-processing residues; fibres are processed under high temperature and pressure and often nitrogen-treated.	Enhances structure and air-holding capacity; commonly blended with other components in peat-free growing media.

5.1.1 Widespread commercial adoption

Across the UK and Scottish horticultural sectors, a range of peat alternatives are now in widespread commercial use, reflecting rapid diversification of the growing media market since the early 2010s. Wood fibre, composted bark, coir, composted green waste and loam form the core constituents of many current retail and professional blends, although their relative importance differs markedly between sectors. Wood fibre, composted bark and coir underpin both professional and retail formulations, whereas composted green waste is used predominantly in the retail market, with very limited penetration into professional growing systems. Each of these components contributes distinct physical and chemical properties, allowing manufacturers to engineer bespoke mixes tailored to specific crop needs and end markets. Most commercial products therefore rely on combinations of these materials, as no single component replicates the balance of air porosity, water-holding capacity and stability traditionally provided by peat (Gruda, 2019; Peano et al, 2012).

5.1.2 Limited or early commercial adoption

While a range of emerging or regionally available feedstocks (e.g. bracken, sheep wool, anaerobic digestate, biochar, spent mushroom compost and reclaimed peat) have been explored in peat-free media formulation, the published evidence base on their performance, quality variability and commercial feasibility remains relatively sparse. Many assessments are preliminary, often confined to small-scale trials or expert commentary rather than coordinated multi-site studies. Further research is therefore required to clarify where these materials may be deployed most effectively and at what scale (Calisti et al., 2023; Johnson and Di Gioia, 2023; Kennard, 2020; Medina et al., 2009; Pitman and Webber, 2013).

Although several of these materials demonstrate technical promise in specific contexts, uptake remains constrained by factors including supply consistency, variability in quality, sustainability considerations, regulatory requirements and the need for additional processing. In interviews, manufacturers of professional growing media consistently described these materials as “promising but peripheral”, noting that they are typically incorporated through pilot collaborations, niche retail products or experimental blends rather than forming part of core formulations.

5.1.3 No current commercial market in Scottish horticulture

A further group of materials is not yet established at commercial scale within UK professional growing media markets but is attracting interest in the context of longer-term peat-free strategies. These include composted heather, rice husk ash, marine sediment, hemp fibre and farmed *Sphagnum*. Rather than offering immediate substitutes, these materials represent prospective feedstocks that could contribute to future supply diversification and reduced dependence on imported substrates.

Several of these materials present theoretical or demonstrated advantages in specific contexts, including regional resource availability, circular-economy potential, carbon storage capacity and favourable structural properties. For example, cultivation of *Sphagnum* biomass through paludiculture systems has been investigated as a renewable peat substitute (Gaudig et al., 2017; Wichtmann et al., 2016), while rice husk ash and marine sediment have been assessed in blended substrates in controlled horticultural trials (Mattei et al., 2017; Omar et al., 2023). However, evidence of large-scale agronomic performance, supply-chain logistics and quality standardisation remains limited across most materials. Published studies are typically experimental, pilot-scale or regionally specific, and few materials have yet been widely validated under recognised horticultural quality standards such as PAS 100 or the Responsible Sourcing Scheme.

Stakeholder interviews characterised these options as high-potential but low-readiness, with further work required to clarify processing requirements, certification pathways, performance consistency and economic viability before widespread commercial uptake could occur. As Scotland progresses its transition away from peat, the future role of such materials will depend on continued research, market development and regulatory alignment rather than immediate substitution potential.

5.1.4 Mineral components and functional additives in peat-free media

The transition to peat-free growing media has prompted a more deliberate combination of organic and mineral components to maintain the structural and functional properties required for reliable plant growth. Mineral additives such as perlite, vermiculite and clay pumice are central to this task. Each offers specific physical benefits that provide structure and buffering capacity, and can be used to improve drainage, air holding capacity, nutrient retention and physical stability. These materials are increasingly important for standardising performance and reducing variability in peat-free formulations.

Alongside mineral additives, manufacturers and researchers have turned to supplements to strengthen the performance of peat-free media. These include biostimulants and wetting agents (surfactants). Biostimulants – including algae extracts, beneficial bacteria, fungal inoculants and mineral salts – are believed to enhance natural plant processes, promoting more efficient uptake of water and nutrients (Kisvarga et al., 2022). Wetting agents, available in liquid or granular form, improve water absorption and distribution within the media, helping to reduce runoff and water waste. Although many wetting agents are derived from synthetic chemicals, more sustainable alternatives are emerging. RHS peat-free trials have reported significant benefits from biostimulant use (RHS, 2025, pers. comm), and some growing media suppliers are now incorporating these into their professional peat-free formulations.

5.2 Media blending

It is widely recognised that there is no “silver bullet” replacement for peat (Koseoglu et al., 2021). Peat uniquely combines high porosity, water-holding capacity, structural stability and low inherent fertility, allowing growers to exercise precise control over nutrition and acidity (pH). Alternative constituents typically provide some, but not all, of these properties in isolation. As a result, the academic literature consistently emphasises that effective peat-free substrates must be formulated through blending multiple components, selected to balance water retention, drainage, nutrient availability and physical stability according to crop type and production system (Gruda and Bragg, 2020; Schmilewski, 2008). International reviews of growing-media systems note that blending is unavoidable, as no individual material replicates peat’s multifunctionality (Bragg and Alexander, 2019). This conclusion is reinforced by recent European analyses, which show that while bio-based resources such as wood fibre, composted bark, composted green waste and coir are available at scale, each presents technical or logistical limitations that must be addressed through careful combination and optimisation (Hirschler et al., 2022).

5.2.1 Tailoring mixes to specific crop needs

Evidence from stakeholder engagement across Scotland indicates that growers and growing media manufacturers who have successfully reduced peat typically rely on formulations combining wood fibre, composted bark, coir and – particularly for retail mixes – composted green waste. Manufacturers have refined these mixes through tailored approaches to wood fibre processing, coir buffering, and bark composting to improve consistency and performance.

European research identifies clear technical thresholds for peat-free material – typically up to 40% wood fibre, 50% composted bark, or 40% composted green waste – beyond which plant growth and substrate structure decline (Blok et al., 2021; Raviv, 2013). These findings underline that peat-free horticulture is not a simple substitution exercise, but one that depends on optimised blends informed by research, collaborative trials and coordinated supply-chain development. Diversification of materials improves performance and resilience, reducing exposure to single-stream supply risks and reflecting wider European recommendations to mobilise bio-based resources while maintaining quality and consistency (Gruda & Bragg, 2020; Hirschler et al., 2022; Schmilewski, 2014).

The transition to peat-free growing media frequently necessitates adjustments to irrigation and nutrient regimes, particularly in nurseries managing diverse crops under shared irrigation systems where substrate water and nutrient dynamics differ. Stakeholders emphasised the importance of tailoring media to specific crops and growth stages, with individual nurseries often requiring fine-textured propagation media alongside coarser, more water-retentive mixes for container-grown plants. As a result, growers commonly source multiple blends from different suppliers. This approach supports crop performance and operational flexibility, but has implications for procurement, consistency and supply-chain coordination.

While research demonstrates that peat-free growing media can support successful plant growth across a wide range of crops, outcomes are contingent on effective management of irrigation, nutrient supply and physical properties through optimised blending. Continued refinement, supported by targeted trials, collaboration and knowledge exchange, will be critical to broadening adoption and strengthening confidence in the performance of peat-free formulations (Bek et al., 2020; Hirschler et al., 2022; Koseoglu et al., 2021; Royal Horticultural Society, 2023; Sradnik et al., 2023). Appendix H presents an industry-led case study demonstrating how blended peat-free and peat-reduced growing media can be designed to meet crop performance requirements using widely available materials.

5.3 Sustainability of alternatives

It is essential that the sustainability of alternatives is clearly understood. This can be assessed through three complementary approaches:

1. **Environmental assessment**: This approach quantifies the environmental footprint of peat alternatives by analysing carbon emissions, energy use, water consumption and end-of-life impacts (Hospido et al., 2010). Studies assessing substitutes such as coir highlight that environmental outcomes vary depending on production methods, transport distances and assessment boundaries, underscoring the need for careful interpretation of life-cycle results (Peano et al., 2012; Toboso-Chavero et al., 2021).
2. **Social sustainability:** This dimension considers labour conditions, health implications and workplace safety within raw material supply chains. Sahu et al. (2019) identified significant health risks among workers involved in coir production, many of whom were women lacking adequate personal protective equipment (PPE), while Peano et al. (2012) highlighted occupational health risks associated with the processing of composted green waste.
3. **Responsible Sourcing Scheme (RSS)**: The Responsible Sourcing Scheme for growing media is an industry-led framework that assesses the environmental and ethical performance of growing media products through a transparent scoring system covering energy use, water use, social compliance, habitat and biodiversity, pollution, renewability and resource-use efficiency. By providing clear ratings and independent auditing, the RSS supports informed decision-making by manufacturers, retailers and growers about the environmental impacts of growing media mixes and encourages continuous improvement in material sourcing (Responsible Sourcing Scheme, n.d.).

5.3.1 Environmental assessment

The assessment summarised in Table 2 provides a high-level overview of the environmental sustainability of sixteen potential alternatives to peat used in horticultural growing media. It draws on published life-cycle assessments (LCAs), industry reports, peer-reviewed literature and stakeholder interviews, supplemented with Scotland-specific evidence where available. Key sources include Gabryś and Fryczkowska (2022), Gruda (2019), Hashemi et al. (2024), Hirschler et al. (2022), Litterick et al. (2019), Peano et al. (2012), Stichnothe (2022), and Toboso-Chavero et al. (2021). Each material is assessed across four sustainability dimensions:

1. **Emissions during production:** Based on available LCAs, including direct fossil fuel use and indirect biogenic carbon release. Where quantitative data are reported, emissions are expressed as kg CO_2e per tonne (or per m^3 for peat), with ranges reflecting methodological variation and uncertainty.
2. **Transport emissions**: Differentiating between locally sourced materials with short supply chains and imported feedstocks associated with long-haul transport.
3. **Risk of offshoring impacts**: A qualitative assessment of whether peat substitution may displace carbon or environmental burdens to other regions (e.g. imported coir or Baltic peat).
4. **Scottish availability**: The extent to which materials can realistically be sourced within Scotland, informing circular-economy potential, transport emissions and exposure to offshored impacts.

The qualitative ratings used in Table 2 (Low, Moderate and High) are intended to support comparative interpretation rather than provide precise measurements. Relative to other peat alternatives, a *Low* rating indicates lower production emissions, limited processing requirements and/or short supply chains based on available evidence. *Moderate* ratings reflect higher energy inputs, greater processing or transport requirements, or mixed evidence across impact categories. *High* ratings indicate materials that consistently show higher emissions, longer supply chains or greater risks of offshoring environmental impacts. Full quantitative data, assumptions and sources underpinning these classifications are provided in Appendix I. Table 2 should therefore be read as a comparative overview, highlighting broad patterns in environmental performance across material groups rather than precise rankings between individual material.

Table 2: Summary environmental assessment of peat alternatives used in horticultural growing media

Material group	Materials	Production emissions	Transport and offshoring	Scottish availability	Overall sustainability signal
Local woody materials	Composted bark	Low	Low-moderate	High	Favourable
	Wood fibre	Low	Low	High	Favourable
Local organic wastes and by-products	Anaerobic digestate (AD)	Low	Low	High	Favourable
	Biochar	Moderate	Moderate	Moderate	Mixed/context-dependent
	Composted bracken	Low	Low	High	Promising but data-limited
	Composted green waste	Low-moderate	Low	High	Favourable
	Sheep wool	Low	Low	High	Promising but data-limited
Soils and sediments	Loam	Moderate	Low	Moderate	Mixed/context-dependent
	Marine sediment	Moderate	Low	Moderate	Promising but data-limited
Imported agricultural by-products	Coir and coir pith	Moderate	High	Low	Higher environmental risk
Imported agricultural by-products	Rice husk ash (RHA)	Moderate-high	High	Low	Higher environmental risk
Novel or emerging materials	Composted heather	Low	Low	Moderate	Promising but data-limited
	Hemp fibre (*Cannabis sativa*)	Moderate	Moderate	Moderate	Promising but data-limited
	Farmed *Sphagnum*	Low-moderate	Low	Moderate	Promising but data-limited
Peat (domestic and imported)	Peat	High	Moderate-high	Declining/ constrained	Unfavourable
	Reclaimed peat	Moderate-high	Low-moderate	Low-moderate	Mixed/context-dependent
	Spent mushroom compost	Low-moderate	Low	Moderate	Mixed/context-dependent

Overall, the assessment indicates that environmental performance is strongly influenced by material provenance, processing intensity and supply-chain geography. Transport and offshoring ratings are based on indicative UK and European sourcing assumptions; however, actual impacts will vary depending on specific supply routes, processing locations and logistics. Across all assessed dimensions, locally sourced woody materials, particularly wood fibre and composted bark, consistently demonstrate more favourable environmental profiles than peat and imported alternatives, reflecting low production emissions, short supply chains and high Scottish availability.

Among waste-derived materials, anaerobic digestate performs favourably across all sustainability dimensions, reflecting its status as a locally available by-product with low marginal emissions and strong alignment with circular-economy objectives. Composted green waste similarly shows favourable environmental performance, with emissions largely confined to processing activities. Other locally available materials, including composted bracken and sheep's wool, demonstrate promising circular-economy potential but remain constrained by limited life-cycle evidence and uncertainty around scalability. Biochar presents potential benefits as a carbon-stable amendment; however, its overall sustainability signal remains context-dependent, varying with feedstock type, energy inputs and the scale of domestic processing capacity.

Materials requiring primary extraction or intensive processing, such as loam and marine sediment, show more mixed environmental profiles. While both benefit from relatively short transport distances, their circular-economy potential is limited by extraction impacts, energy requirements and, in the case of marine sediment, contamination risks and evidence gaps around horticultural suitability at scale. In contrast, imported agricultural by-products, particularly coir and rice husk ash, consistently present higher transport emissions and greater risks of offshoring environmental impacts, limiting their sustainability within a Scottish context despite the widespread use of coir as a peat substitute.

Finally, materials that retain a direct link to peat extraction, including reclaimed peat and spent mushroom compost, offer only partial or transitional environmental benefits. While reclaimed peat avoids new extraction and spent mushroom compost is waste-derived with low additional emissions – and may become inherently peat-free as mushroom production transitions away from peat – both currently remain constrained in their ability to support long-term peatland protection and a fully peat-free growing-media transition (for full SWOT analysis please see Table 24 in Appendix F).

5.3.2 Social sustainability of alternatives

Social sustainability in peat-free growing media encompasses labour conditions, occupational health and safety, and the distribution of social impacts across domestic and international supply chains. While the environmental case for peat substitution is well established, the social implications of alternative materials are more variable and, in some cases, less visible. Addressing these issues is critical to ensuring that the transition to peat-free horticulture does not externalise social risks onto workers or communities elsewhere. Table 32 in Appendix J sets out key social sustainability considerations.

Social sustainability is highest where supply chains are domestic, formalised and regulated, with well-characterised and controllable occupational risks (e.g. anaerobic digestate (AD), wood fibre, loam, spent mushroom compost (SMC)). Moderate–high ratings reflect generally regulated contexts moderated by seasonal labour, dust or bioaerosol exposure, agrochemical inputs or emerging-sector uncertainty (e.g. wool, farmed *Sphagnum*, composted green waste (CGW)). Moderate ratings capture identifiable exposure risks or regulatory complexity (e.g. hemp, marine sediment). Lower ratings arise where informal labour structures, persistent health concerns or structural sustainability conflicts externalise social risk (e.g. coir, reclaimed peat, rice husk ash).

5.3.2.1 Responsible Sourcing Scheme (RSS) calculator

Published in August 2024, Guidance Notes: Responsible Sourcing Scheme for Growing Media established an industry-led framework for assessing the sustainability of growing media ingredients. The Responsible Sourcing Scheme (RSS) evaluates key input materials used in horticulture against multiple environmental and social criteria to support more informed decision-making by growers, retailers and consumers. Scores are based on manufacturer data that is subject to independent auditing to enhance transparency and credibility. A detailed summary of the RSS methodology and scoring system is provided in Appendix K.

While the scheme incorporates measures related to carbon and climate within criteria such as energy use and pollution, it does not directly quantify greenhouse gas (GHG) emissions or carbon sequestration in the manner of a full lifecycle assessment. Instead, climate-relevant impacts are inferred through proxy indicators such as fossil fuel consumption, transport inputs and other resource use measures. Methane and nitrous oxide are acknowledged within the broader framework but are not systematically modelled as discrete climate impact outputs.

As a result, the RSS provides a structured, transparent and multi-criteria tool for comparing the relative sustainability of growing media ingredients, but its treatment of carbon and climate impacts is indirect and not comprehensive. This has implications where peat-reduction policy is closely linked to quantified carbon outcomes, especially when comparing materials with differing biogenic carbon dynamics or soil carbon effects.

Positioning the RSS alongside more detailed climate-accounting approaches highlights the trade-offs between usability and precision: the scheme’s graded index supports practical sourcing decisions and market signalling, whereas lifecycle-based carbon inventories offer deeper quantification of climate footprints for research and policy evaluation.

5.3.3 Industry perspectives on environmental sustainability

Stakeholder engagement confirmed that environmental performance remains central to the rationale for peat reduction, though interpretations of “sustainability” varied considerably in practice. Manufacturers and growers emphasised carbon reduction, circular-economy principles and local sourcing as core sustainability strategies.

Several participants highlighted closed-loop systems and renewable energy use, including compost production powered by food-waste-derived biogas and investment in carbon-capture technologies. Others prioritised regional sourcing to reduce transport emissions, with some growers deliberately avoiding imported coir in favour of domestic forestry residues. Resource diversification was also identified as a key strategy, with interest in utilising biomass streams such as bracken and wool to support circular supply chains and reduce reliance on imports.

However, stakeholders also cautioned against environmental trade-offs and “hidden carbon costs,” particularly in relation to long-distance transport of coir and continued reliance on imported peat. Concerns were also raised about contamination in green-waste compost and the need for robust quality assurance to maintain product performance and consumer confidence.

5.3.4 Knowledge gaps in sustainability assessment of alternatives

Although multiple frameworks exist to assess the sustainability of peat-free growing media – including Life Cycle Assessment (LCA), social risk analysis and the Responsible Sourcing Scheme (RSS) – there remain significant methodological and evidential gaps. These gaps affect the comparability, transparency and policy relevance of sustainability claims associated with peat alternatives. More detailed explanation of these gaps is given in Appendix L.

5.4 Availability of alternatives

5.4.1 Overview

The transition to peat-free growing media depends on reliable access to alternative materials at sufficient scale and consistent quality. Availability is determined by domestic resource capacity, competition from other sectors, processing infrastructure, and the feasibility of imports. In Scotland, forestry and agricultural by-products provide a strong resource base, however, meeting national demand will require addressing technical, logistical and regulatory constraints.

Established inputs such as wood fibre, composted bark, green waste and imported coir already underpin much of the UK market. Alongside these, several materials remain at limited or developmental stages, including bracken, wool, heather residues, anaerobic digestate, biochar and farmed Sphagnum. Evaluating their role requires consideration of market scale, processing capacity and their contribution to displacing remaining peat use. At UK level, peat consumption has fallen substantially in recent years, however, further substitution depends on the reliable supply and optimisation of the principal alternative materials. Appendix M provides a quantitative comparison of the four most widely adopted alternatives relative to remaining UK peat demand, indicating their current market volumes and the constraints that may limit further expansion. In summary:

- Wood fibre and composted bark represent the most significant near-term substitutes, constrained by bioenergy competition and processing capacity.
- Composted green waste provides meaningful volume but depends on consistent quality assurance to manage contamination risks.
- Bracken and low-grade sheep wool offer renewable, locally available feedstocks with potential for niche or supplementary use, though operational and regulatory barriers remain.
- Loam, digestate fibre and biochar are unlikely to provide large-scale substitution, serving primarily additive or specialist functions.

- Emerging materials – including farmed *Sphagnum*, heather residues, hemp and marine sediments – show longer-term or localised potential but are not currently scalable.
- Imported materials such as coir and rice husk ash can supplement domestic supply but introduce carbon and supply-chain vulnerabilities.

Overall, achieving national peat replacement will require coordinated expansion of domestic processing capacity, improved resource recovery systems and targeted innovation to scale viable alternatives.

5.4.2 Global context of the supply chain of raw materials

The availability of alternative raw materials is shaped not only by technical suitability but by competing industrial demands and wider geopolitical dynamics. Supply-chain pressures are experienced differently across the sector: growers report direct exposure to trade, availability and logistical constraints, whereas manufacturers more commonly emphasise regulatory consistency, feedstock certification and contamination standards (Litterick et al., 2019).These structural dynamics influence the reliability, scalability and long-term resilience of Scotland's peat-free transition.

Assessment of key alternatives indicates three broad patterns of exposure:

- Domestic materials, including wood fibre, composted bark and composted green waste, are subject to limited geopolitical risk but face strong internal competition from bioenergy, construction and agricultural markets (Koseoglu and Roberts, 2025). Availability is therefore closely linked to forestry outputs, waste-management systems and energy policy.
- Import-dependent materials, notably coir and rice husk ash, are exposed to global market volatility, shipping costs and potential export controls, increasing supply uncertainty for Scottish growers (Koseoglu and Roberts, 2025). These materials remain sensitive to geopolitical developments and international trade conditions.
- Emerging or under-utilised Scottish resources, such as bracken, heather residues, anaerobic digestate fibre and sheep wool, carry minimal geopolitical exposure but depend on regulatory alignment, processing infrastructure and land-management incentives to become viable at commercial scale (Gaudig et al., 2017; Hill, 2022; Pitman and Webber, 2013).

Taken together, these findings indicate that material security depends less on absolute resource availability and more on cross-sector competition, infrastructure capacity and regulatory coherence within Scotland and the wider UK. A detailed material-by-material assessment of competing uses and geopolitical exposure is provided in Appendix N.

5.4.3 Biosecurity in peat-free growing media production

Biosecurity is a critical consideration in peat-free horticulture, as contaminated growing media can introduce plant pathogens and threaten crop health (Elliot et al., 2023; Frederickson-Matika et al., 2024; Litterick et al., 2025; Vandecasteele et al., 2018). Scotland's transition away from peat brings renewed attention to these risks, particularly given the increased use of organic and recycled inputs. Key challenges are summarised in Appendix O and include:

- **Pathogen risk in organic substrates:** Organic and recycled materials may harbour plant pathogens, underscoring the need for clearly defined sanitisation protocols and plant-health-specific quality standards (Elliot et al., 2023; Vandecasteele et al., 2018).
- **Limited plant-health coverage in certification schemes:** Existing accreditation frameworks primarily address human-health and contamination thresholds, with limited explicit provision for plant-pathogen risk (Elliot et al., 2023).
- **Traceability and import assurance considerations:** Effective risk management depends on consistent material tracking, proportionate import controls and clear guidance on waste reuse and disposal (Elliot et al., 2023; Litterick et al., 2025).
- **Variation in substrate risk profiles:** Biosecurity risk differs between materials. Green waste composts certified under BSI PAS 100 are generally considered moderate risk, as the standard focuses on human-health criteria rather than plant-pathogen assurance. Heat-treated wood fibre and composted bark are typically regarded as lower risk. Virgin peat has historically been considered comparatively low risk due to limited microbial activity; however, detections of *Fusarium oxysporum* f. sp. *melonis* and *Rhizoctonia* spp. have been reported (Frederickson-Matika, 2024; Litterick et al., 2025).

Evidence indicates a lack of sector-wide standardisation in sanitisation regimes, particularly regarding time, temperature and moisture thresholds – an issue most pronounced among smaller producers (Litterick et al., 2025). While peat has often been regarded as comparatively low risk due to limited biological activity, studies have demonstrated that peat-based substrates can support the survival and proliferation of plant pathogens where contamination occurs (Benavent-Celma et al., 2023; James, 2005).

Systematic, comparative surveillance of baseline pathogen loads across peat and peat-free media however remains limited (Müller et al., 2025). Current evidence therefore does not support a definitive conclusion that peat-free substrates inherently present greater biosecurity risk than peat. Rather, risk appears to be influenced by processing controls, quality assurance systems and supply-chain management. Achieving equivalent assurance across materials depends on transparent quality control, consistent testing and clearly defined sanitisation standards (Elliot et al., 2023). Biosecurity considerations therefore form one component of the broader technical, environmental and supply-chain assessment required when evaluating peat alternatives and designing resilient media blends for Scottish horticulture (Müller et al., 2025).

5.5 The economics of peat-free growing media

Recent analysis (Koseoglu & Roberts, 2025) and stakeholder engagement indicate that cost remains a significant barrier to peat-free transition. Of the 18 grower interviews analysed in Phase 2 of this research, 16 (89%) reported increased growing media costs following transition to peat-free or peat-reduced mixes. Reported increases most commonly fell within a range of approximately 10-40% when comparing like-for-like volumes of peat-free media with previously purchased peat-based mixes. Some growers cited substantially higher differentials, including instances where price was reported to have doubled. These figures reflect grower-reported purchase prices rather than standardised per-unit market comparisons. These stakeholder-reported increases are broadly consistent with findings from a UK-wide Royal Horticultural Society (2023) survey, which identified a 15–25% higher average cost for peat-free compared with peat-reduced growing media among responding businesses (n=35).

Cost impacts appear to vary across sectors, with ornamental, forestry, fruit and vegetable, and potato mini-tuber growers all reporting upward pressure, though the magnitude differed according to crop type, blend formulation and procurement arrangements. In some cases, growers indicated that transition would not have been economically viable without external financial support. Despite the consistency of reported cost increases, there remains limited peer-reviewed research directly comparing peat and peat-free media under equivalent production conditions, highlighting a gap in systematically collected cost data.

5.5.1 Material cost differentials

Stakeholder interviews and recent supply-chain analysis identify relative cost differences between major peat-free constituents (Table 3). Manufacturers indicated that composted bark and wood fibre are currently among the more cost-competitive peat-free components. Stakeholder-reported pricing suggested composted bark was below some peat-blended media, while wood fibre was moderately higher. In contrast, coir-based mixes were consistently described as substantially more expensive, with reported cost increases of 30-50% attributed to washing, buffering and international freight. Hirschler and Osterburg (2025), and Koseoglu and Roberts (2025) similarly identify coir as among the more expensive peat-free constituents, reflecting its processing requirements and transport intensity.

Composted green waste feedstocks are often available at relatively low bulk prices within the recycling sector. However, higher bulk density and additional processing requirements (e.g. screening, drying and quality control) contribute to final blended media costs, making simple raw price comparisons with peat imprecise (Koseoglu and Roberts, 2025). Digestate-based composts were reported at intermediate price points, reflecting maturation and handling requirements despite waste-derived feedstocks. A comparative cost analysis in a commercial plant nursery context found that compost derived from anaerobic digestion could present cost advantages relative to peat when assessed on a lifecycle cost basis, including labour and handling impacts (Restrepo et al., 2013).

For materials that do not yet have an established place in the UK growing media market (e.g. hemp fibre, marine sediment, rice husk ash, farmed *Sphagnum* and composted heather), reliable cost data are largely unavailable. These materials are typically produced at pilot scale, are regionally specific, or are not yet integrated into established supply chains. As a result, pricing information is either unpublished, commercially confidential, or highly context-dependent. This makes direct comparison with peat or mainstream alternatives difficult at present.

Table 3: Relative cost differences and cost drivers for widely adopted peat-free constituents

Material	Indicative cost position (relative to peat) *	Key cost drivers
Composted bark	Comparable to or slightly above peat	Processing, screening
Coir and coir pith	Substantially above peat	Import, washing, buffering
Composted green waste (CGW)	Moderately above or competitive, depending on processing and blend context (no standardised pricing)	Processing, screening, drying
Wood fibre	Moderately above peat	Processing, screening

* Relative positions reflect stakeholder and literature evidence rather than fixed market pricing.

Independent market analysis in Germany found that peat-free growing media cost on average approximately 21% more than peat-containing products at retail, although prices for individual growing-media components did not differ consistently. This suggests that mix formulation, processing and market structure contribute to observed price differentials (Hirschler & Osterburg, 2025). It is important to note that growing media component prices are subject to fluctuation due to factors including energy costs, freight rates, exchange rates, seasonal demand and regulatory changes. For this reason, the table above presents relative cost positions and principal cost drivers rather than fixed price estimates.

5.5.2 Ancillary production costs

Growers emphasised that cost increases extend beyond media purchase prices. Transition to peat-free substrates often requires adjustments to irrigation regimes, fertiliser strategies and handling systems. Several growers reported increased labour inputs associated with altered media structure, including more frequent tray filling adjustments and manual interventions. One nursery estimated overall production costs increased by 25-30% following transition, reflecting nutrient and labour inputs rather than media costs alone. Larger producers reported that economies of scale, in-house blending and automation mitigated some cost increases. In contrast, smaller nurseries and independent growers, with lower purchasing power and limited mechanisation, reported sharper per-unit impacts.

5.5.3 Supply-chain and structural cost drivers

Analysis by Koseoglu and Roberts (2025) identifies several structural factors that influence the cost profile of peat-free growing media. These drivers extend beyond the headline price of individual constituents and reflect broader supply-chain characteristics.

Transport dynamics are a key consideration. Many peat alternatives differ from peat in bulk density and compressibility, affecting transport efficiency and haulage costs per usable volume.

Modern supply-chain analyses and industry assessments identify transport configuration, logistics and processing requirements as significant structural contributors to cost outcomes (Hirschler and Osterburg, 2025; Koseoglu et al., 2021; Vandecasteele et al., 2018).

Processing requirements also contribute to overall cost. Producing horticulture-grade compost involves screening, grading and quality assurance steps that increase handling and infrastructure demands. Tightened contamination thresholds—particularly relating to plastics—require investment in improved screening systems and covered storage (Scottish Environment Protection Agency, 2025; Waste and Resources Action Programme, 2016). For imported materials such as coir, additional washing, buffering and long-distance freight introduce further logistical and processing inputs. In parallel, production systems historically designed for fine, flowable peat may require modification to accommodate more fibrous or structurally variable substrates, requiring operational adjustments and transitional capital investment.

Taken together, these system-level factors mean that cost outcomes are shaped not only by raw material choice but also by infrastructure capacity, logistics configuration and scale of operation. Larger manufacturers may absorb some pressures through in-house blending and automation, whereas smaller operators can experience proportionately higher impacts. Evidence suggests that some of these cost differences may reduce over time as domestic recycling and processing capacity expands and supply chains mature (Koseoglu & Roberts, 2025). However, in the short to medium term, these factors continue to influence the economic conditions under which peat-free media are produced and adopted.

5.6 Conclusions – alternative growing media

Section 5 demonstrates that peat-free growing media is now a technically viable but systemically complex transition. There is no single “drop-in” substitute for peat. Instead, successful peat-free production depends on carefully optimised blends that combine materials with complementary physical, chemical and biological properties. Wood fibre, composted bark, composted green waste (retail) and coir currently underpin most UK formulations, with other materials contributing additive, niche or developmental roles.

Evidence from stakeholder engagement and technical literature indicates that peat-free growing media must be formulated to achieve a reliable air–water balance, with crop and stage-specific adjustments driven primarily by particle-size distribution, container geometry and irrigation regime rather than a fixed recipe. Pore-size distribution governs performance: finer fractions increase water retention but may reduce aeration, while coarser fractions increase air-filled porosity and drainage. As crops move from propagation into larger containers, mixes are refined to reflect changing rooting volume and structural demand. In plugs and trays, short substrate columns retain proportionally more water and can limit air-filled porosity, while propagation substrates are typically maintained at low nutrient and soluble salt levels to avoid inhibiting germination or early root development. For ericaceous crops, maintaining a suitably low pH remains a critical constraint shaping constituent choice and limiting pH-raising inputs.

Across sustainability dimensions, performance varies primarily by provenance and processing intensity. Locally sourced woody materials and domestic organic by-products generally demonstrate more favourable environmental and social profiles, reflecting shorter supply chains, lower transport emissions and regulated labour conditions. Import-dependent materials, particularly coir and rice husk ash, remain technically effective but introduce higher transport emissions and greater risk of offshoring environmental and social impacts. Emerging materials – including farmed *Sphagnum*, bracken, wool and hemp – show promise in circular-economy terms but require further validation, scaling and certification before widespread deployment.

Availability is shaped less by theoretical resource abundance and more by infrastructure capacity, cross-sector competition and regulatory coherence. Forestry residues and organic waste streams provide Scotland with a strong domestic resource base, yet scaling substitution depends on investment in processing, contamination control, quality assurance and logistics. Biosecurity assurance, particularly for recycled and organic substrates, remains a critical component of system resilience.

Economic evidence confirms that cost remains a material barrier. Most growers report increased media expenditure following transition, typically in the range of 10-40%, with additional operational costs associated with irrigation, nutrition and handling adjustments. Structural supply-chain factors – including processing intensity, bulk density, transport efficiency and scale of operation – play a significant role in shaping final cost outcomes. While some cost differentials may reduce as supply chains mature, short-to medium-term pressures remain.

Taken together, the evidence indicates that Scotland's peat-free transition will depend on coordinated expansion of domestic processing capacity, optimisation of blended formulations, strengthened quality and biosecurity standards, and continued innovation to diversify supply. Peat substitution is achievable, but it is best understood as a process of system redesign rather than simple material replacement. Table 4 summarises the relative performance of each component, drawing together the sustainability, supply, cost, and horticultural suitability metrics discussed in this section. Peat is included as a baseline for comparison; although technically reliable and historically cost-competitive, its extraction is incompatible with Scotland's long-term peatland protection and climate objectives

Table 4: Overall summary of peat alternatives

Material	Sustainability	Availability	Relative cost signal	Technical suitability
Anaerobic digestate (AD)	Strong	Limited	Moderately higher	Functional
Composted bark	Strong	Established	Comparable/ lower	Reliable
Biochar	Mixed	Limited	Moderately higher	Functional
Composted bracken	Strong	Limited	Insufficient evidence	Functional
Coir and coir pith	Mixed	Established	Substantially higher	Reliable
Composted green waste (CGW)	Strong	Established	Moderately higher	Functional
Composted heather	Mixed	Not currently	Insufficient evidence	Functional
Hemp fibre (*Cannabis sativa*)	Mixed	Not currently	Insufficient evidence	Functional
Loam	Mixed	Limited	Moderately higher	Functional
Marine sediment	Mixed	Not currently	Insufficient evidence	Functional
Peat (baseline for comparison)	Significant conflict	Limited	Comparable/ lower	Reliable
Reclaimed peat	Significant conflict	Limited	Insufficient evidence	Reliable
Rice husk ash (RHA)	Mixed	Not currently	Insufficient evidence	Functional
Sheep wool	Mixed	Limited	Moderately higher	Functional
Spent mushroom compost	Mixed	Established	Moderately higher	Functional
Farmed *Sphagnum*	Mixed	Not currently	Insufficient evidence	Reliable
Wood fibre	Strong	Established	Moderately higher	Reliable

Table 5: Compact key for Table 4. Ratings reflect stakeholder evidence and published studies within a Scottish context.

Rating dimension	Green	Yellow	Red	White
Sustainability	Strong environmental and social alignment	Mixed/context dependent	Significant environmental or policy conflict	
Availability	Established commercial supply (Scotland/UK)	Limited or emerging supply	Not currently scalable	
Relative cost signal	Comparable to or lower than peat	Moderately higher*	Substantially higher	Insufficient evidence
Technical suitability	Reliable performance in peat-free blends	Functional but mainly additive/niche		

Note: ‘Moderately higher’ costs typically fall within 10-40% above peat where evidence exists.

6 Feasibility of alternatives in Scotland

6.1 Sector context and current transition status

Horticulture in Scotland sits within the broader agricultural sector and, for the purposes of this research, encompasses ornamentals, trees for forestry and woodland creation, fruit and vegetables, and potato mini-tubers. The analysis also considers growing media manufacturers and retailers, reflecting the central role of substrate supply in peat reduction.

In 2024, potatoes, vegetables, fruit, and flowers and nursery stock together contributed an estimated £831.4 million to Scotland's crop output, accounting for 54.5% of the total (Scottish Government, 2025b) (Figure 3). Nurseries producing plants for forestry and woodland creation generated approximately £19 million in turnover in the same year (Scottish Forestry, 2024). In the UK, household expenditure on growing media was estimated at £790 million in 2023 (Oxford Economics, 2024), underscoring the scale of the growing media market and its relevance to peat-free transition.

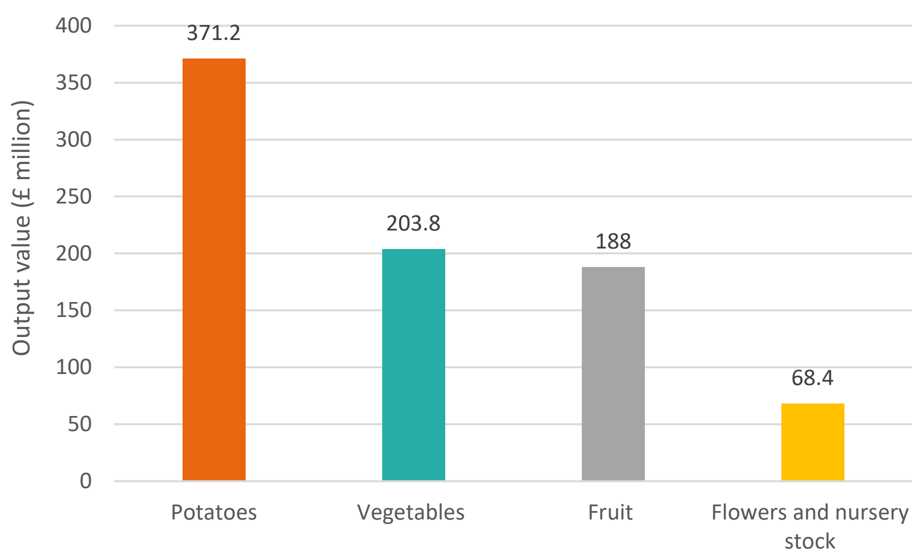

Figure 3: Output value Scottish potatoes and horticultural sectors, 2024 (Scottish Government, 2025b) Values represent farm output at current prices. Potatoes includes seed, ware and early potato production. Combined output from potatoes and horticultural crops accounted for approximately 54.5% of total Scottish crop output value in 2024 (Scottish Government, 2025b)

To complement published evidence, detailed interviews were conducted with 18 professional growers during Phase 2 of the research, with a further four growers engaged through stakeholder workshops in Phase 1 (total n = 22). Growers were selected to achieve broad representation across the sector, including variation in crop type, business size, and geographic location (including areas beyond the central belt (Appendix D)). This sampling approach aimed to capture a robust range of operational experiences and perspectives on peat-free feasibility.

6.1.1 Current transition status of Scottish growers

Across the professional growers interviewed, most remain in a peat-reduced phase rather than fully peat-free production. Peat continues to underpin commercial systems, although varying degrees of substitution with materials such as wood fibre, coir and composted bark were reported.

6.1.1.1 Ornamentals

All ornamental nurseries interviewed continue to use peat to some extent. Typical blends contain 50-70% peat for main crops, with wood fibre and coir serving as the principal alternatives. Propagation remains heavily reliant on peat-based media, often incorporating mineral components to modify drainage and structure. One micro-scale nursery reported fully peat-free production of herbaceous plants and grasses; however, they were unable to source trees, shrubs or aquatic plants that had not been propagated in peat, limiting their ability to eliminate peat entirely from their supply chain.

6.1.1.2 Trees for forestry and woodland

Among tree growers supplying forestry and woodland creation projects, two operate fully peat-free systems, while one uses a peat-reduced mix but could not specify the peat proportion at the time of interview. However, challenges remain: one peat-free grower was considering reverting to a 40% peat mix to mitigate crop losses, and another reintroduced a small proportion of peat in 2024 to address stalling growth in two species. In addition, externally sourced tree seed is sometimes stratified in peat prior to delivery, preventing complete removal of peat from the production chain.

6.1.1.3 Fruit

Fruit growers have made substantial progress toward peat-free production but expressed concern about reliance on coir as a primary substrate. Blueberries remain a notable exception due to their requirement for acidic growing conditions and are typically cultivated in a 50:50 peat-coir blend. Growers reported reluctance to reduce peat content further, citing potential risks to yield and fruit quality associated with substrate pH stability.

6.1.1.4 Mushrooms

Mushroom growers have also advanced toward peat-free production, with both businesses interviewed harvesting and marketing peat-free crops. However, transition remains at an early stage. Increased costs, reduced yields and smaller fruiting bodies were reported. As a result, both growers currently operate mixed production systems, combining peat-free and 100% peat-based substrates to maintain market supply while reducing overall peat use.

6.1.1.5 Potato mini-tubers

All surveyed potato mini-tuber growers have reduced peat use, operating at approximately 60–85% peat content. All three source media from the same manufacturer and supplement mixes with coir and wood fibre. Nevertheless, growers expressed caution about further reductions until high-performing alternative substrates are validated through trialling.

6.1.2 Scottish grower-led trials and experimentation

Despite continued reliance on peat overall, growers demonstrated a clear willingness to undertake on-site trials to advance peat-free production. These ranged from informal business-led experimentation to structured collaborations with researchers and growing-media manufacturers.

All eight interviewed ornamental growers had undertaken or were currently conducting trials, as were two of the three forestry tree producers. In the fruit sector, one large cooperative is trialling both novel materials and established peat substitutes as part of efforts to reduce reliance on coir as a primary substrate. All three mini-tuber producers reported engagement in internal or externally supported trials. Although both mushroom growers are already marketing peat-free crops, they described themselves as being in an ongoing learning phase, with further experimentation under way. Trial durations typically spanned one to three growing seasons, reflecting crop-specific requirements and the early stage of sector-wide transition. Trial length was frequently constrained by staff capacity and, in some cases, by cost.

Outcomes were mixed and highly crop-specific. Bedding plants, herbs, perennials and grasses generally performed well in peat-free blends incorporating wood fibre and coir. In contrast, ericaceous species and propagation-stage crops often exhibited reduced germination rates or weaker root establishment. Some growers reported that mixes containing more than 50% alternative materials were associated with reduced vigour or nutrient imbalance. Several also noted that successful transition required adjustments to irrigation and fertiliser regimes; however, these adaptations were not always implemented due to labour constraints and additional input costs. This suggests that performance outcomes depend as much on cultural and management adaptation as on substrate composition.

Despite variable results, growers consistently viewed trialling as essential to building technical confidence and practical experience. Smaller and more specialised nurseries reported greater flexibility in experimenting with new blends, whereas larger operations expressed caution due to the financial risk associated with large-scale crop loss. Encouragingly, a growing number of businesses have achieved marketable crops in fully peat-free media and continue to refine blends annually in collaboration with manufacturers. This iterative, grower-led experimentation reflects an emerging culture of innovation, even as challenges relating to media consistency, water management and cost remain.

Grower motivations for trialling and transition were shaped by a combination of anticipatory, market-driven and value-based factors. Many described experimentation as preparation for anticipated legislation, seeking to position themselves ahead of a potential peat ban. Others cited customer and supply-chain pressures, particularly from local authorities and retail groups requesting peat-free products. A smaller number framed transition as principle-led, aligned with internal sustainability commitments. Some growers also anticipated reputational or market advantages, although several reported that these had yet to translate into measurable commercial returns.

6.2 Current barriers

6.2.1 Barriers for professional growers

Stakeholder engagement identified a consistent set of barriers constraining professional growers' transition to peat-free production. These span financial, technical, regulatory and structural dimensions and affect businesses across scales and sectors. A detailed account is provided in Appendix P. Overall, these findings align with published research highlighting the economic and technical complexity of peat substitution (Bek et al., 2020; Koseoglu and Roberts, 2025).

Cost and resource pressures were the most frequently cited constraint. Peat-free and peat-reduced media were cited as typically 30-40% more expensive than peat-based products, reflecting higher freight, processing and input costs. While local authorities and retailers increasingly request peat-free plants, growers reported limited willingness within the supply chain to absorb higher prices. Rising fertiliser costs and increased water demand further compound financial pressures. Transition may also require capital investment in storage, handling and irrigation systems, and in some cases new machinery to accommodate bulkier or less uniform substrates.

Technical compatibility and consistency present additional challenges. Peat-free blends, particularly those containing high proportions of wood fibre, were reported to clog or compact unevenly in automated filling and transplanting equipment. Variability between batches – linked to raw-material sourcing or processing – was frequently cited as undermining crop consistency and confidence in performance. Some growers also reported reduced structural stability in wood-based substrates over longer production cycles.

Labour and productivity impacts were widely noted. Peat-free mixes often require closer monitoring, more frequent irrigation and adjustments to nutrient regimes. In some cases, crops such as lavender required up to an additional month to reach marketable size. These factors increase labour inputs and extend production timelines, creating particular strain for smaller nurseries operating on narrow margins.

Skills and knowledge gaps continue to impede progress. Several growers reported limited understanding of substrate composition and management requirements, contributing to inconsistent irrigation and feeding practices. Training provision in production horticulture was described as limited within Scotland, restricting access to specialist technical support.

Representation and communication barriers were also identified. Some participants felt underrepresented within existing trade bodies and disconnected from UK-wide initiatives. Membership costs, limited regional engagement and a perceived emphasis on retail rather than commercial production were cited as factors limiting participation.

Business scale and geography shape adaptive capacity. Smaller and more remote nurseries face higher transport costs, minimum-order constraints and restricted supplier choice. Without the purchasing power to commission bespoke blends, many rely on generic formulations that may not be optimised for their crop range or local climatic conditions.

Finally, **biosecurity and regulatory requirements** introduce additional complexity. Plant-health rules governing cross-border trade and the use of certain organic materials can limit access to suitable peat-free substrates. For example, UK-Northern Ireland trade arrangements restrict the re-entry of certain wood-fibre media, while PAS 100-certified composts are considered unsuitable for some crops, such as raspberries, due to pathogen risk. In contrast, some growers rely on alternative assurance schemes, such as Dutch RHP certification, which apply more specific controls for horticultural growing media.

6.2.2 Barriers for media manufacturers

Published evidence on barriers specific to manufacturers remains limited. However, stakeholder engagement and sector reports consistently identify material supply, infrastructure capacity, input quality, economic viability, and policy clarity as key constraints to scaling peat-free growing media production in Scotland and the wider UK. While demand for alternatives such as wood fibre, bark, coir, and composted green waste continues to increase, feedstock reliability, processing capacity, and regulatory certainty have not developed at the same pace. A detailed account of these barriers is provided in Appendix Q.

Material supply constraints were identified as a primary challenge. Although domestic bark arisings from UK forestry and sawmilling are substantial in aggregate volume, only a proportion consistently meets the quality, particle size, and phytosanitary standards required for professional growing media. Competition for suitable bark from other sectors e.g. bioenergy, further limits availability and contributes to price volatility. Wood fibre supply is subject to similar pressures, with processing capacity constrained and feedstocks dependent on forestry outputs and wider industrial market cycles. As a result, reliance on imported alternatives – particularly coir – reflects both quality specifications and cross-sector competition, rather than absolute domestic scarcity. Tightening biosecurity requirements for bark imports add further cost and logistical complexity.

Infrastructure and logistics limitations compound these constraints. Stakeholders highlighted that even where raw materials are available, UK capacity for grading, maturation, blending, and quality control remains insufficient to ensure consistent, high-quality substrates at scale. Materials such as digestate fibre require specialised processing and extended stabilisation periods, while the bulk density and storage requirements of wood fibre and composted materials increase capital and transport costs. Both the Growing Media Taskforce (2022) and Office for the Internal Market (2023) identify infrastructure investment as critical to achieving reliable, scalable peat-free production.

Input quality and standards were also cited as significant barriers. Manufacturers report variability in wood fibre and composted materials arising from differences in source material, processing methods, and contamination levels. Green waste contamination – including plastics and persistent herbicide residues – continues to undermine confidence in recycled inputs. The absence of harmonised grading systems and clearly defined technical standards was described as a structural gap in the sector. The reformed Growing Media Association (Bragg, N., 2025, pers. comm.; HortWeek, 2025a) is developing new technical frameworks; however, stakeholders emphasised that coordinated research, independent trials, and transparent performance data are required to validate materials and support wider adoption.

Economic constraints further limit supply chain resilience. Transitioning away from peat has increased production costs, driven by new machinery requirements, higher storage needs, and increased transport expenditure. Wood fibre processing may require capital investment of £500k–£2 million per facility (Growing Media Taskforce, 2022), while expanding processing capacity for peat-free inputs such as coir may require investment of approximately £0.8–£1.2 million per plant (Office for the Internal Market, 2023). Heavier alternatives such as composted green waste incur substantially higher transport costs because of their greater bulk density, historically estimated at up to around 90% higher than peat on a per-volume basis (English Nature and the Royal Society for the Protection of Birds, 2002).

Policy uncertainty was identified as a cross-cutting barrier. Manufacturers reported that the absence of clear, harmonised timelines for peat restrictions across UK nations constrains long-term planning and discourages capital investment in infrastructure and equipment.

6.2.3 Barriers for plant retailers

Plant retailers play a key intermediary role in the transition to peat-free horticulture, linking consumers, growers, wholesalers and manufacturers. However, they face intersecting supply chain, economic, behavioural and policy barriers that constrain both the availability and uptake of peat-free products. Around half of retail plant businesses surveyed by the Scottish Government (2023b) expected to be negatively affected by a peat ban, underscoring the sector's exposure to transition risks. Appendix R provides further detail.

Supply chain and infrastructure constraints were identified as a primary concern. Limited domestic processing capacity and inconsistent availability of peat-free growing media restrict the ability of some retailers to offer a fully peat-free product range. Larger businesses reported that shortages during peak trading periods could intensify competition for available volumes, potentially disadvantaging smaller outlets with less purchasing power (Office for the Internal Market, 2023). Storage and handling requirements present additional pressures. Peat-free media performance in storage varies by formulation, and trade guidance indicates that prolonged storage of bagged peat-free compost can lead to quality deterioration. Dry, covered storage and faster stock turnover are therefore recommended, potentially increasing space, handling and cost demands – particularly for smaller retailers.

Economic pressures further constrain progress. Peat-free growing media were reported by stakeholders to be approximately 30-40% more expensive than peat-based equivalents, with several retailers indicating that they absorb part of this differential to maintain competitive pricing. Smaller independent businesses, lacking the purchasing leverage of national chains, may be particularly exposed to input price volatility. Consumer price sensitivity reinforces these pressures: affordability remains a primary reason cited for continued peat use (Koseoglu and Roberts, 2025). In some cases, imported peat-based products remain cheaper than domestically produced peat-free alternatives, creating competitive imbalance within the retail market.

Quality and consistency concerns were also raised. Retailers reported variability in nutrient balance, pH, moisture retention and contamination within peat-free products. Trials conducted by the Stockbridge Technology Centre (HortWeek, 2025b) identified variability in the performance of retail media samples. Inconsistent product performance can generate negative customer feedback, reduce repeat purchases and undermine confidence. Retailers also noted that some peat-free plants may require more attentive irrigation management, increasing display maintenance demands.

Cultural and consumer barriers compound these practical challenges. Although surveys indicate that many consumers express a preference for peat-free options, this is not consistently reflected in purchasing behaviour (Dahlin et al., 2019; Office for the Internal Market, 2023). Retailers described a gap between environmental intention and consumer action, with some customers remaining sceptical regarding peat-free compost performance or perceiving it as less reliable. While experienced or sustainability-motivated gardeners often adapt successfully to peat-free systems, general awareness of best practice remains limited. Time constraints during peak seasonal trading reduce opportunities for customer education, though collaborative initiatives involving retailers, growers and manufacturers seek to address this through outreach and guidance materials (Horticultural Trades Association, n.d.).

Policy and standards gaps were identified as an additional barrier. Retailers reported that the absence of a unified certification or labelling framework for peat-free media allows wide variation in quality and environmental claims, complicating procurement decisions and consumer communication. Regulatory divergence between domestic and international markets was also highlighted: imported plants grown in peat are not currently subject to equivalent restrictions, potentially creating competitive imbalance. Clearer labelling, consistent enforcement and harmonised standards were identified as measures that could strengthen market confidence and support transition.

6.2.4 Sector and crop specific barriers

The transition to peat-free production is not uniform across horticulture; certain crop groups and production systems present distinct and heightened barriers, examined in greater detail in Appendix S.

Ericaceous crops – including rhododendrons, heathers and blueberries – are technically challenging to produce without peat due to their adaptation to acidic, low-nutrient soil conditions. Commercial grower monitoring in the UK identifies acid-loving ericaceous crops among those most difficult to transition away from peat (Koseoglu and Roberts, 2025). Growers cautioned that a rapid or inflexible ban could reduce plant diversity and limit the availability of specialist cultivars. These concerns are economically significant: Scotland is a major contributor to the UK berry sector, which generated an estimated £624 million in Gross Value Added (GVA) in 2023, with blueberries one of the four principal berry crops alongside strawberries, raspberries and blackberries (HortiDaily, 2025).

Experimental evidence in ericaceous systems indicates that peat-free components such as coir can support plant growth in bark-based substrates, although performance, nutrient dynamics and pH stability remain highly formulation- and management-dependent and must be considered alongside wider sustainability considerations (Kingston et al., 2020; Scagel, 2003). Industry trials have also reported encouraging results: a recent commercial peat-free trial of Inkarho rhododendrons demonstrated that well-formulated peat-free mixes can achieve satisfactory growth and quality under nursery conditions (HortWeek, 2025d).

Potato mini-tuber production – a foundational stage of the UK seed potato industry – presents distinct structural and biosecurity constraints. Scotland accounts for approximately 75% of Great Britain’s certified seed potato area, positioning it as a cornerstone of the UK seed potato supply chain (Thomson, 2024).The sector contributes substantially to the rural economy and underpins both domestic ware production and export markets. Production operates under stringent certification and plant health regimes, overseen by statutory authorities, to maintain Scotland’s high-health status and minimise the risk of pathogen introduction and spread (Scottish Government, n.d.). Within this tightly regulated context, growers are highly risk-averse to changes that could compromise crop uniformity, traceability or disease status.

Research demonstrates that substrate physical properties are critical determinants of tuber number, size uniformity and overall crop performance in controlled mini-tuber systems (McGrann et al., 2020). Variability in alternative substrates can therefore affect operational reliability in a production model where consistency is paramount. Growers reported concerns regarding handling characteristics and perceived biosecurity risks associated with unfamiliar peat-free media. While definitive evidence linking peat-free substrates to increased pathogen transmission remains limited, recent analysis highlights uncertainty around the provenance, processing and sanitisation of some peat-free constituents, reinforcing caution in high-value seed systems (Litterick et al., 2025). Higher substrate costs and limited downstream market demand for peat-free seed production were also cited as barriers, particularly within a specialised sector with limited leverage over input suppliers.

Propagation represents one of the most technically sensitive stages in peat-free cultivation across multiple crop types. Successful germination and early root development depend on tightly controlled substrate physical properties, including moisture retention, aeration, structural stability and nutrient buffering (Gruda, 2019; Schmilewski, 2008). Evidence from both academic studies and industry trials indicates that variability in peat-free constituents – particularly wood fibre and compost-based materials – can affect water dynamics and nutrient availability during early growth stages, increasing management sensitivity (Koseoglu and Roberts, 2025; Litterick et al., 2025). These challenges are especially pronounced in fine-seeded crops and pressed block systems, where structural cohesion and uniform moisture distribution are critical.

Peat-based plugs and liners remain widely used within UK propagation supply chains, and a substantial proportion of young plants are sourced from overseas production systems that continue to rely on peat-containing media (Office for the Internal Market, 2023). This constrains short-term full substitution at nursery level, even where domestic growers are transitioning. Targeted research into peat-free blocking systems highlights the technical complexity involved:

trials in vegetable propagation have demonstrated that achieving sufficient block strength, stability during handling and consistent water distribution requires careful optimisation of fibre composition and processing (Eyre et al., 2022). Practical on-farm evaluations similarly report variability in cohesion and transplant performance in peat-free blocks, reinforcing the need for further refinement (Walker and Litterick, 2024). Ongoing research programmes, including work led by Coventry University (2023) aim to address these structural and performance constraints; however, growers emphasise the need for coordinated commercial-scale trials, clearer regulatory alignment and targeted investment to reduce technical and financial risk.

6.2.5 Evidence of viability in peat-free systems

Although significant technical and structural barriers persist in certain sectors, evidence from both stakeholder experience and published research indicates that peat-free production is already functioning effectively across a range of horticultural systems.

Peer-reviewed studies demonstrate that well-formulated peat-free substrates can achieve plant growth and quality comparable to peat-based media in ornamental and edible crops, provided irrigation and nutrient regimes are appropriately adapted (Gruda, 2019; Maher et al., 2008; Schmilewski, 2008). Recent UK-based trials similarly report satisfactory performance in container-grown systems following refinement of fertilisation and water management practices (Litterick et al., 2025; Royal Horticultural Society, 2024).

Performance outcomes appear to vary by crop type and production duration. Short-cycle crops, including bedding plants, grasses and herbaceous perennials, were widely regarded by stakeholders as comparatively lower-risk during transition, although successful establishment following planting may depend on appropriate irrigation management. Limited growing time in the substrate reduces exposure to longer-term structural degradation or pH drift, and rapid turnover minimises financial risk associated with media experimentation. Substrates incorporating bark or wood fibre typically exhibit higher air-filled porosity and improved drainage relative to peat (Gruda, 2019); for species adapted to well-drained conditions, including alpines and certain Mediterranean-origin plants, growers reported equivalent or improved performance under peat-free regimes.

Beyond agronomic outcomes, several businesses identified reputational and market alignment benefits. Growing public concern regarding peatland degradation and climate impacts has increased scrutiny of peat use in horticulture (Scottish Government, 2023b). Early adoption of peat-free systems was described by some growers as strengthening environmental credentials and supporting brand differentiation.

These findings indicate that transition feasibility is uneven across crop types and production systems. While long-cycle and mechanically intensive systems face greater constraints, many ornamental and short-cycle crops are already being produced successfully without peat. This heterogeneity reinforces the need for proportionate, sector-specific transition strategies.

7 What might support a successful transition for the horticultural industry in Scotland?

7.1 Standards for growing media

7.1.1 Evidence of need: confidence, consistency and risk

Stakeholder engagement, consultation responses and published research identify variability in peat-free growing media as a structural barrier to transition. Across professional horticulture, retail and supply chains, there was broad agreement that legislative restriction alone is unlikely to deliver reliable substitution without strengthened quality assurance (see Appendix T for more detail).

Responses to the "Ending the sale of peat in Scotland" consultation (Scottish Government, 2023b) linked inconsistent crop performance to variability in raw materials, processing standards and quality control; similar concerns were raised in England and Wales (Department for Environment, Food & Rural Affairs, 2022). One growing media organisation reported mortality rates of up to 30% in lime-sensitive species when raised on poorly buffered substrates, illustrating the commercial consequences of inadequate formulation or testing.

Published literature supports these findings. Alternative materials such as wood fibre, composted bark and coir can perform comparably to peat but require careful processing and formulation to ensure consistent physical and chemical properties (Gruda, 2019; Schmilewski, 2008). Variability in particle size distribution, salinity, pH buffering capacity and biological activity is particularly consequential in propagation systems, where tolerance for error is low (Gruda, 2019). Recent UK research has further highlighted calls for clearer national sanitisation standards and routine pathogen testing within a formal quality framework (Litterick et al., 2025).

While PAS 100 provides quality benchmarks for composted materials (Waste and Resources Action Programme, 2016), no harmonised UK-wide standard governs the full range of peat-free constituents or finished-product performance.

7.1.2 Sector specific requirements

Although support for strengthened standards was consistent, stakeholder requirements vary according to crop sensitivity, production system and biosecurity exposure. Table 6 summarises sector-specific risk profiles and corresponding standardisation needs.

Table 6: Sector-specific standardisation requirements to support peat-free transition

Sector/system	Primary risks	What is going wrong?	What kind of standard would help?
Professional growers (all)	Reduced efficiency and increased production risk	Inconsistent crop performance, machinery compatibility issues, greater sensitivity to irrigation and nutrient management.	Clear minimum performance standards for finished growing media (e.g. physical structure, stability, nutrient buffering and water-holding capacity).
Media manufacturers	Variable raw materials and contamination	Differences in input quality (wood fibre fines, compost maturity, contamination) affecting consistency.	Defined processing standards, contamination limits, input traceability requirements.
Plant retailers	Customer complaints and loss of trust leading to loss of income	Inconsistent product performance and differences between retail and professional grades.	Clear labelling and certification to distinguish tested, quality-assured products.
Ericaceous crops	Crop failure over long growing cycles	pH drift and nutrient instability affecting plant health over time.	Crop-specific performance thresholds (pH buffering capacity and low-salinity limits).
Potato mini-tuber systems	Biosecurity and yield loss	Uncertainty over pathogen status and inconsistent moisture retention affecting tuber development.	Mandatory sanitisation and pathogen testing, alongside defined water-holding performance benchmarks.
Propagation (seed systems)	Poor germination and early losses	Rapid surface drying and uneven moisture in fine-seeded trays.	Defined moisture retention and particle size standards for propagation media.
Plug plant supply chains	Limited control over substrate used in young plants	Many plugs are sourced from external or overseas propagators using peat-based media, with restricted choice due to licensing and supply arrangements.	Traceability and disclosure requirements for plug media composition, alongside incentives for peat-free propagation capacity.
Pressed growing block systems	Incompatibility with mechanised production systems	Peat-free blocks may lack strength and moisture stability for reliable mechanical transplanting, requiring more frequent irrigation and increasing nutrient loss.	Defined performance standards for block strength, cohesion and moisture retention under mechanised handling conditions.

Ornamental nurseries emphasised reliability in propagation and plug production. As one large tree and shrub nursery stated, “One bad load of compost can set you back a season – if the roots don’t take, you’ve lost that crop window.” Participants called for defined thresholds relating to particle size distribution, structural stability and microbiological status.

Soft fruit producers, many of whom have adopted coir-based systems, expressed concern regarding variability in buffering and salinity management. “Coir works for us, but only if it’s treated right,” noted one grower. Standards ensuring consistent processing and transparent sourcing were viewed as essential.

Potato mini-tuber systems adopted a more precautionary position, emphasising biosecurity and sterility as non-negotiable. Stakeholders questioned whether a single generic standard would adequately reflect pathogen sensitivity thresholds in high-risk systems.

Growing media manufacturers advocated segmentation between amateur and professional markets, reflecting tighter performance tolerances in commercial propagation and mechanised systems.

These perspectives indicate that any standards framework must accommodate differentiated performance thresholds rather than assume uniform risk tolerance across sectors.

7.1.3 Implementation models and pathways

Stakeholders identified both international reference models and emerging UK initiatives that could inform implementation. Several participants pointed to the Dutch RHP certification scheme as an example of structured quality assurance. RHP certifies raw materials and finished growing media products against defined and regularly updated quality standards covering physical, chemical and biological parameterrs – including water uptake, air content, pH, electrical conductivity and nutrient status – applied across the production chain. Stakeholders emphasised that the scheme’s value lies in its combination of technical thresholds, traceability and independent verification. As one ornamental grower observed, certification provides “a baseline – if it’s certified, you know what you’re working with.”

Workshop discussions outlined practical components of a potential UK-aligned pathway:

- Establish defined parameter bands for key constituents and finished products, including contaminant and microbiological thresholds.
- Require batch-level testing and documented growth trials, subject to third-party audit.
- Differentiate standards between amateur and professional markets.
- Introduce a recognisable certification mark linked to transparent compliance criteria.
- Implement structured monitoring to assess the impact of standards on peat reduction rates.

Industry coordination is advancing. The regrouped Growing Media Association has initiated development of a PAS-style specification drawing on PAS 100 and PAS 110 (HortWeek, 2025a). According to stakeholders, the draft includes chemical, physical and microbiological testing parameters, defined target ranges and documented growth testing, with independent audit and corrective timelines.

7.1.4 Governance implications

Interview evidence indicates that stakeholder confidence is closely linked to the credibility and coordination of any standards framework. Voluntary guidance alone was widely viewed as insufficient; independent oversight and transparent verification were considered central to supporting trust in peat-free media.

Participants stressed the importance of UK-wide alignment to avoid market fragmentation, while ensuring Scottish priorities are reflected in emerging PAS-style developments. Structured knowledge exchange - including dissemination of certified product data and crop-specific guidance for high-risk systems - was identified as an important complementary measure.

Overall, stakeholder evidence suggests that effective standards will depend not only on technical specification, but on governance clarity, coordination across administrations and credible independent verification. Standards were therefore framed as an enabling mechanism within the wider peat-free transition, rather than an end point in themselves.

7.2 Growing trials

In this context, a horticultural growing trial refers to a structured comparison of alternative growing media under commercial production conditions, typically assessing crop performance, physical and chemical substrate properties, and operational compatibility over defined crop cycles.

7.2.1 National trial activity and capacity constraints

Evidence from stakeholder engagement and national initiatives indicates broad recognition that structured trials are essential to reducing technical risk in peat-free transition. However, commercial growers reported significant constraints in conducting robust trials independently, citing limitations in time, staffing and data-logging capacity. Several interviewees described running meaningful comparative trials as “almost a full-time job,” noting reliance on in-house agronomy rather than external research support.

The need for structured trial support has been shaped in part by the long-standing policy trajectory toward peat reduction. In 2011, the UK Government set a voluntary target to phase out peat use in professional horticulture by 2030 (HM Government, 2011). Stakeholders emphasised that pursuing this transition without coordinated trial programmes increases commercial exposure. Participants expressed willingness to trial alternative media where external agronomic expertise, supervision and data analysis were available, highlighting the importance of partnership models rather than isolated experimentation.

Views differed regarding optimal trial design. Some growers favoured on-site trials, arguing that microclimatic conditions, irrigation systems and machinery compatibility are highly site-specific. Others supported centralised research-led trials, citing benefits such as biosecurity control and methodological consistency. Across sectors, however, there was agreement that trials must be conducted at commercially meaningful scale; small-plot experiments were widely considered insufficient to influence decision-making.

Several UK initiatives provide relevant models. The AHDB-ADAS CP138 project combined predictive modelling with on-site grower demonstrations, identifying both opportunities and constraints in peat substitution (Agriculture and Horticulture Development Board, 2019). More recently, the Royal Horticultural Society's Transition to Peat-Free Fellowship (launched in 2022) represents the largest coordinated UK trial programme to date. The five-year project partners the RHS, Defra and commercial media suppliers with multiple nurseries to test peat-free formulations across diverse crop groups, including ericaceous and other traditionally sensitive plants. Interim findings indicate that peat-free media can perform comparably to peat under standard irrigation regimes in several nursery settings, with final results expected in 2027 (Royal Horticultural Society, 2024; n.d.).

7.2.2 Priority crops and technical evidence gaps

Stakeholder engagement identified specific crop categories where technical uncertainty remains high and where targeted, crop-specific trials were viewed as a priority.

Ericaceous ornamentals (including rhododendrons, azaleas and heathers) were frequently cited. While short-term trials have demonstrated encouraging performance in peat-free systems (HortWeek, 2025d), growers expressed uncertainty regarding long-term pH stability and nutrient buffering over extended production cycles.

Propagation systems emerged as a consistent priority. Stakeholders emphasised the need for focused trials on plug plants and growing blocks, where physical cohesion and moisture stability are critical to mechanical transplanting and uniform root development. As one specialist noted, peat substitutes must be sufficiently cohesive to support blocking systems without crumbling during handling.

Potato mini-tuber production, however, was identified as a distinct and higher-risk category requiring targeted investigation. Given Scotland's central role in certified seed potato production and the sector's stringent biosecurity and traceability requirements, growers described substrate reliability and pathogen control as non-negotiable. Research demonstrates that substrate physical properties directly influence tuber number, size uniformity and crop performance in controlled systems (McGrann et al., 2020). Stakeholders therefore emphasised the need for dedicated commercial-scale trials to evaluate peat-free media under certified mini-tuber production conditions.

Several **niche crops** adapted to Scottish conditions – including short-lived perennials such as *Meconopsis* – were also flagged as requiring bespoke trial design, particularly where moisture sensitivity is pronounced. More broadly, stakeholders emphasised that priority should be given to crop systems that remain dependent on specific physical and chemical properties traditionally provided by peat. Ongoing national initiatives are testing a number of these sensitive groups, including carnivorous plants.

7.2.3 Support mechanisms and coordination considerations

Stakeholder engagement highlighted that future Scottish trial activity should build on existing UK initiatives rather than duplicate them. Several participants suggested formal Scottish participation within established programmes – for example, extending the Royal Horticultural Society’s peat-free trial network to include Scottish-coordinated sites – to ensure representation of local climatic and production conditions.

Interviewees emphasised that trial participation requires structured support. Suggested mechanisms included financial assistance for host nurseries, provision of agronomic expertise to design and monitor experiments, and training in data collection and analysis. Some growers proposed a “trial facilitator” model, whereby an industry-funded agronomist supports multiple nurseries with experimental setup and data logging, reducing individual administrative burden.

Clear dissemination of findings was repeatedly identified as essential. While national initiatives have produced reports and resources, stakeholders expressed concern that results are not always easily comparable across crop types and systems. Participants suggested that a coordinated Scottish knowledge platform could consolidate certified trial data, case studies and technical guidance.

Key stakeholder-identified actions include:

- Embed commercial-scale trials within existing UK frameworks, ensuring Scottish sites are included where relevant to capture regional conditions.
- Provide technical and financial support for host nurseries, including access to agronomic expertise and structured data collection.
- Prioritise crop systems identified as high risk, including ericaceous species, propagation and potato mini-tubers.
- Facilitate peer-to-peer learning, through field demonstrations, workshops and structured mentoring between early adopters and other growers.

Across interviews, stakeholders characterised the current constraint less as unwillingness to transition, and more as residual uncertainty in specific systems. Structured, collaborative trials were viewed as mechanisms to generate transferable evidence under commercial conditions. Trial outcomes were also viewed as providing an empirical foundation for the refinement of future growing media standards.

7.3 Enabling conditions for industry transition

While standards (Section 7.1) and structured trials (Section 7.2) address technical uncertainty and product consistency, stakeholder engagement identified a broader set of enabling conditions that influence the pace and stability of peat-free transition. These relate to financial exposure, feedstock availability, regulatory frameworks and knowledge infrastructure. Progress in these areas was viewed as necessary to enable sustained commercial uptake.

7.3.1 Financial and infrastructure considerations

Stakeholders emphasised that transition carries both capital and operational cost implications. Survey evidence from UK growers suggests that fully peat-free growing media may cost approximately 15-25% more per cubic metre than peat-reduced alternatives (Royal Horticultural Society, 2023), although reported differentials vary by crop type and contract structure. Additional costs may arise from equipment modification, irrigation adjustments, storage infrastructure and staff training. Several participants indicated that targeted, time-limited financial mechanisms – including capital grants, transitional funding or co-funded research participation – could reduce early-adopter risk in sectors operating under tight margins (Royal Horticultural Society, 2023). These suggestions were framed as short-term adjustment support during market transition rather than long-term subsidy dependence.

Feedstock competition was identified as a structural consideration. Participants noted increasing demand for wood-based materials across sectors, particularly between growing media manufacturers and biomass energy producers. Formal analysis of peat-policy impacts has similarly reported cross-sector competition for wood residues used in biomass fuel production (Office for the Internal Market, 2023). UK biomass market data indicate that the country is a major importer and consumer of wood pellets for electricity and renewable heat generation (Department for Energy Security and Net Zero, 2023), indicating that demand from the energy sector may influence the availability and pricing of wood residues and by-products used in peat-free growing media formulations.

7.3.2 Regulatory and supply chain constraints

Access to suitable alternative feedstocks is influenced by waste classification systems, contamination thresholds and approval processes. Stakeholders reported that regulatory complexity can delay or deter the use of secondary materials, including anaerobic digestate and recycled wood products, limiting domestic diversification of inputs.

In parallel, concerns were raised regarding contamination in green waste streams, particularly where contractual clauses permit low levels of non-organic material. Variability in compost quality affects manufacturer confidence and restricts its suitability for sensitive applications. Stakeholders suggested that clearer guidance, proportionate review of waste classifications and strengthened enforcement of contamination standards could improve supply reliability, subject to environmental safeguards.

These issues highlight that peat-free transition is not solely a matter of product reformulation, but also of regulatory coherence and supply chain infrastructure.

7.3.3 Knowledge, education and applied research gaps

Beyond crop-specific trials, stakeholders identified broader knowledge gaps affecting implementation. These include:

- Limited long-term, Scotland-specific performance data across diverse crop systems.
- Incomplete quantification of transition costs across different production scales.

- Insufficient applied guidance on irrigation, fertiliser regimes and storage management for peat-free media.
- Uneven access to structured training and peer-to-peer knowledge exchange.

While research is ongoing at UK level, participants emphasised the importance of accessible, crop-specific best-practice guidance and coordinated dissemination mechanisms. Structured knowledge exchange was viewed as complementary to standards and trials, enabling technical learning to translate into operational confidence.

7.3.4 Coordination and policy coherence

Across interviews and survey evidence, stakeholders framed peat-free transition as a system-level adjustment rather than a single technical substitution. Standards, trials, feedstock supply, infrastructure investment and training were described as interdependent components of a stable transition pathway.

Effective coordination across administrations and sectors was therefore viewed as important not only for regulatory clarity, but for maintaining supply-chain confidence and market competitiveness during adjustment. Stakeholders did not characterise the primary constraint as unwillingness to transition, but rather as exposure to uneven implementation conditions across crops and supply chains.

In this context, government’s role was framed as enabling coherence across these domains – ensuring that technical progress, market signals and regulatory frameworks operate in alignment. Stakeholders therefore characterised successful transition not as a question of technical feasibility, but of coordinated implementation across the wider horticultural system.

8 Feasibility and sequencing of transition in Scotland

The evidence presented in Sections 5-7 shows that peat-free growing media are already working in parts of Scottish horticulture. Many ornamental crops, short-cycle plants and some forestry systems are being produced successfully in peat-free or significantly peat-reduced substrates. However, full removal of peat across all sectors will take time and will not progress at the same pace in every crop group. Feasibility is therefore not a single question. It depends on three main factors:

- Time needed for manufacturers to expand reliable supply of alternatives.
- Time needed for growers to test and validate new mixes under commercial conditions.
- Degree of policy alignment across the UK.

Taken together, these factors suggest that transition is achievable, but that sequencing and coordination will be critical.

8.1 Infrastructure and validation lead time

Media manufacturers require time to increase processing capacity for key materials such as wood fibre and composted bark. Installing new refiners, dryers and screening equipment can take two to three years. Expanding production of high-quality compost with consistently low contamination may take three to five years, particularly where additional quality controls are needed. Emerging materials, such as farmed *Sphagnum*, are likely to require longer development periods before they can contribute at commercial scale (c.5-10 years).

Growers also need time. Most businesses test new growing media over several seasons before adopting them fully. This reflects biological cycles rather than reluctance to change. Crops must be assessed for germination, root development, growth rate, yield and long-term health. For short-cycle ornamental crops, two to three growing seasons may be sufficient. For longer-cycle crops such as shrubs, trees, blueberries and some fruit crops, growers commonly require five years or more to confirm reliable performance.

High-biosecurity systems, particularly potato mini-tuber production, present the longest adaptation horizon. These systems operate under strict certification requirements and low tolerance for variation in substrate performance. Growers reported that multi-year validation would be essential before complete peat removal could be considered. In these sectors, shorter timelines were viewed as commercially high risk.

These lead times are therefore driven by infrastructure investment cycles and biological validation requirements, rather than by lack of technical potential.

8.2 Variation across crop systems

The transition does not affect all sectors equally. Retail growing media is already largely peat-free, and many ornamental producers have significantly reduced peat use. In the soft fruit sector, most Scottish berry production (with the exception of blueberries) is already peat-free, typically using coir-based systems. This shows that peat-free production can work at commercial scale. However, coir is imported and associated with transport emissions and wider environmental impacts. It is a functional alternative to peat, but not an environmentally neutral one.

In contrast, ericaceous crops, blueberries and other acid-demanding species remain more dependent on peat due to pH stability and nutrient-buffering requirements. While peat-free systems are being trialled, long-term performance under commercial conditions requires further validation.

Propagation systems, including plugs and pressed growing blocks also present technical sensitivity. These systems depend on precise moisture retention, particle size and structural cohesion. Although progress is being made, growers emphasised the need for continued trialling and refinement.

This unevenness suggests that a single, uniform timetable may not reflect sector realities. A phased approach that recognises crop-specific constraints would better align with the evidence presented in earlier sections.

8.3 UK alignment and competitive considerations

Several stakeholders raised concerns about moving significantly ahead of the rest of the UK. If peat-grown plants or peat-based growing media remain available in other nations, Scottish producers could face higher production costs while competing in shared markets. In addition, young plants and plugs are often sourced from outside Scotland, and in some cases from overseas production systems that continue to use peat. Without UK-wide alignment, full removal of peat at nursery level may be constrained by upstream supply chains. These issues do not undermine the case for transition. However, they highlight the importance of policy coordination and clarity to avoid unintended competitive disadvantage or carbon displacement.

8.4 Indicative phasing

Based on stakeholder evidence and the technical analysis presented earlier in this report, a broadly phased pattern of transition can be identified:

- Retail and amateur markets are closest to full peat removal.
- Mainstream professional crops, including many ornamentals and forestry plants, are capable of substantial further reduction in the medium term, subject to continued infrastructure expansion and trial validation.
- High-sensitivity systems, including potato mini-tubers, certain propagation systems and ericaceous crops, are likely to require longer validation periods before complete peat substitution is commercially secure.

These phases are indicative rather than prescriptive. The precise pace of change will depend on infrastructure investment, research outcomes, standards development and UK policy alignment.

8.4.1 Indicative time horizons by sector

Stakeholder evidence provides a clearer picture of the likely time required for different parts of the industry to transition fully away from peat. Figure 4 illustrates how these sector-specific timelines translate into indicative transition windows from 2026 onwards. These estimates reflect infrastructure lead times, crop testing cycles and normal equipment replacement schedules. They are indicative and based on reported industry experience rather than fixed commitments.

Growing media manufacturers

Manufacturers highlighted that expansion of domestic processing capacity cannot occur immediately. The following timelines reflect capital investment cycles and regulatory approval processes. They relate only to those materials for which stakeholders provided specific evidence on infrastructure lead times during engagement. Not all alternative materials assessed elsewhere in this report were discussed in comparable detail in relation to scaling timelines.

- **Wood fibre and composted bark:** typically 2-3 years to install additional refining, drying and screening equipment. Availability of horticultural-grade fine bark remains a constraint.
- **Composted green waste:** 3-5 years to establish consistently low-contamination, PAS-100 compliant production lines at scale.
- **Digestate-derived materials:** 3-4 years of further research, pilot work and process refinement to manage ammonium levels and ensure consistent product quality.
- **Coir:** supply chains are established but remain import-dependent and subject to quality variability.
- **Farmed *Sphagnum*:** stakeholders suggested 5-10 years before commercial-scale volumes could realistically be available in Scotland, subject to cost, sterilisation and land-use considerations.

Grower sub-sectors

Time needed for adoption varies significantly by crop type and production system.

- **Retail and amateur markets:** largely peat-free already; remaining transition expected within 1-2 years based on current trends.
- **Ornamental growers:** small growers reported that 2-3 growing seasons may suffice. Larger operations anticipate 5-10 years where machinery modification or infrastructure redesign is required.
- **Tree growers for forestry and woodland:** smaller producers indicated rapid adaptation is possible if suitable substrates are available; larger nurseries suggested 3–5 years to trial mixes under site-specific conditions.
- **Fruit and vegetable growers:** Strawberries and raspberries are largely peat-free already (coir-based systems). Blueberries and other longer-cycle fruit crops require extended validation, often beyond 5 years. Vegetable growers commonly cited around 5 years as a realistic planning horizon, subject to secure material supply.
- **Potato mini-tuber growers:** the most cautious sector. Stakeholders suggested that full conversion of facilities could require up to 10 years, reflecting biosecurity requirements, multi-season validation and certification constraints.
- **Ericaceous crops:** stakeholders indicated that longer timelines are likely, potentially within the 5–10 year horizon identified for high-sensitivity systems, reflecting ongoing challenges in achieving stable low-pH, peat-free systems at scale.

Overall pattern

Taken together, stakeholder evidence suggests a broadly phased trajectory beginning around 2026:

- Short term (1-2 years): Retail markets and low-risk systems complete transition.
- Medium term (3-5 years): Mainstream professional crops achieve substantial reduction, supported by expanded processing capacity and validated blends.
- Longer term (5-10 years): High-sensitivity and high-biosecurity systems transition once multi-year evidence confirms performance and reliability.

These time horizons are contingent on infrastructure expansion, standards development, coordinated trials and UK policy alignment. Timeframes are indicative and assume transition commencing in 2026.

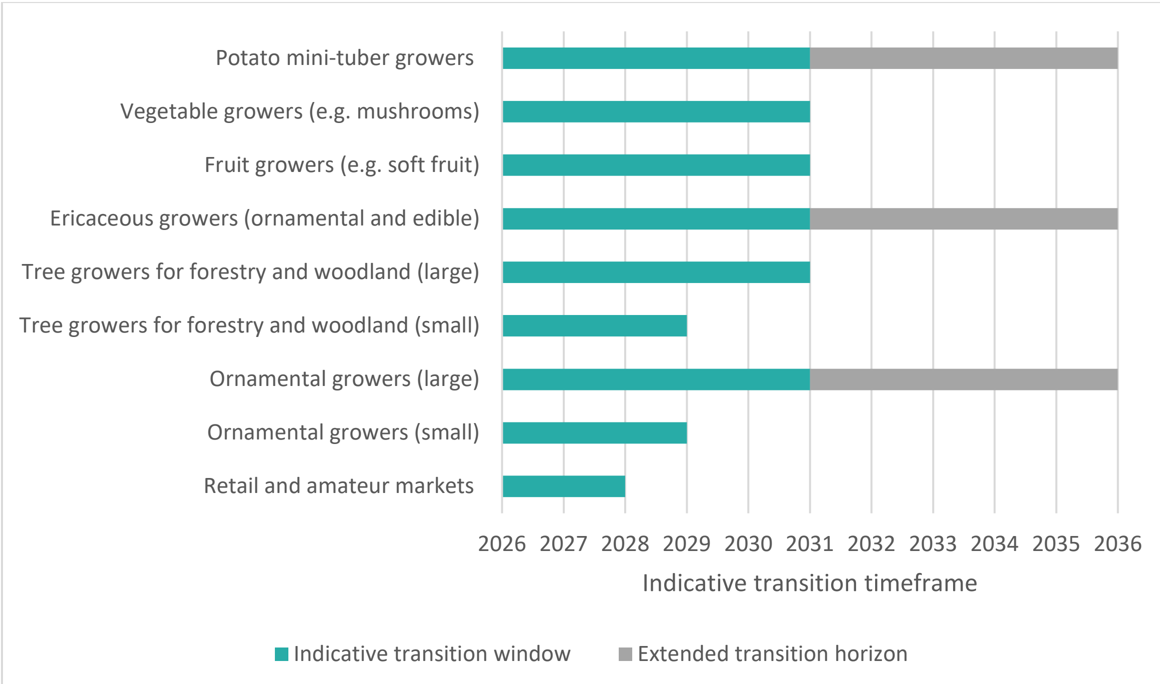

Figure 4: Indicative stakeholder-informed timelines for peat-free transition across grower sub-sectors. Teal bars indicate the earliest feasible transition window reported by stakeholders. Grey extensions show potential additional time required where technical or infrastructure constraints persist. Timelines are illustrative planning horizons rather than forecasts of when peat use will cease.

8.5 Conditions for effective transition

Across all sectors, stakeholders consistently emphasised that successful transition depends on coordinated implementation rather than isolated action.

Key enabling conditions include:

- Clear and consistent quality standards for peat-free media;
- Structured, commercially meaningful growing trials;
- Reliable domestic processing capacity;
- Access to technical guidance and workforce training;
- Clarity and alignment of policy across the UK.

Where these conditions are in place, evidence suggests that peat-free production can operate effectively. Where they are absent, technical uncertainty and commercial risk increase.

Overall, the feasibility of transition in Scotland is therefore best understood as a question of sequencing and coordination rather than of technical possibility. The industry has demonstrated willingness to adapt. The remaining challenge lies in aligning infrastructure, standards, research and policy to support consistent and economically stable implementation.

9 Conclusions

This research examined the technical, environmental, social and economic evidence on alternatives to horticultural peat in Scotlandthrough a literature review, workshops and 46 stakeholder interviews.

No single material fully replicates peat, which has a unique mix of physical, chemical and biological properties. However, stakeholder evidence consistently shows that well formulated blends – notably those based on wood fibre, composted bark and coir – already support commercial production, while others show strong development potential.

Some types of growing, particularly soft fruit production, rely on imported materials. This increases transport emissions and can create supply-chain risks, which may affect long-term environmental and economic resilience. The main challenge is therefore not a lack of alternatives, but ensuring consistent performance through effective blending of materials, suitable infrastructure, clear quality standards and adapted crop management. Across the UK, the supply of leading alternatives exceeds remaining peat use. Wood fibre alone could replace current peat use. However, a reliable supply depends on having enough processing capacity, clear grading standards and the ability to manage competition from other sectors for raw materials, as well as effective transport systems. Supply therefore depends less on whether raw materials exist, and more on investment, quality control, and coordination across the market. In the longer term, Scotland could improve environmental performance and strengthen supply security by reducing its reliance on imported materials.Different parts of the sector can move away from peat at different speeds. Retail growing media and many ornamental growers have made substantial progress in reducing peat use. Soft fruit growers operate successfully using coir-based systems for most crops, with the exception of blueberries. In contrast, some systems are more difficult to change, including ericaceous (acid-loving) crops, potato mini-tubers, and certain propagation systems. These systems face distinct challenges. Potato mini-tuber production operates under strict biosecurity (plant health) and certification requirements. Ericaceous crops require stable low-pH conditions across growing cycles. Propagation systems depend on highly controlled moisture balance and media structure during early growth stages. These differences reflect that the transition involves adapting production systems, not simply replacing one material with another. Stakeholders did not indicate resistance to change, but highlighted commercial risks where performance is uncertain.

The success of a peat-free transition depends on careful planning and realistic timing. It takes time to develop infrastructure– typically 2-5 years for core materials and longer for emerging alternatives such as farmed *Sphagnum*. Crop production cycles and the need to test over several seasons can take additional time – up to 5–10 years for large or sensitive systems. A single timeline for the whole sector would not reflect these differences, so a phased approach based on evidence and experience is more practical.

Overall, the evidence indicates that Scotland can move to peat-free growing. The speed of change will depend not on technical limits but on strong coordination, clear policy direction and building confidence through standards and collaboration. With the right planning, investment and alignment across the sector, Scotland can phase out peat while maintaining production and a reliable supply. The transition also offers an opportunity to protect peatlands, strengthen local recycling and reuse of materials, and support a more resilient and sustainable horticulture sector.

9.1 Next Steps

- Stakeholder feedback highlights several key factors that will affect the pace and success of a peat-free transition across the Scottish horticulture sector.**Clear transition planning:** The sector requires a phased transition timeline based on evidence. Different parts of the industry need different amounts of time to adapt. Policy coherence across UK administrations would help reduce competitive distortion and investment uncertainty.
- **Domestic processing capacity:** The UK needs more investment in facilities to process alternative materials, including bark grading, compost quality assurance, and blending infrastructure. Increasing domestic capacity may help ensure steady supply and reduce price volatility.
- **Quality assurance and biosecurity standards:** The UK could develop consistent frameworks for peat-free growing media, similar to PAS 100 – the UK quality standard for compost. Frameworks should cover how materials are processed, limits on contaminants, tracking of sources, and plant-health safeguards. Clear standards could improve consistency and build trust among growers.
- **Coordinated commercial-scale trials:** The industry requires multi-season trials to test peat-free materials in high-sensitivity sectors such as ericaceous crops, propagation systems and potato mini-tuber production. This will help generate reliable evidence of performance.
- **Market signals and procurement:** Stronger demand signals will encourage businesses to invest. This could include public-sector procurement and sustainability-linked sourcing approaches. Visible, long-term demand could help companies plan and expand production.
- **Technical guidance and workforce support:** Growers would benefit from better access to training and practical advice. This includes support on adapting irrigation, nutrition, and handling techniques suited to peat-free systems.

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11 Appendices

Appendix A : Research context

The research was conducted in two phases: Phase 1 (October 2024 – March 2025) identified evidence gaps, which in turn shaped the objectives of Phase 2 (April – September 2025). Stakeholder engagement was central throughout, with two workshops held in Phase 1 and interviews with 46 industry professionals in Phase 2, supported by a review of published literature.

Phase 1 Objectives

1. Undertake a rapid narrative evidence review on current knowledge gaps in the transition to peat-free horticulture using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses approach for rapid reviews to provide transparency in the review process, maintain a clear and organised approach, and reduce bias.

2. Synthesise evidence to develop an engagement framework for:

    a. Cross-sectoral engagement through workshops examining requirements for peat-free transition and pathways to implementation.
    b. Determining engagement requirements for future grower trial research.

3. Identify cross-sectoral requirements to achieve a peat-free transition through an introductory workshop.

4. Develop an analytical framework for future grower trials:

    a. Undertake rapid evidence review on peat-free trials across UK industry (extent, success and implementation challenges) with a focus on supporting implementation across Scotland including standards and quality for peat-free mixes, sustainable and efficient growing conditions and capacity for engagement and education to support supply chains and consumers.
    b. Assess capacity and infrastructure within a variety of relevant contexts (e.g., academic, industrial, hobbyist) to develop appropriate experimental approaches for peat-free trials.

5. Understand scope for scenario building for the pathway to peat-free transition via:

    c. Cross-sectoral engagement in a final workshop.
    d. Site visits from the RGBE and SRUC to supply chain actors within the horticulture industry to understand current capacity and future challenges.

6. Produce final report detailing results, conclusions and recommendations from objectives 1-5 to. Present to ClimateXChange and associated steering committee.

Phase 2 Objectives

1. Determine practical steps to support tangible development of industry collaboration and trials:
    a. Identify growing media suitable to aid the move to peat-free, focussing on those sectors struggling to transition.
    b. Consider the potential of farmed *Sphagnum* in terms of emissions, sustainability, reliability of supply, cost effectiveness and suitability for specific plant growth.
    c. Interview selected growers around their needs in terms of trials.
    d. Interview selected manufacturers to gather information on the properties of growing media, availability (predictability of supply and volumes), costs and sustainability. Explore the potential for their role in co-ordinated trials.
    e. Examine the potential for peat-free plug production:
        i. Initial review of the current state of research and production in Scotland, the rest of the UK and across Europe.
        ii. Assess the scale of demand i.e. the number of plugs required by the Scottish horticulture industry. Given the tight timescale of Phase 2, there is potential for a case study of one sub-sector.
2. Provide an assessment of the potential for the most promising growing media identified in Phase 1 by discussing outcomes with growers and growing media manufacturers. Consider the potential of *Sphagnum* to aid transition where growing specific plants peat-free is challenging.
3. Discuss the development of standards for peat-free growing media with growers and growing media manufacturers, considering value, development and practical implementation.

The research was conducted by Robyn Macdonald (RBGE), Principal Investigator (PI) and Dr Rosie Everett (SRUC), Post Doctoral Research Associate (PDRA); Project delivery was supported by a steering group, including representatives from Scottish Government and ClimateXChange. The influence of researcher positionality and its potential to impact the research process are addressed in the following positionality statements:

Robyn Macdonald, Senior Horticulturist, Royal Botanic Garden Edinburgh

I approach this research as a Senior Horticulturist at the Royal Botanic Garden Edinburgh (RBGE), where I have worked across education, training, and practical horticulture for more than a decade. My role as Principal Investigator on this project reflects both my broad horticultural background and RBGE's longstanding commitment to conservation and sustainability.

My role as Principal Investigator has been to facilitate dialogue and accurately capture the perspectives of diverse stakeholders—including growers (ornamental and production), growing media manufacturers and retailers—who face real and varied challenges in reducing peat use.

Dr Rosie Everett, Postdoctoral Research Associate (PDRA), Scotland's Rural College

As the co-author of this report and a researcher in peatland policy, I acknowledge that my work is shaped by my particular background, values, assumptions, and institutional position. My aim in presenting this statement is to increase transparency about how I perceive, interpret, and engage with the subject matter.

My academic research engages peatland science, policy, and environmental governance. My research seeks to advance sustainable peatland management, including the transition to peat-free growing media. As a researcher, I engage with growers, industry actors, and policymakers; I thus occupy a boundary role between academic and practice spheres.

Appendix B : Stakeholder workshop methodology

Research phase 1 (October 2024 – March 2025): Stakeholder workshops

Two workshops were held on behalf of ClimateXChange at Royal Botanic Garden Edinburgh (RBGE) in partnership with Scotland's Rural College (SRUC) based on the following themes:

1. Barriers to the transition to peat-free horticulture in Scotland.
2. Scenario building in the transition to peat-free horticulture in Scotland.

Workshop design and planning

The workshops played a key role in bringing key stakeholders together for a shared discussion, with the following aims:

1. Identify the key barriers and opportunities in transitioning to peat-free horticulture.
2. Facilitate discussions among stakeholders.
3. Develop strategies for overcoming challenges related to infrastructure, economics, cultural adaptation, and policy alignment.

Participants were selected to ensure diverse cross-sector representation (Table 6), including:

- Growers (ornamentals, fruits, vegetables, cut flowers)
- Growing media manufacturers
- Garden centres and wholesalers
- Non-governmental organisations (NGOs) and trade associations
- Researchers and industry experts

Table 7: Workshop participants

Business/sector represented	Total (WS1)	Total (WS2)
Grower: Trees and ornamentals	8	11
Growers: Fruit, veg and potatoes	3	4
Growers: Cut flowers		1
Growing media producers	8	11
Garden centres	1	2
Wholesalers of horticultural supplies	2	2
Non-governmental organisation/charity	2	7
Trade Association	1	4
Totals	25	42

Prior to the workshops, surveys were distributed to gather baseline data on current peat-free adoption levels, challenges, and industry perspectives and facilitators were briefed on discussion themes, potential conflicts, and engagement strategies.

Workshop Structure and execution

Each workshop followed a structured format (Tables 8 and 9) consisting of:

1. Welcome and introduction: Overview of objectives, agenda, and expected outcomes.
2. Expert presentations: Insights from researchers and industry experts on peat-free horticulture trends, challenges, and innovations.
3. Thematic discussion sessions: interactive breakout groups focused on:
    - Infrastructure and supply chain challenges.
    - Economic barriers and financial support mechanisms.
    - Quality control and standardisation of peat-free growing media.
    - Education, knowledge-sharing, and consumer awareness strategies.
    - Policy and regulatory alignment.
4. Plenary session: Group discussions were summarised, and key findings were shared.
5. Action planning and recommendations: Collaborative drafting of strategies for implementation, including industry commitments.

Throughout the workshops, the following facilitation and engagement techniques were employed:

- Roundtable discussions: Encouraged open dialogue between participants from different sectors.
- Case study discussions: Real-world examples of peat-free transitions were discussed to highlight best practices and lessons learned.
- Breakout groups: Smaller, focused discussions allowed for in-depth exploration of specific topics.
- Panel debates: Experts and industry leaders debated controversial topics, such as the feasibility of immediate peat bans.

Data collection and documentation was facilitated throughout each workshop with the following approaches:

- Audio and video recording: Sessions were recorded for accuracy in reporting and analysis.
- Facilitator notes: Workshop moderators documented key points from discussions.
- Live digital collaboration tools: Platforms such as Miro were used for online participant real-time idea sharing and documentation.

Post-Workshop analysis and reporting

Following the workshop, all notes were collated and analysed using thematic analysis. Discussions were transcribed and analysed using qualitative coding based on keywords (repeated terms) and where possible, attributed to a specific industry. Key themes, concerns, and recommendations were extracted and quantitative data from surveys were integrated to support findings.

Reporting and Dissemination

- A summary report was prepared for each workshop, outlining:
    - key discussion points and industry perspectives
    - identified barriers and proposed solutions
    - actionable recommendations for stakeholders
- Reports were distributed to workshop participants, policymakers, and relevant industry bodies.

Appendix C : Stakeholder workshop programmes

Table 8: Workshop 1 schedule

No.	Item	Presented by	Time
	Registration, welcome and refreshments		09:30 – 10:00
1.0	Workshop opening	Raoul Curtis-Machin, RBGE	10:00 – 10:15
2.0	Introduction to CXC research and workshops	Rosie Everett, SRUC	10:15 – 10:25
3.0	Current state of Scottish horticultural industry and its readiness for transition	Stan Green, Growforth/HTA	10:25 – 10:45
	Questions and comfort break		10:45 – 11:00
4.0	Session 1 Identifying barriers to transition: Infrastructural, economic, cultural	Led by Dr Rosie Everett, SRUC	11:00 – 12:30
LUNCH			12:30 – 13:15
5.0	Transition to peat-free at Hillier Nurseries	Charles Carr, Hillier Nurseries	13:15 – 13:45
6.0	Session 2 Requirements to overcome barriers	Led by Dr Rosie Everett, SRUC	13:45 – 15:15
7.0	Peat-free mixes used by RBGE Horticulture Department	Louise Galloway, Indoor Department Supervisor and Duncan Young, Herbaceous Supervisor	15:15 – 15:30
	Feedback and closing remarks		15:30 – 15:45
	End		15:45

Table 9: Workshop 2 schedule

No.	Item	Presented by	Time
	Registration, welcome and refreshments		09:30 – 10:00
1.0	Workshop opening	David Knott, RBGE	10:00 – 10:15
2.0	Peat-free transition: Industry opportunities	Dr Emma Hinchliffe, IUCN Peatland Programme	10:15 – 10:30
3.0	Peat-free transition at Elsoms Trees – rationale, progress to-date and challenges	Rodney Shearer, Sales Director at Elsoms Trees	10:30 – 11:00
4.0	Session 1 Scenario building: Growing pathways, scaling up, quality control	Led by Dr Rosie Everett, SRUC	11:00 – 12:30
LUNCH			12:30 – 13.15
5.0	RHS, Industry, and Defra Collaborative 'Transition to Peat-Free' Project: Research Updates, Progress, and Upcoming Trials	Dr Raghavendra Prasad, RHS	13:15 – 13:45
6.0	Development of trials for Scottish growers	John Frater, SRUC	13:45 – 14:00
7.0	Session 2 Scenario building: Standards, education, sustainability	Led by Dr Rosie Everett, SRUC	14:00 – 15:30
8.0	Peat-free growing media and biosecurity	Dr Matt Elliot, RBGE	15:30 – 15:50
	Closing remarks and feedback	Dr Rosie Everett	15:50 – 16:00
	End		16:00

Appendix D : Stakeholder interviews methodology

Research phase 2 (April-September 2025): Stakeholder interviews

A qualitative research design was employed to explore experiences, barriers, and opportunities associated with the transition to peat-free horticulture in Scotland. Semi-structured interviews (Appendix E) were selected as the primary method to allow for both consistency across participants and flexibility to probe specific issues in greater depth. The interview guide was developed to ensure comparability of responses across different groups while accommodating the unique perspectives of growers and growing media manufacturers.

Sampling and Recruitment

Participants were purposively selected to capture a diverse cross-section of the horticulture industry. Criteria included enterprise type (grower, media manufacturer, industry/academic expert), business size (micro, small, medium, or large), and stage of transition (peat-free, peat-reduced, or not yet transitioned). Recruitment targeted individuals and businesses with direct experience of peat and/or peat alternatives to ensure that insights reflected practical, sector-specific realities. Effort was made to ensure that geographical spread of growers across the country was also achieved as far as possible (Figure 5). Final numbers for the interviews conducted across phase 2 of the research were: 8 growers of ornamental plants; 3 growers for forestry and woodland projects; 4 fruit and vegetable growers; 3 potato mini-tuber growers; 11 growing media manufacturers; 7 individuals/organisations working on the development of promising peat alternatives, and 5 industry experts/researchers working in the field of sustainable media for horticulture.

Figure 5 Phase 2 grower distribution (NB: 2 growers in England are not represented) (Mapline, 2026)

Business size thresholds are defined in Table 10 with stakeholder mapping for the interview process outlined in Tables 11, 12 and 13.

Table 10: UK Company size thresholds (Williams, 2025)

Company size thresholds effective for financial periods beginning on or after the 6 April 2025:	Business size					
	Micro	Micro	Small	Small	Medium	Medium
	current	new	current	new	current	new
Turnover not exceeding:	£632k	£1m	£10.2m	£15m	£36m	£54m
Gross assets not exceeding:	£316k	£500k	£5.1m	£7.5m	£18m	£27m
Average number of employees not exceeding:	10	10	50	50	250	250

Data collection

Interviews were conducted using the semi-structured guide (Appendix E), which was organised into thematic sections: general business profile, transition status and experiences, supply and production practices, industry collaboration, quality standards, and sustainability considerations. Each participant was asked core questions relevant to their role, with additional prompts used to elicit more detailed accounts of practice, challenges, and expectations. This approach ensured comparability across interviews while providing the flexibility to capture context-specific insights.

Data analysis

All interviews were recorded with participant consent and transcribed for analysis. A thematic coding framework was applied to identify recurring patterns, challenges, and opportunities. Particular attention was given to points of convergence and divergence between growers, manufacturers, and plug producers, as well as to variations by scale of operation and transition status. Transcripts were also examined for examples of innovation and best practice that could inform wider sector learning.

Ethical Considerations

Participants were provided with an information sheet outlining the study objectives and the voluntary nature of their involvement. Informed consent was obtained prior to data collection. Anonymity was maintained in reporting, with identifiable business details removed or anonymised unless already publicly available.

Table 11: Stakeholder mapping for interviews in phase 2

Business type	Company size	Principal crop	Customer base	Current transition status	Engaged in phase 1
Ornamental growers	Micro	Wide range inc. herbaceous, grasses, shrubs and trees. Hardy Scottish-grown plants	General public from site during open season	Transitioned (except bought-in trees, shrubs and aquatic plants)	No
Ornamental growers	Micro	Best known for hardy perennials and alpines	General public from site during open season and via mail order	Peat-reduced	No
Ornamental growers	Small	Bedding plants	Wholesale to garden centre sector	Peat-reduced	No
Ornamental growers	Small	Rhododendrons and Azaleas	Public direct sales from nursery site and mail order	Peat-reduced	Yes
Ornamental growers	Small	Most widely known for bedding	Public: Propagating and growing for nurseries, garden centres, local authorities, contactors	Peat-reduced	No
Ornamental growers	Small	Bedding plug plants	Professional growers for parks department	Not transitioned (bedding); peat-reduced (other crops)	Yes
Ornamental growers	Small	Most widely known for bedding	Wholesale and to public and from garden centres	Peat-reduced	Yes
Ornamental growers	Small	Most widely known for trees and shrubs	Landscapers, designers, Scottish Woodlands and council bodies	Peat-reduced	Yes
Tree growers for forestry/woodland projects	Micro	UK native and non-native trees and hedging for forestry/woodland	Local estates and public	Peat-reduced	No

Tree growers for forestry/woodland projects	Small	UK native and non-native trees and hedging for forestry/woodland	Woodland creation sector and local estates	Peat-reduced	No

Table 11 (continued): Stakeholder mapping for interviews in phase 2

Business type	Company size	Principal crop	Customer base	Current transition status	Engaged in phase 1
Tree growers for forestry/ woodland projects	Small	UK native trees for forestry and woodland	Woodland creation sector, inc. National Trust and Woodland Trust (both of whom request peat-free)	Transitioned, but had to revert back to peat for some crops in 2025	Yes
Fruit and vegetable growers	Small	Wide range of soft fruit plants.	Retail and commercial sales, including online to general public.	Peat-reduced.	Yes
Fruit and vegetable growers	Small	Soft fruit: strawberries, raspberries, blueberries, blackberries, cherries	Major supermarkets, shops, restaurants and food and drinks manufacturers.	Peat-reduced (ericaceous); transitioned (all other crops)	Yes
Fruit and vegetable growers	Large	White, chestnut and portobello mushrooms.	Distribution throughout UK and Europe.	Have been trialling and selling brown peat-free mushrooms since 2025	No
Fruit and vegetable growers	Large	White, chestnut and portobello mushrooms	Distribution throughout UK and Europe, agreement with USA and Canada	Produced peat-free white mushrooms in 2024, substrate details not disclosed.	Yes

Potato mini-tuber producers	Small	Mini-tubers for seed potato production	Eventual distribution of potatoes to Europe, Africa (primarily Egypt and Morocco) and the UK	Not transitioned	Yes
Potato mini-tuber producers	Small	Mini-tubers for seed potato production	Eventual distribution of potatoes to Europe, Africa (primarily Egypt and Morocco) and the UK	Not transitioned	No

Table 11 (continued): Stakeholder mapping for interviews in phase 2

Business type	Company size	Principal crop	Customer base	Current transition status	Engaged in phase 1
Potato mini-tuber producers	Small	Mini-tubers for seed potato production.	Eventual distribution of potatoes to Europe, Africa (primarily Egypt and Morocco) and the UK.	Not transitioned	No
Growing media manufacturers	Micro	Digestate	Amateur and professional	Peat free from inception	No
Growing media manufacturers	Micro	Composted bracken, sold as a sole constituent	Amateur	Peat-free since inception	No
Growing media manufacturers	Micro	Do not disclose ingredients. Do not use coir	Not yet on market	Aiming to market a range of peat and coir-free products to the professional market	Yes
Growing media manufacturers	Small	Composted green waste, wood fibre, composted bark	Amateur	Range of peat-containing, peat-reduced and peat-free products	Yes
Growing media manufacturers	Small	Bracken, sheep's wool, comfrey (other constituents not disclosed online)	Amateur	Peat-free from inception	Yes

Growing media manufacturers	Small	Composted green waste, seaweed (other constituents not disclosed online)	Amateur	Peat-free	Yes
Growing media manufacturers	Small	Composted bark, wood fibre, coir, small amounts of composted green waste in some mixes	Amateur and professional	Peat-free since inception	Yes

Table 11 (continued): Stakeholder mapping for interviews in phase 2

Business type	Company size	Principal media constituents	Customer base	Current transition status	Engaged in phase 1
Growing media manufacturers	Medium (growing media wing of company)	Wood fibre and bark. Do not use composted green waste.	Professional	Range of peat-containing, peat-reduced and peat-free products.	No
Growing media manufacturers	Medium	Wood fibre (‘green fibre’), composted green waste, coir, perlite.	Professional	Range of peat-containing, peat-reduced and peat-free products.	Medium
Growing media manufacturers	Medium	Wood fibre and coir	Amateur and professional	Range of peat-containing, peat-reduced and peat-free products.	Yes
Growing media manufacturers	Large	Wood fibre, composted bark, coir. Do not use composted green waste.	Professional	Range of peat-containing, peat-reduced and peat-free products.	No

Table 12: Stakeholder mapping for interviews in phase 2

Business type	Principal media constituent	Intended customer base	Current market status	Industry professionals consulted	Engaged in phase 1
Peat alternatives showing promise for wider adoption	Heather biomass	To be defined.	Not yet on market.	Environmental consultant who co-led a three-year project funded by the Department of Energy Security and Net Zero (DESNZ) which assessed the potential of heather biomass as a peat substitute and feedstock for energy generation.	No
Peat alternatives showing promise for wider adoption	Farmed *Sphagnum*	To be defined. Has shown promise for Carnivorous growers.	Not yet on market in UK; has been tested as part of RHS peat-free trials.	1. Renowned grower of carnivorous plants. Involved in RHS peat-free trials.	Yes, email contact
Peat alternatives showing promise for wider adoption	Farmed *Sphagnum*	To be defined. Has shown promise for Carnivorous growers.	Not yet on market in UK; has been tested as part of RHS peat-free trials.	2. Major producer of salad crops on peat soil. Involved in moss-farming pilot with Beadamoss.	Yes, site visit
Peat alternatives showing promise for wider adoption	Farmed *Sphagnum*	To be defined. Has shown promise for Carnivorous growers.	Not yet on market in UK; has been tested as part of RHS peat-free trials.	3. Collaborators in project with Greifswald Moor Centrum.	No
Peat alternatives showing promise for wider adoption	Farmed *Sphagnum*	To be defined. Has shown promise for Carnivorous growers.	Not yet on market in UK; has been tested as part of RHS peat-free trials.	4. Leading UK producer of farmed Sphagnum, using micro-propagation techniques and trialling cultivation outdoors and in protected environments.	Yes, email contact and site visit.

Table 12 (continued): Stakeholder mapping for interviews in phase 2

Business type	Principal media constituent	Intended customer base	Current market status	Industry professionals consulted	Engaged in phase 1
Peat alternatives showing promise for wider adoption	Bracken	Currently on amateur market.	Does not make up large proportion of growing media overall. One UK-based manufacturer lists it as a key ingredient, another sells it as a standalone composted product on a very small scale.	1. Plant Ecologist based at the James Hutton Institute who has been involved in the Strategic Bracken Framework project.	No
Peat alternatives showing promise for wider adoption	Bracken	Currently on amateur market.	Does not make up large proportion of growing media overall. One UK-based manufacturer lists it as a key ingredient, another sells it as a standalone composted product on a very small scale.	2. The Scottish Bracken Working Group.	No

Table 13: Stakeholder mapping for interviews in phase 2

Business type	Institution/organisation	Nature of research/expertise	Engaged in phase 1
Industry and research contacts	Agricultural Development Advisory Service (ADAS) (part of RSK group).	Agricultural and environmental consultancy. Led CP138, a five-year project assessing peat-free materials and how to blend them to suit different crops (funded by Defra and AHDB Horticulture).	No
Industry and research contacts	Coventry University	Project team for 2-year project designing and evaluating peat-free blocking for organic vegetable growers (funded by Innovate UK).	No
Industry and research contacts	Horticultural Trades Association (HTA)	Active in representing Scottish Horticulture industry at government level.	Yes
Industry and research contacts	National Institute of Agricultural Botany (NIAB)	Aims to support the industry as it shifts to peat-free media. Has run trials of peat-free media over several years for bedding and hardy nursery stock plants.	Yes
Industry and research contacts	Scottish Agricultural Organisation Society (SAOS)	Keeping abreast of developments in peat-free growing media to support crop cooperatives.	No

Appendix E : Semi-structured interview guide

Section 1: General profile (all participants)
6. Can you briefly describe your business and role?
7. Do you consider your operation: Small-scale / SME / Large-scale commercial?
8. What plant types or crops do you primarily produce?
9. Who is your customer base?
10. Have you fully, partially, or not yet transitioned to peat-free growing media?
Section 2: For Growers
If peat-free or peat-reduced:
11. What peat-free or peat-reduced media brand(s) have you adopted?
12. What are the main ingredients in your preferred peat-free media?
13. What has worked well when moving to peat-free/peat reduced?
14. What issues have you encountered in transitioning?
15. Has transitioning impacted the way that you produce plants?
16. Have you seen a change in input costs or labour requirements?
17. Have you encountered losses because of the transition e.g. through wastage?
If not yet peat-free:
18. What are the main reasons for not yet transitioning?
19. What support or assurances would be necessary for you to begin the transition?
20. Who do you think would be best placed to provide this support?
21. What do you expect from growing media manufacturers beyond supply (e.g., R&D, education, samples?)
Section 3: For growing media manufacturers
22. What are the main constituents of the growing media that you produce?
23. Is there a difference in composition between your commercial and amateur products?
24. Are you actively developing peat-free options?
25. Which alternative materials do you see as most viable?
26. What challenges do you face in scaling up the production of peat-free options?
27. Growers have mentioned difficulties in obtaining small quantities of growing media to trial, would your company be prepared to offer such samples to growers?
28. Would your company be willing to contribute growing media to larger scale coordinated peat-free trials with growers?

29. What kinds of partnerships would be most useful in supporting this R&D?
30. Does your business have the capacity to work one-to-one with growers as they transition to peat-free?
Section 4: For plug producers
31. How many plugs do you produce annually?
32. Do you produce all plugs in-house or source some externally?
33. What are the main components of your plugs?
34. Who is your customer base?
35. Have you experimented with peat-free plug media?
36. What specific opportunities or challenges arose when trialling peat-free plug production?
37. Do you see a feasible path to completely peat-free plug production within your business model?
38. Would external support help with the transition? What form might this take?
Section 5: Industry collaboration and trials (all participants)
39. Have you previously participated in industry trials or collaborative research around growing media?
40. (If yes) Do you intend to continue participating in trials and/or research?
41. What might enable you to participate in future trials/research (e.g. incentives, conditions etc.)
42. What value do you see in cross-sector collaboration in developing and testing peat-free media?
43. Do you favour individual, in-house trials or coordinated multi-stakeholder ones?
44. Do you currently have the skills needed in-house to conduct your own trials?
45. What kind of trial format would be practical for your operation?
46. Over how many growing seasons would you be willing to participate in a trial?
47. How should success in peat-free trials be measured?
Section 6: Standardisation (all participants)
48. Do you think that there should be quality standards for peat-free media production?
49. (If yes) Why?
50. (If no) Why not?
51. What specific aspects of peat-free growing media need to be considered as part of a quality standard?
52. What difference(s) would quality standards make to your business?

53. Who should oversee and maintain the implementation of these standards?
54. Do you think the development of media standards for specific crops e.g. ericaceous plants, would make it easier for some growers to transition?
55. Are there any other plant groups that you think need specific growing media standards?
Section 7: Final reflections (all participants)
Support and regulation
56. From your perspective, what is the single biggest means to accelerate the move to peat-free horticulture in Scotland?
57. What is the most pressing barrier preventing the industry from achieving full adoption of peat-free media?
58. How do you view current government messaging around peat reduction?
59. What type of body or bodies should set quality standards for growing media?
60. What role should researchers or government play in bridging knowledge gaps between growers and others in the industry?
61. What forms of knowledge-sharing (workshops, demos, digital materials) are most useful to you?
Sustainability
62. Do you currently consider or measure the carbon footprint or emissions associated with your growing media use?
63. How important are sustainability certifications or carbon calculations in your decision-making?
64. Do you think that there will be any environmental trade-offs associated with a shift to peat-free media?
65. Do you have any other reflections, insights, or priorities that you feel this project should consider?

Appendix F : SWOT analysis of peat alternatives

This appendix provides a structured assessment of the strengths, weaknesses, opportunities and threats associated with the alternatives to peat in growing media (Tables 14-29). The SWOT framework has been selected to synthesise evidence from literature, market data, and stakeholder perspectives into a concise format that highlights both internal sectoral factors and external policy or market drivers.

The analysis considers the horticultural industry's current reliance on peat, the technical and economic aspects of alternative materials, and the implications for growers, supply chains and policy. Strengths and weaknesses address internal capacities and limitations within the sector, while opportunities and threats reflect external developments such as regulatory changes, international trade, climate commitments, and technological innovation.

By presenting these elements together, the SWOT analysis provides an overview of the conditions under which Scotland's horticulture industry can shift to peat-free systems, identifying the areas where government action, investment, and research support will be most effective. It should be read as a complement to the main report findings and as a guide to priority areas for policy and industry intervention.

Table 14: SWOT analysis of anaerobic digestate (AD)

Category	**Key points**
Strengths (Technical/environmental/ economic benefits)	**Circular nutrient source:** AD fibre is rich in organic nitrogen and nutrients, reducing fertiliser needs. **Demonstrated commercial use:** Already used in peat- and coir-free growing media in Scotland. **Strong sustainability narrative:** Links renewable energy with reuse of organic residues in horticulture.
Weaknesses (Technical limitations, regulatory/logistical constraints)	**High salts and moisture:** Risk of plant damage if not properly treated; heavier and bulkier than peat. **Feedstock variability:** Inconsistent pH, nutrients, and contaminants; requires composting/maturation. **Regulatory barriers:** Classified as waste (PAS 110 in UK); limited certified supply.
Opportunities (Market potential, supply chain advantages, policy alignment)	**Growing supply base:** Expansion of AD plants increasing digestate availability. **Import substitution:** Potential to replace imported materials like coir. **Policy-driven availability**: Renewable energy and waste policies support increased supply. **Circular farming alignment:** Supports on-farm circular economy and sustainability goals.
Threats (Competition, import dependence, biosecurity/environmental risks)	**Competing markets:** Demand as fertiliser may limit availability for growing media. **Contamination risk:** Possible presence of unsuitable contaminants. **Logistical constraints:** Transport challenges due to weight and rural locations. **Grower acceptance:** Perception as “manure-like” may hinder adoption without evidence.

Table 15: SWOT analysis of composted bark

Category	Key points
Strengths (Technical/environmental/ economic benefits)	**Stable forestry by-product:** When composted, bark is a low-bulk-density, structurally stable material with high air-filled porosity. **Proven performance in blends:** Trials show that replacing around 30–70% of peat with composted bark can maintain or improve plant growth when appropriately fertilised. **Nutrient control:** Bark has low inherent nutrient content, allowing precise fertiliser management for different crops. **Established professional use:** Composted bark is widely used and well studied in professional container production internationally.
Weaknesses (Technical limitations, regulatory/logistical constraints)	**Processing requirement:** Bark must be thoroughly composted to avoid nitrogen immobilisation; insufficient fermentation can negatively affect plant growth. **Quality variability:** Bark is often not produced specifically for horticulture, leading to inconsistent physical and chemical properties and the need for secondary processing, which increases costs. **Lower water-holding capacity:** Compared to peat, bark retains less water and typically needs blending with finer materials to meet crop water requirements. **Constrained premium supply:** Availability of high-quality bark, particularly pine bark, is increasingly limited in the UK, restricting wider use.
Opportunities (Market potential, supply chain advantages, policy alignment)	**Forestry sector integration:** Scotland's large forestry industry provides scope to add value to bark as a by-product through horticultural use. **Established industry demand:** All major UK growing-media manufacturers already incorporate composted bark, indicating a ready market if supply can be expanded. **Supply-chain investment potential:** Improved composting infrastructure and closer partnerships with sawmills could increase the availability of quality-assured bark.

	Policy alignment: Support for forestry, wood recycling and by-product utilisation could encourage wider use of bark in horticulture.
Threats (Competition, import dependence, biosecurity/environmental risks)	**Risks of insufficient composting:** Inadequate fermentation can lead to nitrogen drawdown and introduce pests or pathogens into nursery systems. **Supply vulnerability:** Dependence on bark may be exposed to disease outbreaks (e.g. pine wood nematode) or fluctuations in timber markets. **Quality and confidence issues:** Inconsistent particle size or contamination from poor processing can undermine grower confidence. **Competing uses:** Increasing demand for bark in bioenergy and traditional applications (e.g. mulch) constrains availability for growing media. **Market disadvantage:** Bioenergy markets accept mixed or lower-grade bark, making them a simpler and often more attractive outlet for sawmills than horticultural supply chains.

Table 16: SWOT analysis of biochar

Category	Key points
Strengths (Technical/environmental/ economic benefits)	**Improves physical and chemical performance:** Biochar increases aeration and drainage while retaining water and nutrients through high internal porosity and cation-exchange capacity; it can also raise media pH slightly, reducing lime requirements in acidic mixes. **Demonstrated benefits at moderate rates:** Trials show that 10–30% biochar in peat-free mixes can improve germination, growth, and nutrient-use efficiency in crops such as lettuce, tomatoes, and ornamentals, without yield penalties. **Structurally stable:** Highly resistant to degradation, helping maintain media structure over time. **Strong climate-mitigation narrative:** Biochar locks carbon into media and eventually soils for decades, offering a distinctive long-term carbon-sequestration benefit.
Weaknesses (Technical limitations, regulatory/logistical constraints)	**Variable quality:** Properties depend on feedstock and pyrolysis conditions; biochars may differ in pH, nutrient content and presence of residues. Poorly produced material may contain phytotoxic residues. High application rates (>50%) have been linked to nutrient lock-out and excessive pH. **Requires grower familiarity:** Biochar often needs pre-charging with nutrients; without this, it can temporarily immobilise water and nutrients, leading to early deficiencies. **Lack of standards:** No widely adopted horticultural quality standard currently exists, increasing the risk of inconsistent performance. **Limited professional uptake:** Use in professional growing media remains low, with application largely confined to niche or amateur products. **Cost and supply constraints:** Production is energy-intensive and reliant on pyrolysis infrastructure, keeping prices high and volumes limited.
Opportunities (Market potential, supply chain advantages, policy alignment)	**Strong climate alignment:** Biochar can partially replace peat in growing media and later function as a long-term soil amendment, sequestering carbon and aligning closely with climate and net-zero policy goals.

	Local supply potential: Scotland's forestry and agricultural residues offer scope for domestic biochar production, supporting waste valorisation and supply chains. **Rising research interest:** Increasing peat-free trials are exploring biochar blends, particularly as a functional additive to improve moisture regulation, aeration, or nutrient retention in other materials (e.g. coir or composted green waste). **Market differentiation:** Early adopters could capitalise on biochar's carbon-sequestration credentials.
Threats (Competition, import dependence, biosecurity/environmental risks)	**Cost and competition:** Demand from other markets (soil improvement, pollution remediation, livestock feed additives) may constrain supply or keep prices high; rising energy costs or restrictions in feedstock supply may render biochar unaffordable to the media manufacture market. **Quality risk and confidence:** In the absence of industry standards, variable or poor-quality biochar could damage crops and erode grower confidence, slowing adoption of an otherwise promising material. **Regulatory uncertainty:** Evolving regulatory treatment may create ambiguity over how biochar-containing media are classified or approved, potentially adding compliance barriers. **Biosecurity and contamination:** If produced from contaminated feedstocks (e.g. treated wood), biochar could introduce undesirable chemicals into horticultural systems, necessitating strict feedstock control.

Table 17: SWOT analysis of composted bracken

Category	Key points
Strengths (Technical/environmental/ economic benefits)	**Abundant upland biomass:** Bracken is widespread in UK uplands; when composted it produces a lightweight, low-bulk-density material with good air-filled porosity, supporting root aeration. **Peat-like acidity:** Composted bracken typically falls within a pH range (~4.6–6.5) suitable for ericaceous and other acid-loving plants. **Safe after composting:** Sustained high-temperature composting (>60 °C for ~12 weeks) destroys naturally occurring bracken toxins, rendering the material safe. **Favourable nutrient profile:** Low in nitrogen and phosphorus but relatively high in potassium, allowing fertiliser regimes to be tailored in a similar way to peat-based mixes.
Weaknesses (Technical limitations, regulatory/logistical constraints)	**Limited and seasonal supply:** Bracken harvesting is region-specific (mainly uplands) and seasonal (typically autumn), with volumes currently small; to date, uptake has been limited to a single small UK media producer. **Lower water retention:** Holds less water than peat, requiring careful formulation and irrigation management. **Low nutrient status:** Particularly low in nitrogen, meaning it cannot be used alone without supplementary feeding. **High processing burden:** Harvesting is labour-intensive and raw bracken must be fully composted to eliminate phytotoxicity, increasing cost and logistical complexity.
Opportunities (Market potential, supply chain advantages, policy alignment)	**Niche peat-free applications:** Well suited to ericaceous and other acid-loving crops, offering a specialist low-pH alternative within peat-free mixes. **Land-management co-benefits:** Harvesting bracken can support grazing and conservation objectives, controlling an invasive species while generating useful biomass. **Scope for institutional partnerships:** Collaboration with forestry and conservation bodies could help scale supply and build confidence.

	Regional development potential: Targeted investment in harvesting and composting infrastructure (potentially mobile harvesting units) could enable bracken to function as a localised peat alternative within a diversified materials portfolio.
Threats (Competition, import dependence, biosecurity/environmental risks)	**Scalability and ecological limits:** Bracken supply is geographically restricted and variable year to year; reliance at scale could risk habitat damage or soil erosion if harvesting is poorly managed. **Consistency risks:** As a wild-harvested material, bracken compost may show greater variability or contamination with debris, affecting media uniformity. **Perception and reputational risk:** Persistent concerns around bracken's carcinogenic compounds (despite effective neutralisation through composting) may deter growers and consumers. **Commercial adoption barriers:** Limited supply certainty and lack of large-scale proof points make major manufacturers cautious, reinforcing bracken's status as a niche rather than mainstream option.

Table 18: SWOT analysis of coir and coir pith

Category	Key points
Strengths	**Favourable physical properties:** Quality coir pith has ~85–95% total porosity and ~50–60% water-holding capacity, while still providing good aeration for roots. **Strong crop performance:** When properly washed and buffered, coir can match or exceed peat for many crops, due to excellent re-wettability and root-zone aeration. **Waste-derived, globally established:** Coir repurposes agricultural residues from coconut production (mainly India and Sri Lanka) and is one of the most widely adopted peat alternatives worldwide. **Lower climate impact than peat:** When sourced and transported efficiently, coir can have a lower environmental footprint than peat extraction.
Weaknesses	**Variable quality, import-dependent:** Raw coir often contains high chloride, sodium and potassium; without thorough leaching and buffering it can stunt plant growth. **Processing-intensive:** Washing and buffering are essential to make coir horticulture-ready, adding cost and complexity. **Supply-chain vulnerability:** Entirely reliant on overseas production, exposing growers to shipping costs, delays and geopolitical risk. **Sustainability concerns:** Coir production can be water-intensive, with ongoing social and environmental questions in producer regions. **Limited global capacity:** Even total global coir supply would be insufficient to replace peat at scale, constraining its role as a universal alternative.
Opportunities	**Established market acceptance:** Coir already accounts for a substantial share of peat-free growing media, indicating strong market confidence when quality is assured. **Improved domestic processing:** UK manufacturers increasingly wash and buffer imported coir domestically, improving consistency and reducing grower risk.

	Alignment with peat-reduction goals: Coir supports reduced reliance on primary peat extraction and can deliver social benefits in producer regions when sourced responsibly. **Scope for product innovation:** Advances such as compressed formats, nutrient-buffered products and tailored blends can broaden horticultural applications.
Threats	**-Import dependency:** Disruption to shipping, trade routes or export policies could rapidly constrain supply. **Quality inconsistency risk:** Variation between suppliers or seasons can affect crop performance, discouraging heavy reliance. **Externalised environmental impacts:** Growing scrutiny of carbon and water footprints may reduce coir's attractiveness if full lifecycle impacts are accounted for. **Biosecurity concerns:** Inadequately treated coir could introduce pests or pathogens into horticultural systems. **Cross-sector competition:** Demand from other industries may divert supply or increase prices, affecting availability for growing media.

Table 19: SWOT analysis of composted green waste (CGW)

Category	**Key points**
Strengths (Technical/environmental/ economic benefits)	**Abundant domestic supply:** CGW is produced at scale from municipal collections and is widely available across the UK. **Nutrient and organic matter contribution:** CGW is rich in organic matter and often supplies useful levels of nitrogen and potassium, supporting fertility in mixes. **Circular-economy benefits**: Use of CGW diverts material from landfill and returns organic carbon to horticultural systems. **Structural benefits (quality-dependent):** When produced to high standards, CGW can enhance substrate structure and water-holding capacity. **Established market use:** CGW is widely used in retail and landscaping blends, contributing to peat-free formulations and acting as a slow-release nutrient source.
Weaknesses (Technical limitations, regulatory/logistical constraints)	**Quality and consistency risks:** Even PAS 100–certified CGW can contain physical contaminants and show variable chemical and biological properties. **Contamination sensitivity:** The UK's tight plastics limit (0.06% m/m) reflects the fact that even small visible fragments undermine grower confidence. **Chemical variability:** Nutrient levels and pH can fluctuate between batches, and persistent herbicides (e.g. clopyralid) may survive composting and damage sensitive crops. **Logistical constraints:** CGW is heavier and bulkier than peat, increasing transport costs, particularly when sourced from centralised facilities.
Opportunities (Market potential, supply chain advantages, policy alignment)	**Scalable supply potential:** With improved processing and quality control, CGW could become a reliable, low-cost peat alternative.Scope to adopt best practice: Applying stricter European-style quality standards could increase consistency and build trust among professional growers. **Strong policy alignment:** CGW supports waste-reduction and recycling objectives, with the UK's focus on higher compost quality creating scope for innovation.

	Peat displacement potential: If contamination and variability are addressed, CGW could significantly reduce peat use in amenity horticulture and some commercial applications.
Threats (Competition, import dependence, biosecurity/environmental risks)	**Perception and confidence risk:** Persistent contamination or high-profile crop failures could erode trust and trigger tighter regulatory controls. **Feedstock competition:** Garden waste may be diverted to alternative uses (e.g. anaerobic digestion) or affected by changes in municipal collection policies. **Nutrient management risk:** High nutrient and salt levels can cause phytotoxicity in container crops if not carefully formulated, limiting professional uptake. **Biosecurity concerns:** Inadequate composting can introduce weeds or pathogens into horticultural systems.

Table 20: SWOT analysis of composted heather

Category	Key points
Strengths (Technical/environmental/ economic benefits)	**Suitable physical and chemical properties:** Chopped or composted heather has low bulk density and a naturally acidic pH (≈4.8–5.3), making it well suited to ericaceous crops; trials show 30–60% peat substitution can deliver growth comparable to peat-based mixes. **Improved stability through composting:** Composting reduces phytotoxic risk, enhances material stability, and contributes potassium to the growing medium. **Circular use of management residues:** Heather utilisation valorises biomass generated through routine habitat management that would otherwise be burned, disposed of, or left on site.
Weaknesses (Technical limitations, regulatory/logistical constraints)	**Limited performance at full substitution:** 100% heather substrates tend to be overly dense with low water retention, requiring use in blended formulations; application remains largely experimental. **Processing requirement:** Raw heather contains waxes and phenolic compounds that can inhibit plant growth unless composted or mechanically treated. **Constrained and uneven supply:** Heather biomass is regionally restricted and seasonally available, reflecting managed cutting cycles typically spanning 10–20 years. **Infrastructure dependency:** Producing a consistent heather product requires specialised processing (e.g. shredding or digestion), which is not yet widely available.
Opportunities (Market potential, supply chain advantages, policy alignment)	**Integrated land-management benefits:** Using heather biomass supports conservation and moorland management while enabling regional supply chains and rural employment. **Policy and innovation alignment:** Heather projects could benefit from funding streams linked to biomass utilisation, land management, or low-carbon innovation. **Targeted horticultural niche:** Heather fibre offers a peat-free option tailored to ericaceous crops with low-pH requirements. **Market differentiation:** As a native Scottish material, heather could be positioned to appeal to environmentally conscious consumers and biodiversity-led initiatives

Threats (Competition, import dependence, biosecurity/environmental risks)	**Ecological trade-offs:** Excessive removal of heather could conflict with habitat functions or soil protection if not carefully managed. **Economic viability:** Processing infrastructure may be difficult to justify given relatively limited and variable biomass volumes. **Biosecurity risks:** Inadequate processing could introduce pests (e.g. heather beetle) into nursery systems. **Unproven commercial uptake:** The absence of large-scale manufacturers suggests heather remains a promising but as-yet unvalidated material at market scale.

Table 21: SWOT analysis of hemp fibre (Cannabis sativa)

Category	Key points
Strengths (Technical/environmental/ economic benefits)	**Domestic renewable fibre:** Hemp is a home-grown crop; its woody core (hurds/shiv) is lightweight and porous, providing aeration and structural support similar to wood fibre in container mixes. **Demonstrated partial peat replacement:** Trials show hemp hurds can replace around 20–30% of peat without compromising plant growth. **Wider horticultural applicability:** Hemp fibres have also been used in mats and blocks for hydroponic systems, performing comparably to rockwool in some crops. **Strong sustainability profile:** As a fast-growing annual requiring low inputs, hemp aligns well with low-impact and sustainable production goals.
Weaknesses (Technical limitations, regulatory/logistical constraints)	**Limited current supply:** UK hemp cultivation remains small-scale, with production focused on seed or fibre and limited surplus hurd available for growing media. **Processing constraints:** There is little dedicated infrastructure for producing clean, graded hemp hurds suitable for horticultural use. **Performance limits at higher inclusion:** At substitution rates above ~30%, hemp can disrupt nutrient balance, including raised pH and associated micronutrient issues. **Stability concerns:** Hemp can decompose rapidly in substrates, leading to CO_2/N_2O release and structural shrinkage unless stabilised. **Regulatory and social barriers:** Licensing requirements and residual stigma may pose minor obstacles to scaling production.
Opportunities (Market potential, supply chain advantages, policy alignment)	**Emerging market and policy interest:** Hemp is gaining attention as a multi-purpose low-carbon crop. Government support for sustainable materials and expanding UK fibre-processing capacity is likely to increase hemp cultivation, generating greater volumes of by-products such as hurd that could be diverted into growing media.

	Domestic alternative potential: As a home-grown material, hemp could reduce reliance on imported alternatives such as coir if produced at scale, while offering a novel sustainability narrative likely to resonate with environmentally conscious consumers. **Scope for agronomic innovation:** Breeding or selecting hemp varieties for high biomass yields or fibre traits suited to growing media. **Policy alignment:** Hemp aligns with Scotland's carbon-sequestration and regenerative-agriculture objectives, potentially attracting research investment and funding.
Threats (Competition, import dependence, biosecurity/environmental risks)	**Scale and competition:** Until production expands, hemp will remain a niche input, with competing markets (e.g. construction, bedding, textiles) likely to outbid growing-media uses. **Risk of early agronomic failure:** Without careful formulation, issues such as pH drift or shrinkage could undermine grower confidence. **Market resistance:** Established wood-fibre supply chains may limit uptake unless hemp offers clear performance or cost advantages. **Biosecurity requirements:** Thorough processing is required to ensure hurds are free of weed seeds and pathogens.

Table 22: SWOT analysis of loam

Category	**Key points**
Strengths (Technical/ environmental/ economic benefits)	**Balanced mineral soil:** An ideal mix of sand, silt, clay and organic matter. **Excellent structure for roots:** Combines good aeration with water-holding capacity and high cation-exchange capacity (CEC). Naturally contains a broad spectrum of nutrients and buffers pH, providing a stable nutritional environment compared with inert substrates. **Proven agronomic value:** Loam-based mixes (e.g. traditional John Innes composts) have long been used to produce robust nursery stock and crops, often delivering strong root development and growth in trials. **Localised Scottish resource:** Pockets of high-quality sandy loam exist in Scotland (e.g. Carse of Gowrie, Moray) and have long been valued for horticulture.
Weaknesses (Technical limitations, regulatory/logistical constraints)	**Finite and protected resource:** Loam is effectively topsoil and cannot be extracted at scale without damaging agricultural land. In Scotland, large-scale removal is restricted by environmental regulation due to its importance for food production and ecosystem services. **Heavy and non-sterile:** Its weight increases handling and transport costs, making bagged products more expensive to move. **Biosecurity risks:** May contain weed seeds, pests or pathogens, requiring sterilisation for propagation use, which adds cost and complexity.
Opportunities (Market potential, supply chain advantages, policy alignment)	**Targeted, complementary role:** Loam can contribute to peat-free blends in niche or high-value applications (e.g. John Innes-type mixes, large containers), where small proportions improve stability and nutrient buffering. **Sustainable local sourcing:** Scottish horticulture could make use of loam from managed sources, such as recycled topsoil from construction projects or controlled stripping linked to farmland improvement. **Scope for clearer guidance:** While large-scale extraction is discouraged, policy guidance could support limited, sustainable sourcing for critical uses (e.g. tree nurseries or conservation horticulture) without environmental harm.

Threats (Competition, import dependence, biosecurity/environmental risks)	**Unsuitable for scaling:** Widespread substitution of peat with loam would conflict with soil protection policy and risk degrading agricultural land, likely triggering regulatory and public opposition. **Competing demand:** High-quality loam is in demand for landscaping and land restoration, which may limit availability for growing media. **Biosecurity risk**: If not properly handled or sterilised, loam can introduce soil-borne diseases or invasive weeds into nurseries, reinforcing grower reluctance following any negative incidents.

Table 23: SWOT analysis of marine sediment

Category	**Key points**
Strengths (Technical/environmental/ economic benefits)	**Large potential resource:** Dredging of ports and waterways produces tens of millions of cubic metres of sediment annually in Europe. **Evidence of horticultural suitability:** Trials using treated marine sediment blended with peat or compost have shown comparable yields to pure peat controls. **Favourable physical and chemical properties:** Marine sediments often contain clay and organic matter, contributing to water-holding capacity, nutrient retention and the supply of micronutrients (e.g. Ca, Mg, Fe). **Resource efficiency benefits:** Studies indicate that, when properly remediated, sediment use does not increase heavy-metal uptake, can reduce fertiliser requirements, and provides a beneficial reuse route for material otherwise disposed of.
Weaknesses (Technical limitations, regulatory/logistical constraints)	**Contamination and salinity:** Raw marine sediments can contain high salt levels and contaminants such as heavy metals, hydrocarbons and microplastics. Significant remediation (e.g. washing, stabilisation) is required to make them safe, adding cost and complexity. **Variability and handling constraints:** Sediment properties vary widely (texture, organic content, pollutant load), making standardisation difficult. The material is also heavy and wet (unless dried), limiting transport away from dredging sites. **Regulatory barriers:** Dredged sediment is typically classified as waste, meaning reuse in horticulture would require regulatory approvals and rigorous safety testing. **Lack of market readiness:** There are currently no commercial producers in Scotland processing marine sediment for growing media, so largely experimental at this stage.
Opportunities (Market potential, supply chain advantages, policy alignment)	**Circular economy:** Improved remediation could enable locally sourced, large-scale peat alternatives in coastal regions. Scottish port cities could convert dredging waste into a horticultural product through partnerships with environmental technology companies, building on existing European research and pilot initiatives.

	Policy alignment: Sediment reuse connects to marine environmental policy (reducing ocean dumping) and resource recovery goals. If Scotland invests in green port initiatives, remediating and reusing sediment could be part of that package. **Long-term potential:** If proven viable, remediated sediment could supply high-volume components for manufactured topsoils or landscape substrates, reducing reliance on peat and other mined materials.
Threats (Competition, import dependence, biosecurity/environmental risks)	**Contamination risk:** Residual heavy metals or hydrocarbons present significant risks to crops, public trust and legal compliance. Stringent testing, regulation and liability may deter commercial uptake. **Economic uncertainty:** Remediation costs may equal or exceed those of existing growing-media components, with limited market acceptance due to negative perceptions of dredged material. **Supply reliability:** Availability depends on consistent dredging activity; changes in port operations could disrupt supply. **Competing uses:** Sediment may be preferentially diverted to construction or land-reclamation projects, where quality requirements are lower and economic returns clearer.

Table 24: SWOT analysis of reclaimed peat

Category	Key points
Strengths (Technical/environmental/ economic benefits)	**Secondary resource:** Recycled peat silt collected from watercourses draining peatlands (marketed as *Moorland Gold*), offering some peat-like qualities without requiring new peat extraction. **Waste repurposing:** Utilises peat particles that have eroded naturally, conceptually repurposing material arising from peatland runoff or restoration processes. **Functional performance:** Because it is peat in origin, it can improve water retention and structure in growing-media mixes in a similar way to peat. It has been promoted as a more sustainable form of peat, potentially allowing growers to achieve peat-like performance on a small scale while avoiding fresh extraction from intact bogs.
Weaknesses (Technical limitations, regulatory/logistical constraints)	**Still peat:** Fundamentally, reclaimed peat is not a different material but the same carbon-rich substance, with associated issues around decomposition, CO_2 release and its origin within peatland ecosystems. Its use does not fully align with peat-free objectives. **Limited evidence base:** There is little published scientific evidence supporting its efficacy or consistency as a growing-media component. Material may contain mineral sediments or contaminants from streambeds, and some industry experts view it sceptically, raising concerns that it may blur messaging around peat reduction. **Unreliable supply:** Supply is inherently sporadic, relying on material eroded from peatlands rather than controlled production. As a result, it cannot be produced on demand and does not represent a reliable option for growers at any meaningful scale
Opportunities (Market potential, supply chain advantages, policy alignment)	**Niche transitional use:** There may be a small market among enthusiast gardeners or specialist growers willing to use reclaimed peat as a transitional product, retaining peat's performance while marketed as recycled rather than newly extracted. **Residual recovery:** If peat extraction is prohibited, small quantities of residual peat held in settlement ponds or reservoirs could potentially be recovered for highly limited or specialist applications. **Restoration-linked reuse:** Reclaimed peat could, in theory, be associated with peatland restoration activities, such as the removal of peat slurry during drain or dam clearance. Rather than disposal, this

	material could be diverted for limited use, provided it is carefully positioned to avoid undermining restoration objectives.
Threats (Competition, import dependence, biosecurity/environmental risks)	**Policy direction:** Peat policy in Scotland is moving towards the complete cessation of peat use in horticulture. Reclaimed peat is likely to fall within these restrictions, as neither regulators nor industry support the reintroduction of peat under alternative labels. **Reputational risk:** Any business using reclaimed peat risks reputational damage, with potential perceptions of attempting to circumvent the intent of peat bans. **Lack of scalability:** Available volumes are extremely limited, meaning reclaimed peat cannot form a meaningful solution and may distract from the development of genuinely peat-free alternatives. There is also a risk that creating demand could incentivise harmful practices, including disturbance of peatlands under the guise of runoff or sediment recovery. **Market rejection:** Taken together, regulatory pressure and market sentiment are likely to preclude reclaimed peat as a viable long-term option, positioning it as a legacy or historical material rather than a future pathway.

Table 25: SWOT analysis of rice husk ash (RHA)

Category	Key points
Strengths (Technical/environmental/ economic benefits)	**Lightweight inorganic material:** Highly porous and predominantly composed of silica, helping to improve drainage and aeration in growing-media blends in a manner similar to perlite. Typically has an alkaline pH and contains minerals such as potassium, calcium and magnesium, which can contribute to plant nutrition. **Demonstrated performance:** Studies have shown horticultural benefits, including enhanced growth of leafy greens when coir is amended with approximately 25% RHA, and yield increases of more than 20% in cucumber and melon crops when RHA is blended with peat and perlite. **Waste-derived input:** As a repurposed agricultural by-product (produced by burning rice husks), RHA generally requires less energy to produce than mined aggregates such as perlite.
Weaknesses (Technical limitations, regulatory/logistical constraints)	**Supply and availability:** Rice is not grown in Scotland, so RHA would require import (typically from Asia), creating dependence on global supply chains and added transport costs. **Chemical constraints:** RHA is highly alkaline, meaning excessive inclusion rates can raise growing-media pH beyond optimal ranges. Careful formulation is required, and there is potential for contaminants, including heavy metals such as arsenic depending on the source material. **Processing and handling:** Quality control and pre-treatment (e.g. washing) may be necessary to ensure consistency and safety. Fine ash can be dusty and pose handling or inhalation risks for workers unless granulated, adding further processing complexity.
Opportunities (Market potential, supply chain advantages, policy alignment)	**Perlite substitution:** If logistics can be addressed, RHA could partially replace imported perlite or vermiculite in growing media, reducing reliance on energy-intensive mined and expanded aggregates. **Supply-chain development:** RHA is already used by some growers in Asia and parts of Europe, creating scope for knowledge transfer. Sourcing from European rice-producing regions could shorten supply chains compared to Asian imports, and bulk importation may become more viable as peat-free demand grows.

	Circular-economy potential: As a recycled agricultural by-product, RHA aligns with circular-economy objectives. Collaboration with other sectors that already use RHA (such as construction or concrete manufacture) could help secure consistent supply streams for horticulture.
Threats (Competition, import dependence, biosecurity/environmental risks)	**Import dependence and competition:** Reliance on imported RHA exposes supply to trade volatility and competition from higher-value uses in other sectors, particularly construction and cement manufacture, where rice husk ash is valued as a pozzolan and may out-compete horticulture on price. **Environmental and biosecurity concerns:** Long-distance transport may undermine carbon-reduction objectives unless lifecycle impacts are clearly demonstrated. Although combustion sterilises the material, inadequate processing could introduce contaminants or residual husk material, raising biosecurity concerns. **Adoption barriers:** Limited grower familiarity, combined with a lack of UK-specific guidance on application rates and crop suitability, may slow uptake and restrict RHA to niche or experimental use.

Table 26: SWOT analysis of sheep wool

Category	Key points
Strengths (Technical/environmental/ economic benefits)	**Nutrient-rich natural fibre:** Low-grade sheep wool, often a waste by-product of sheep farming, contains approximately 10–15% nitrogen by weight and releases nutrients slowly as it biodegrades. This provides a built-in slow-release fertiliser effect, potentially reducing the need for synthetic nitrogen inputs. **Physical and biological benefits:** Wool fibres can improve moisture retention and aeration in growing media. Studies indicate that incorporating around 10–20% wool can enhance seed germination and plant growth. Wool is fully biodegradable, contributes organic matter, and supplies micronutrients such as sulphur. **Circular-economy value:** The use of waste fleece supports the recycling of agricultural by-products and carries a strong sustainability narrative linked to farm waste reduction.
Weaknesses (Technical limitations, regulatory/logistical constraints)	**Processing, regulation and sourcing:** Raw wool often contains contaminants (e.g. dirt and sheep-dip residues) and must be scoured or composted before use. As an animal by-product, it is subject to Animal By-Products Regulations (ABPR), and sourcing consistently clean, chemical-free fleece can be challenging. **Nutrient and physical constraints:** Wool has a high C:N ratio and, at high inclusion rates, can temporarily immobilise nitrogen during decomposition. If poorly processed or allowed to become wet, fibres may mat together, potentially impeding drainage. **Limited scale and expertise:** Specialist processing and blending expertise is required, and current UK supply chains remain niche, with production largely confined to a single manufacturer.
Opportunities (Market potential, supply chain advantages, policy alignment)	**Domestic waste valorisation:** Scotland and the wider UK produce large volumes of low-grade wool with limited market value, creating an opportunity to divert an agricultural waste stream into horticulture. Existing long-term use of wool-based composts demonstrates technical viability and provides a model that could be replicated or scaled. **Rural and specialist-market alignment:** Wool use aligns with sustainable agriculture and rural-economy objectives by adding value to a farm by-product and potentially supporting sheep farmers' incomes. Its

	slow-release nutrient supply and moisture-retention properties may also suit organic or specialist growing systems.
Threats (Competition, import dependence, biosecurity/environmental risks)	**Supply-chain fragility:** Processing infrastructure is highly concentrated, with wool-based compost production largely dependent on a single facility. Capacity constraints, contamination incidents or disease-related disruptions could interrupt supply, with limited alternative routes available. **Biosecurity and perception risk:** Any suggestion of inadequate treatment, disease transfer or contamination would present a significant reputational risk and could undermine confidence among growers, regulators and the public. **Competition and consistency:** Wool may be diverted to other emerging uses, such as insulation, if these offer higher returns, reducing availability for horticulture. In addition, natural variability between fleeces (by breed or season) may affect performance unless tightly standardised.

Table 27: SWOT analysis of spent mushroom compost (SMC)

Category	**Key points**
Strengths (Technical/environmental/ economic benefits)	**Recycled organic material:** A by-product of the mushroom industry, typically composed of straw- and manure-based compost with a casing layer (often peat and lime). SMC is nutrient-rich and has a long history of use as a soil improver, demonstrating its ability to enhance soil organic matter, water retention and fertility. **Established availability:** Large volumes have historically been available in the UK (e.g. approximately 500,000 m³ per year in the mid-2000s), reflecting its scale as an agricultural by-product. **Cost-effective nutrient source:** SMC provides bulk organic matter and nutrients at relatively low cost while diverting material from waste streams. In peat-free growing media, it can contribute nutrients and some structural fibre, and has been blended by at least one manufacturer to produce acidic, nutrient-rich mixes.
Weaknesses (Technical limitations, regulatory/logistical constraints)	**Residual peat content:** Most SMC still contains peat from the mushroom casing layer, typically around 10-15% by volume. As a result, many SMC products are not fully peat-free, creating challenges for peat-reduction objectives and, historically, some confusion around labelling. **Chemical constraints:** SMC is often alkaline and high in soluble salts due to liming and fertilisation during mushroom production. This limits its suitability as a primary growing medium for many plants, with risks of root damage or nutrient imbalance unless carefully blended. **Bulk, variability and processing needs:** SMC is heavy and bulky to transport, and composition varies depending on substrate formulation and the number of mushroom crops grown. Nutrient levels decline with successive flushes, meaning SMC typically requires further processing or blending.
Opportunities (Market potential, supply chain advantages, policy alignment)	**Peat-free transition:** If the mushroom industry adopts peat-free casing materials, SMC would no longer contain peat, substantially improving its suitability as a sustainable growing-media input and converting a large waste stream into a peat-free resource at scale. **Product reformulation:** Peat-free SMC could be reformulated and standardised for horticulture, for example through pH and nutrient adjustment, enabling its use as a consistent component in potting mixes**.**

	Scale and circular economy: SMC is abundant and low-cost, making it well suited to outdoor growing and less sensitive crops. Increased utilisation aligns with waste-reduction and circular-economy objectives and could help offset demand for virgin peat where technical constraints are appropriately managed.
Threats (Competition, import dependence, biosecurity/environmental risks)	**Peat and reputational risk:** Until mushroom casing materials become peat-free, use of SMC introduces residual peat, conflicting with peat-free objectives and creating reputational risks for brands positioning themselves as peat-free. **Performance and contamination risk:** High nutrient levels and alkaline pH increase the risk of misuse in containers, potentially leading to crop damage and discouraging adoption. Although generally pasteurised, SMC may also carry residual contaminants or pests, requiring careful quality control. **Supply-chain competition and dependency:** Most SMC is currently utilised in agriculture, and diverting material to horticulture would require new supply chains and compete with established farm uses. Changes within the mushroom industry itself could further affect availability.

Table 28: SWOT analysis of farmed *Sphagnum*

Category	Key points
Strengths (Technical/environmental/ economic benefits)	**Peat-like functional stability:** Farmed *Sphagnum* closely mimics peat's air-water balance, high water-holding capacity, good re-wettability and slow decomposition, allowing it to maintain structure and performance over a growing season. Its acidic, low-nutrient profile suits ericaceous crops and enables precise fertiliser control. **Renewable peatland crop:** Cultivated on rewetted bogs, *Sphagnum* can be harvested on a multi-year rotation and can significantly reduce greenhouse gas emissions compared with drained peatlands. **Proven use:** Trials in Europe and the UK show farmed *Sphagnum* can replace peat in propagation and long-cycle crops where many alternatives perform poorly.
Weaknesses (Technical limitations, regulatory/logistical constraints)	**Limited scalability:** *Sphagnum* farming requires specific site conditions (flat, rewetted peat soils with controlled hydrology), which restricts suitable locations. In Scotland, extensive blanket bogs dominate peatlands, limiting domestic production potential primarily to lowland or previously extracted sites. **Slow establishment and low yields:** Establishment is slow, with harvestable yields typically achieved only after c.3 years. Reported yields remain relatively low, constraining output and limiting rapid scale-up. **High cost and technical barriers:** Current supply volumes are small, keeping costs high in the absence of economies of scale. Expansion requires specialist knowledge and upfront investment, including water-management infrastructure, weed control during establishment, and production of starter material.
Opportunities (Market potential, supply chain advantages, policy alignment)	**High-value niche applications:** Farmed *Sphagnum* is well suited to uses where few peat-free alternatives perform adequately, such as propagation of difficult species and long-cycle substrates. Even at low inclusion rates (e.g. 20-30%), it can impart peat-like properties to blends. **Policy and funding alignment:** *Sphagnum* farming aligns strongly with peatland restoration, paludiculture and climate-mitigation objectives, with potential support through UK and EU funding streams aimed at rewetting peatlands and reducing emissions.

	Knowledge transfer and future scaling: Established experience in countries such as Germany provides opportunities for international collaboration, knowledge transfer and interim supply. Growing demand could stimulate innovation in production methods, increasing availability over time.
Threats (Competition, import dependence, biosecurity/environmental risks)	**Supply and cost risk:** Until production scales up, supply remains vulnerable to disruption from crop failure, project funding changes or limited producer numbers. High costs may also confine use to niche applications, potentially limiting wider industry investment. **Perception and communication risk:** If not clearly distinguished from mined peat, use of the term "*Sphagnum* moss" could cause confusion or criticism, creating reputational or public-relations challenges without careful messaging. **Environmental and climate vulnerability:** As a cultivated system, *Sphagnum* farming could be affected by disease or management failures, and longer-term climate pressures such as drought or extreme weather may threaten reliability if hydrology cannot be maintained.

Table 28: SWOT analysis of wood fibre

Category	Key points
Strengths (Technical/ environmental/ economic benefits)	**Physical performance:** A lightweight, high-porosity organic fibre that improves drainage and aeration in growing media. It is widely proven across Europe as a peat substitute and is already a core component of many UK peat-free mixes. **Sustainable sourcing:** Readily biodegradable and typically derived from sawmill by-products, giving wood fibre a lower carbon footprint than peat and supporting its role as a renewable, sustainable alternative.
Weaknesses (Technical limitations, regulatory/logistical constraints)	**Water and nutrient limitations:** Wood fibre has a lower water-holding capacity than peat and a high C:N ratio, which can lead to nitrogen immobilisation unless supplemented with additional fertiliser. **Formulation dependence:** It is rarely used as a standalone medium, as it can compress and retain insufficient water unless blended with other components. **Quality and processing:** Material properties vary depending on wood source and processing method, and production requires specialised machinery (e.g. shredding or extrusion), creating barriers to consistent supply.
Opportunities (Market potential, supply chain advantages, policy alignment)	**Domestic supply and resilience:** The UK, including Scotland, has significant potential to source wood fibre from forestry residues, strengthening domestic supply chains and reducing reliance on imported materials. **Established market role:** Wood fibre is already a cornerstone of peat-free growing media, comprising over half the volume of some commercial mixes, indicating strong grower acceptance and scope for further substitution. **Innovation and circular economy:** Advances in processing (e.g. extruded or stabilised fibres) could improve durability and performance, while use of forestry by-products aligns with zero-waste and circular-economy objectives within the timber sector.
Threats (Competition, import dependence,	**Domestic supply and resilience:** The UK, including Scotland, has significant potential to source wood fibre from forestry residues, strengthening domestic supply chains and reducing reliance on imported materials.

biosecurity/ environmental risks)	**Established market role:** Wood fibre is already a cornerstone of peat-free growing media, comprising over half the volume of some commercial mixes, indicating strong grower acceptance and scope for further substitution. **Innovation and circular economy:** Advances in processing (e.g. extruded or stabilised fibres) could improve durability and performance, while use of forestry by-products aligns with zero-waste and circular-economy objectives within the timber sector.

Appendix G : Detailed description of alternative materials

Anaerobic digestate (AD)

Among UK growing media producers, this research identified only one that adopted AD fibre as a central ingredient. The manufacturer uses a grass-fed anaerobic digestion system to generate both renewable energy and fibrous residues, which are then matured and blended with other renewable components such as composted bark, wood fibre, and bracken. This vertically integrated model exemplifies a circular production system, where feedstocks are farm-grown, energy self-sufficient, and waste outputs are turned into horticultural products. The manufacturer described digestate fibre not as a secondary ingredient but as a “cornerstone” of its commercial range, designed to replace both peat and coir.

From a sustainability perspective, AD fibre offers several advantages. It is a byproduct of renewable energy generation, with a relatively low greenhouse gas footprint compared to imported organic materials (Peano et al, 2012, 2012; Stichnothe, 2022). In life cycle assessments, only around 6% of the total carbon burden from the anaerobic digestion process is allocated to the fibre fraction, with the majority assigned to biogas production (Stichnothe, 2022). Studies indicate that blending digestate solids with materials such as composted bark or wood fibre improves both structure and nutrient balance, reducing ammonia volatilisation and enhancing nitrogen availability (Alburquerque et al., 2012; Gruda, 2019). When matured or composted post-digestion, the fibre exhibits stable organic matter content, good water-holding capacity, and neutral-to-alkaline pH, supporting consistent plant growth (Tambone et al., 2010).

Several interviewees noted that digestate-based blends align strongly with circular economy and energy transition goals, particularly for Scotland, where biogas infrastructure and livestock agriculture provide potential feedstock sources. However, they also cautioned that quality assurance and consistency remain essential: untreated digestate can contain residual ammonia, high EC, or variable fibre size, making controlled maturation crucial before blending. Unlike imported coir, digestate fibre offers a fully domestic, low-carbon alternative, linking renewable energy, waste reduction, and peat substitution within one system.

Composted bark

Composted bark, primarily from softwood species such as pine and spruce, is a well-established alternative to peat in soilless substrates. It offers low bulk density, high porosity and stability, contributing to good drainage and aeration when blended with coir or other organic materials (Carlile et al., 2015; Sax and Scharenbroch, 2017). The composting or ageing process is critical: fresh bark contains phytotoxic compounds such as phenols and tannins and can immobilise nitrogen due to its high C:N ratio (Carlile et al., 2015; Solbraa, 1979). Correctly composted bark avoids these problems, reduces disease incidence (e.g. Fusarium) and can partially replace perlite in coir blends without compromising crop yield (Dias et al., 2025). Trials across a range of herbaceous and woody species confirm that replacing 30–70% of peat with bark-based material can maintain or improve plant performance, provided that additional fertiliser is supplied to manage nitrogen drawdown (Carlile et al., 2015; Lu et al., 2006).

Composted softwood bark has been shown to improve drainage and structure, and buffers nutrient dynamics, with quality dependent on species mix, composting control, particle size, and contamination management (Prasad et al., 2024; Schmilewski, 2008).

All the major manufacturers acknowledged the importance of composted bark in their peat-free blends. However, they were clear that supply of the highest quality bark—particularly pine—is increasingly tight. One commercial media manufacturer noted difficulties in securing sufficient volumes, while a manufacturer for the amateur market highlighted the need for rigorous composting and grading to ensure reliable performance, particularly when working with mixed conifer sources such as spruce or larch. Smaller suppliers also underlined that inconsistency in composting or particle size can compromise crop outcomes.

Biochar

Biochar, produced via pyrolysis of organic feedstocks, is increasingly studied as a partial substitute for peat in growing media. Its performance depends on feedstock and pyrolysis conditions, which influence pH, cation exchange capacity (CEC), and porosity. Wood-derived biochars typically increase aeration and nutrient retention while also raising pH, sometimes substituting for lime (Nemati et al., 2014; Steiner and Harttung, 2014). Biochar has been shown to improve germination and nutrient use efficiency without yield penalties in crops such as lettuce, tomato and some ornamentals (Chrysargyris et al., 2020; Vandecasteele et al., 2023). Higher substitution rates (>50%) are less reliable, with risks of alkalinity, nutrient imbalance and phytotoxicity (Nemati et al., 2014). An additional advantage is its “cascade use”: biochar first functions in substrates, then can be recycled as a soil amendment, increasing soil carbon and fertility while locking up a portion of carbon for decades (Vandecasteele et al., 2023).

Stakeholder engagement with growing media manufacturers generally reported limited practical use of biochar in growing media to date. While interviewees recognised its potential to improve porosity and microbial function, they suggested that most applications so far have been small-scale or experimental. None of the major manufacturers described current inclusion of biochar, though some noted ongoing trials that were commercially sensitive.

Composted bracken

Bracken (*Pteridium aquilinum*) has long been considered for horticultural use due to its acidity and high annual biomass yields across temperate zones (Marrs and Watt, 2006). When composted, bracken produces a lightweight, acidic substrate (pH 4.6–6.5) with low bulk density (~0.23 g cm^{-3}) and high air-filled porosity (>20%), but relatively low water-holding capacity compared to peat. Composting eliminates the carcinogenic compound ptaquiloside if maintained above 60 °C for 12–16 weeks, rendering the material safe to handle. Nutritionally, composted bracken is low in nitrogen and phosphorus but rich in potassium, making it similar to peat in requiring controlled fertiliser additions. Trials have shown it can support growth of acid-loving ornamentals and crops when blended with other components, though water management remains critical (Pitman & Webber, 2013).

Whilst limited to one small growing media manufacturer in the UK, their success with bracken as a niche addition to blends demonstrates potential. The manufacturer reported actively combining bracken with composted bark, coir, perlite, and grit across a wide range of crops, and noted that the material had performed well when harvested in autumn and properly prepared. They also referred to collaborative trials with the Forestry Commission, which reinforced the positive performance data. Although volumes are constrained by harvest season, stakeholders felt bracken could play a valuable role as part of a broader portfolio, given its availability in Scotland (Pakeman, 2023).

Coir and coir pith

Coir, a by-product derived from the husk of coconuts, is one of the most widely used alternatives to peat (Litterick et al., 2019). It is supplied within horticulture in three forms: coir chips, coir fibre (referred to as coir), and coir pith (also known as meal or dust). Of the forms available, coir pith provides the best balance between water retention and aeration and most closely resembles peat (Schmilewski, 2008). Coir pith typically exhibits very high total porosity (often ≥90%) and can hold substantial amounts of water relative to dry weight, while also providing good aeration compared with many other organic substrates (Abad et al., 2005; Anbarasu et al., 2024). Water-holding capacity expressed as volume per volume varies with particle size and source, and may not consistently fall within a single narrow range.Typically exhibiting a pH between 5.5 and 6.8, coir has a favourable cation balance when properly washed and calcium-buffered (Barrett et al., 2016; Gruda, 2019). When correctly processed, it supports vigorous plant growth; crops such as tomatoes, peppers, and some ornamentals grown in buffered coir frequently match or even outperform those in peat-based media, benefiting from enhanced rewetting properties and improved root aeration (Gruda and Schnitzler, 2004; Negrini et al., 2020).

Despite these advantages, coir's performance is highly dependent on quality control. Unwashed or poorly buffered coir can contain chloride, sodium, and potassium at phytotoxic levels, leading to nutrient imbalances and crop stress (Sonneveld and Voogt, 2009; Barrett et al., 2016). Supply is also import-dependent, with most material coming from India, Sri Lanka, and the Philippines. While life cycle analyses suggest coir's environmental footprint can be lower than peat's if transport and processing are well managed, questions remain about socio-economic impacts and water use in producing countries (Carlile et al., 2015; Gruda, 2019; Prasad et al., 2024. Overall, published research indicates that coir is a technically effective substrate component but its long-term role in Scottish horticulture depends on consistent quality assurance systems and careful consideration of resilience and sustainability.

Interviewees described coir as a useful yet challenging material. A major growing media producer noted that quality concerns—particularly high salinity—had previously limited its use, but that washing and buffering at UK processing sites now ensures greater consistency. Despite these improvements, the company is actively trialling UK-sourced fine fractions to reduce reliance on imported material. Another manufacturer similarly reported that coir accounted for only around 5% of its mixes in 2024, citing risks linked to supply variability and shipping costs.

Composted green waste (CGW)

Although composted green waste (CGW) is abundant and widely incorporated into retail and landscape products, its use in professional growing media remains limited. The primary barrier is concern over quality and consistency, with multiple independent reviews highlighting persistent shortcomings. The Waste and Resources Action Programme (WRAP) and the Renewable Energy Association (REA) report that physical contaminants such as plastics, glass and sharps remain a recurring issue, particularly where material is derived from co-mingled municipal collections (WRAP, 2017; REA, 2021).

These concerns have been a key driver behind the development of UK compost resource frameworks, which comprise waste regulation, quality standards and end-of-waste protocols governing when composted materials can legally transition from waste to product. The frameworks are designed to protect environmental and human health, provide market confidence, and enable the safe reuse of organic waste within agriculture and horticulture. In Scotland, a particularly stringent maximum plastics contamination limit of 0.06 % m/m in air-dry compost (for particles >2 mm) has been applied since December 2019 (Aspray and Tompkins, 2019; Scottish Environment Protection Agency, 2025a), representing a tighter control on physical contaminants than that historically used elsewhere in the UK. Comparable limits were introduced for England and Wales in autumn 2025, aligning standards across the nations (Environment Agency, 2025; Natural Resources Wales, 2025).

Professional growers interviewed for this project confirmed that even low levels of visible plastic fragments undermine confidence in CGW as a substrate component, particularly in production systems where uniformity is critical. Interviewees also highlighted variability in pH, nutrient release and the potential presence of residual herbicides (e.g. clopyralid) as further deterrents to professional uptake. In parts of continental Europe, CGW has been incorporated more successfully into professional growing media where higher and more consistent quality standards are applied. In Germany, the Bioabfallverordnung (Bio-waste Ordinance (BioAbfV)) has required strict quality control and routine testing for stability and maturity in composted green waste for over 25 years (Federal Ministry for the Environment, Climate Action, Nature Conservation and Nuclear Safety. As a result, municipal compost has become a trusted component of professional horticultural substrates, a level of confidence not yet widely achieved in the UK (Schmilewski, 2008; Prasad et al., 2024).

Whilst composted green waste (CGW) has clear potential as a circular resource (Poudel et al., 2023), its role within Scottish and wider UK growing media is strongly differentiated by market and end user. Evidence from this research indicates that CGW is widely incorporated into retail and landscaping products, where mixes are formulated for amateur gardeners and greater variability in performance is tolerated. Smaller manufacturers, in particular, reported more extensive use of CGW in blended products, citing its availability in multiple formats and compatibility with soils, bark and aggregates.

In contrast, large-scale manufacturers supplying professional growers were consistently cautious, with concerns around contamination risk, nutrient variability and reputational exposure leading to the routine exclusion of CGW from professional-grade mixes. This market bifurcation reflects wider European experience, where the successful use of municipal compost in professional horticulture has been contingent on long-standing, tightly regulated quality assurance frameworks (Prasad et al., 2024; Schmilewski, 2008).

Composted heather

Chopped heather biomass derived from heathland management has been identified as a promising peat alternative for use in growing media for acid-loving plants. Experimental evidence indicates that heather-based residues can provide a naturally acidic, low-salinity material with favourable physical properties when blended into growing media, supporting moisture retention and root development at partial replacement rates. However, performance is highly dependent on processing and inclusion rate: high proportions of raw or minimally processed biomass can increase bulk density and reduce water-holding capacity, with negative implications for root and shoot growth, indicating that heather residues are better suited to blended rather than stand-alone formulations (Miserez et al., 2019).

Importantly, evidence suggests that composting can substantially improve heather's suitability as a growing-media component. In a structured test procedure, heather (*Calluna vulgaris*) was chopped, composted for around eight months and processed to a fine fraction before extended substrate analysis. The resulting material exhibited acidic pH values (~5.1–6.2) and low salt concentrations (<0.5 g KCl L^{-1}), placing it within favourable ranges for horticultural use. In some controlled growing trials, composted heather performed comparably to peat at 50% inclusion and, in certain cases, at 100% substitution (Leiber-Sauheitl et al., 2021). Although composted heather had lower maximum water-holding capacity than peat when used alone, blending restored plant-available water to levels comparable to, or slightly above, peat in the study. The authors further note that composted heather's chemical profile sits well below threshold values commonly associated with green-waste composts, implying it can be used at higher inclusion rates than are typically recommended for CGW (Wissner et al., 2017).

From a policy perspective, heather-based materials offer a compelling circular-economy narrative, linking peat reduction with habitat conservation and the beneficial use of land-management residues. However, wider adoption remains constrained by variability in feedstock and harvesting method, the need for processing to achieve consistent performance, and the inherently limited availability of high-quality biomass. Overall, heather is unlikely to function as a stand-alone peat substitute, but the evidence base supports its role as a targeted, locally appropriate component.

These constraints and opportunities were reflected in stakeholder experiences from pilot initiatives. Participants described heather as a promising but still developmental material, requiring further refinement before wider deployment. One project in upland England reported that work initially focused on energy recovery from heather cuttings but shifted towards growing-media applications following encouraging results from mechanical processing trials. The team indicated that a biodigester-style process could produce a relatively uniform heather fibre within a short processing window, delivering stable pH and physical structure. Their longer-term vision centres on regional processing hubs, enabling estates and land managers to supply cut heather for conversion into substrates for nearby nurseries, thereby reducing transport impacts and strengthening local supply chains.

Hemp fibre (*Cannabis sativa*)

Hemp (*Cannabis sativa*) residues, particularly the woody hurd fraction left after decortication, are increasingly evaluated as substitutes for peat in horticultural growing media. Hemp hurd has favourable physical properties including low bulk density, good porosity, and moderate water-holding capacity, which make it suitable for blending into container substrates (Caballero Mejia et al., 2025). Trials have shown that substituting ~30% of peat with hemp hurd can maintain or improve growth, though higher substitution levels often reduce plant performance due to nutrient imbalances (e.g., iron deficiency or manganese toxicity linked to pH shifts). Hemp fibre composites fabricated through green chemical approaches have also been demonstrated to provide stable, biodegradable hydroponic substrates with suitable water retention and mechanical strength for crops such as radish and pea. In hydroponic tomato systems, hemp fibre bags performed comparably to rockwool in terms of yield and fruit quality, though rapid microbial decomposition and nitrogen immobilisation increased greenhouse gas emissions, highlighting a key sustainability trade-off (Nerlich et al., 2022).

Evidence from controlled experiments suggests that hemp-based substrates can provide a sustainable partial replacement for peat, especially when combined with stabilisers such as biochar to improve nutrient retention and reduce alkalinity (Nilsson, 2022). In Scotland, hemp cultivation is growing slowly but remains niche, with fewer than 150 hectares licensed in 2021, mostly for seed and fibre (Riddell and Bowsher-Gibbs., 2025). This constrains domestic availability of hemp residues for large-scale substrate production. Nevertheless, policy interest in hemp as a low-input “carbon crop” and its compatibility with regenerative agriculture suggest potential for expansion, particularly if market demand for sustainable growing media increases. While large-scale substitution is unlikely in the near term, hemp could provide a regionally sourced additive to support the peat-free transition in Scottish horticulture, complementing imports from larger European hemp-producing countries, such as France and The Netherlands (Carus, 2017).

Hemp has not yet been trialled by Scottish growing media manufacturers, but several stakeholders saw potential for the crop as part of the UK’s expanding fibre sector. They noted that the by-products of hemp fibre processing could offer a porous, lightweight structural component similar to wood fibre. However, they emphasised that supply chains and grading standards would need to be developed before hemp could be considered commercially reliable. This was raised in speculative terms rather than as reported practice, it does not reflect a consensus.

Loam

Loam, a balanced soil comprising sand, silt, clay and a small proportion of organic matter, has long been recognised as a highly versatile mineral substrate for plant production due to its favourable structure, aeration, nutrient availability and water-holding capacity (Yadav et al., 2023). Its high cation exchange capacity and stable aggregate structure allow loam to retain water while maintaining adequate drainage across a wide range of crops (Godwin et al., 2022). Unlike organic substitutes such as coir or composted green waste, loam also provides inherent mineral fertility and buffering capacity, helping to stabilise pH and nutrient supply within growing media (Yadav et al., 2023).

In Scotland, high-quality sandy loams occur in fertile lowland regions such as the Carse of Gowrie and Moray, where they support intensive vegetable and fruit production (Scotland's Soils, 2024). However, loam is a finite topsoil resource, and large-scale extraction for horticultural growing media is inconsistent with prevailing environmental and planning expectations. Although Scotland does not yet have a single, dedicated soils policy (Scotland's Environment, 2023), Environmental Standards Scotland (ESS) has recommended that soils be protected in law, reflecting their fundamental importance for agricultural productivity and ecosystem services (Environmental Standards Scotland, 2024).

Loam has a long heritage in horticulture and remains an important component of John Innes–type products and other specialist media, where it contributes structure, mineral stability, nutrient buffering and water retention. Between 2021 and 2023, loam use in retail horticulture rose by ~9%, while use in professional horticulture increased more than ~440% (Defra, 2025b), however, its use is unlikely to scale further as a major peat replacement due to supply constraints, sustainability considerations, and the practical challenges associated with weight and the need for sterilisation. Compared with modern soilless propagation mixes, loam-based substrates require additional processing and biosecurity controls, leading many stakeholders to favour lighter, inert media for sensitive propagation stages. As a result, loam is best viewed as a complementary ingredient in professional blends, enhancing the performance of organic alternatives such as composted bark, wood fibre or coir rather than serving as a stand-alone replacement for peat.

Marine sediment

Marine dredged sediments, generated in large quantities during port and waterway maintenance (approximately 300 million m^3 annually in Europe (Snellings et al., 2016)), are increasingly being explored as peat substitutes following remediation treatments (Baran et al., 2019; Ferrans et al., 2022). Research indicates that phytoremediated sediments can be blended with organic wastes to produce growing substrates with acceptable bulk density, porosity and nutrient profiles for horticultural use. Trials with strawberries and lettuce have demonstrated comparable yields to peat-based controls, with reduced risks of hydrocarbon or heavy-metal accumulation in edible tissues when sediments undergo appropriate treatment (Macci et al., 2025; Tozzi et al., 2020). Remediated sediments can supply macro- and micronutrients (including Ca, Mg, K and Fe) and organic matter, potentially reducing fertiliser inputs. However, untreated dredgings may contain elevated salinity, hydrocarbons or heavy metals, necessitating combined remediation approaches (e.g. phytoremediation, washing and stabilisation) to meet safety standards (Nicese et al., 2024).

Marine sediments were not reported as components of any current commercial growing-media blends by stakeholders. Nevertheless, some interviewees identified potential opportunities to link dredged materials to circular-economy initiatives, particularly at port locations. They emphasised, however, that extensive processing would be required to address salinity and contaminant risks before safe horticultural use could be achieved. As no stakeholders are actively using this material, these views remain hypothetical rather than reflecting established practice.

Reclaimed peat

One product occasionally marketed as an alternative to conventional peat is reclaimed peat, most notably under the trade name *Moorland Gold*. The concept is described by Chambers (1996), who outlines the recovery of fine peat particles eroded into upland water bodies and subsequently filtered from settlement reservoirs. The product was promoted in the 1990s as a “sustainable peat alternative”, explicitly targeting growers seeking to retain peat’s physical properties while responding to increasing environmental concern around peat extraction.

However, the Chambers article is primarily descriptive and promotional in nature, reflecting contemporary industry debates rather than presenting independent scientific evaluation. While the material is characterised as peat-like in pH, structure and conductivity, and limited horticultural trials are reported, these are not supported by peer-reviewed evidence, replicated experimental design or long-term environmental assessment. Notably, the article itself acknowledges persistent scepticism among growers and peat-free adopters, largely because reclaimed peat remains peat in origin and does not represent a fundamental departure from peat use.

This historical framing aligns closely with findings from stakeholder interviews conducted for this study. None of the major suppliers or growers advocated for the use of reclaimed peat, with several explicitly stating that the sector should focus on the development of genuinely peat-free alternatives rather than revisiting peat under a different label. Interviewees noted that, even if reclaimed material could technically be incorporated into growing-media blends, its extremely limited and unpredictable availability, combined with reputational risks and the need for a clear decarbonisation trajectory, made it an unattractive option for the Scottish market.

Rice husk ash (RHA)

Rice husk ash (RHA), a by-product of burning rice husks, has attracted attention as a component of peat-free growing media due to its high porosity, alkaline pH, and high silica and potassium content (Yin et al., 2022). Studies indicate that incorporating RHA into substrates can reduce bulk density, increase total porosity and water-holding capacity, and improve seedling growth in a range of crops (Li et al., 2024; Ali et al., 2023). For example, a 25% RHA-coir blend improved growth of *Brassica parachinensis* compared with coir alone (Ali et al., 2023), while RHA, peat, vermiculite and perlite blends increased cucumber and melon fruit weight and sugar content by more than 20% (Li et al., 2024). In addition to its physical effects, RHA can contribute nutrients (K, P, Ca and Mg) and enhance cation exchange capacity, supporting improved chlorophyll content and root development (Yin et al., 2022).

No stakeholders reported current use of rice husk ash in Scotland. However, several interviewees acknowledged its established use internationally, particularly in parts of Asia, where it functions as a lightweight alternative to perlite. While some suggested that importation could be feasible, they emphasised that cost, logistics and environmental impacts would require careful evaluation. In the absence of current Scottish uptake, stakeholder views on RHA remain exploratory rather than reflecting established practice.

Sheep wool

Sheep wool has been trialled as a sustainable additive in peat-free growing media due to its high nitrogen content (up to 15% by weight), slow release of nutrients during decomposition, and capacity to improve water retention and aeration (Gabryś et al., 2022; Hill, 2022). Wool fibres degrade gradually, releasing nitrogen, sulphur and trace elements, thereby reducing the need for synthetic fertilisers (Herfort et al., 2023; Komorowska et al., 2023). Research indicates that incorporating wool into media blends can improve seed germination and plant growth – particularly in leafy vegetables and ornamentals – when used at inclusion rates of 10-20% by volume (Gitea et al., 2024; Gruda, 2019). However, raw wool requires careful pre-treatment to remove contaminants such as sheep-dip residues, and its high C:N ratio can temporarily immobilise nitrogen if not blended with other nutrient-rich materials (Hill, 2022).

Stakeholders associated sheep wool almost exclusively with the practices of a single established manufacturer, who has produced wool-based composts for over 30 years. They emphasised wool's dual benefits as a moisture-retaining material and a slow-release nitrogen source, but also highlighted challenges in sourcing consistently clean material, as dipped wool raises significant biosecurity and processing issues that must be managed in compliance with animal by-product regulations. Stakeholders noted that substantial investment in specialised machinery and formulation expertise has been required to address these constraints, creating barriers that smaller operators may find difficult to overcome.

Spent mushroom compost (SMC)

Spent mushroom compost (SMC) is a by-product of the mushroom industry and has long been marketed as a soil improver, with more limited application as a growing-media component. Commercial button mushrooms are cultivated on a composted substrate of straw and poultry or horse manure, which is overlaid with a casing layer traditionally made from peat and lime to regulate moisture and stimulate fruiting (da Silva et al., 2024). After several mushroom flushes, the remaining substrate – comprising straw, manure, gypsum and residual peat from the casing layer – is steam-pasteurised and sold as SMC. The material is nutrient-rich, bulky, and effective at improving soil organic matter, structure and water retention, underpinning its long-established use in agriculture and landscaping (Mwangi et al., 2024).

However, most UK mushroom production continues to rely on peat-based casing materials, meaning that SMC typically contains approximately 10-15% residual peat by volume (AHDB, 2014). As a result, SMC cannot currently be considered fully peat-free, despite sometimes being marketed as such. This presents challenges for peat-reduction objectives and risks confusing growers and consumers seeking to eliminate peat entirely (see REA, 2021 for discussion of labelling practices). In addition, the liming and fertilisation required for mushroom production result in SMC that is typically alkaline and high in soluble nutrients, characteristics that constrain its suitability as a primary growing medium for many container-grown plants without further processing or dilution.

Production volumes have historically been significant in the UK (Growing Kent and Medway, 2025), with the majority of SMC currently utilised on agricultural land as a fertiliser or soil conditioner. Smaller quantities have been incorporated into horticultural products, generally following blending with other organic materials to moderate pH and nutrient levels. Looking ahead, the peat status of SMC may change if the mushroom industry transitions fully to peat-free casing materials, as has already occurred in parts of the UK retail supply chain (European Supermarket Magazine, 2024). Under such circumstances, the resulting SMC would also become peat-free, potentially increasing its attractiveness as a recycled organic input, provided ongoing challenges around pH control and nutrient variability can be addressed.

Stakeholder engagement with growing-media manufacturers reflected these constraints. Only one manufacturer provided detailed evidence of current SMC use, describing its incorporation into blended products formulated for specific plant groups, including acidic mixes and bespoke customer requirements. More broadly, manufacturers acknowledged that SMC's high nutrient content and alkaline profile limit its applicability as a universal growing-media component, particularly in containerised systems. While careful blending and management can enable niche or supplementary uses, these requirements constrain scalability and suggest that, at present, SMC is better positioned as a specialist or secondary input rather than a primary peat substitute.

Farmed *Sphagnum*

Farmed *Sphagnum* is derived from *Sphagnum* mosses, the dominant peat-forming plants of bog ecosystems, and is increasingly explored as a peat-free growing-media constituent for applications where few alternatives perform adequately. Unlike peat extraction or wild moss harvesting, cultivation relies on micropropagated *Sphagnum* propagules, which are established on rewetted peat soils or former extraction fields. Precise water-level control – typically maintained through bunds, irrigation or surface flooding – is required to replicate natural bog hydrology. This approach, known as paludiculture, supports biomass production while avoiding further degradation of peatland ecosystems (Gaudig et al., 2017).

Continental Europe has led research into *Sphagnum* cultivation. In Germany, researchers at Universität Greifswald have studied *Sphagnum* farming for over a decade, reporting dry biomass yields of approximately 3.5-7 t ha^{-1} yr^{-1} in pilot systems, depending on hydrological management and fertilisation (Gaudig et al., 2014). Trials on cut-over bogs have also demonstrated that *Sphagnum* can regenerate following harvest, enabling repeated cutting on a rotational basis and supporting its classification as a renewable peatland crop.

Comparable work has been undertaken in Canada, where long-term studies in Quebec have shown that *Sphagnum* biomass production can be established as a managed, renewable system (Gahlert et al., 2012). Subsequent experiments incorporating 30% farmed *Sphagnum* fibre into peat-based media improved water retention without compromising plant growth (Jobin et al., 2014). These findings suggest that cultivated *Sphagnum* may function both as a direct peat substitute and as a partial replacement for mineral aggregates such as perlite.

The relevance of these findings to the Scottish context, however, requires careful consideration. Species composition, climate and hydrological conditions differ markedly between Canada, continental Europe and Scotland, and the *Sphagnum* species trialled elsewhere are not necessarily those dominant in Scottish peatlands. Where domestic cultivation proves infeasible, importing *Sphagnum* biomass from established production regions may be considered, though this introduces trade-offs related to transport emissions, costs and biosecurity that could offset sustainability gains.

The physical properties of farmed *Sphagnum* underpin its horticultural value. It produces a clean, fine-textured fibre with very high water-holding capacity (up to 20 times its dry weight) and excellent wettability, characteristics that are particularly valuable in propagation, plug production and other water-sensitive systems (Gaudig et al., 2017). Chemically, *Sphagnum* is naturally acidic (pH ~3.5–4.5) and nutrient-poor, mirroring peat and allowing precise fertiliser control, while biologically it decomposes slowly due to decay-resistant phenolic compounds in its cell walls (Robroek et al., 2022). These properties explain why it is consistently identified as one of the few materials capable of replacing peat in technically demanding applications.

In the UK, pilot projects led by BeadaMoss and university partners have demonstrated that *Sphagnum* can be successfully established on rewetted fields using micropropagated material, without reliance on wild harvesting. Stakeholders emphasised the importance of clear differentiation between *Sphagnum* cultivation and peat extraction in both policy and communications. While funding mechanisms such as the Paludiculture Exploration Fund are supporting further trials, scaling remains constrained by site requirements, planning obligations and hydrological control, particularly in Scotland where blanket bogs dominate. Nevertheless, growers testing farmed *Sphagnum* reported strong performance in propagation systems, suggesting that even modest domestic production—supplemented by wider UK or European supply chains—could play a strategically important role in Scotland's peat-free transition.

Wood fibre

Wood fibre, produced from coniferous and other softwood residues, is one of the most established alternatives to peat in European horticulture and is now widely used as a structural component of peat-free growing media (Schmilewski, 2008; Sdao et al., 2025). It provides low bulk density, high porosity and air capacity, improving drainage and reducing shrinkage in blends (Gruda and Schnitzler, 2004; Domeño et al., 2009). However, its water-holding capacity is lower than peat and its high C:N ratio can immobilise nitrogen, meaning supplementary fertilisation is usually required (Frangi and Amoroso, 2008; Prasad et al., 2024). Crop trials indicate that replacing 30–50% of peat with wood fibre can support comparable growth in some ornamental and production crops in container systems, although higher substitution rates are often associated with reduced biomass and nutrient imbalance (Beretta and Ripamonti, 2021; Woznicki et al., 2024).

Wood fibre has demonstrated commercial success as part of blended peat-free formulations and is now a core component of growing media across both retail and professional sectors. Stakeholder interviews consistently identified it as one of the primary building blocks of current peat-free products. One major manufacturer reported that more than half of its UK mixes already depend on wood fibre – typically combined with coir and bark – although limited availability of high-quality pine bark remains a constraint. Two producers noted the use of extruded spruce fibre processed with sap extraction, extending material stability to around fourteen months and enabling the development of coir-free formulations based on UK-derived waste streams.

In the amateur market, a long-established supplier with over 30 years' experience of bark- and wood-based systems highlighted the importance of distinguishing between composted wood fibre and extruded fibre products. While expressing confidence in overall UK supply volumes, they identified logistics and consistent grading as more significant challenges than raw material scarcity.

Across manufacturers, there was clear consensus that wood fibre now underpins commercial peat-free growing media. However, performance remains highly dependent on formulation, processing and quality control. In Scotland, stakeholders emphasised that access to reliable bark grades and efficient local wood-chip logistics may be as important as national supply volumes in determining the long-term viability of wood fibre-based growing media.

Appendix H : Industry case study of blended materials

Research funded by the Agriculture and Horticulture Development Board (2019) and led by RSK ADAS demonstrates how blending selected components can produce growing media with physical properties comparable to peat-based substrates. Rather than promoting a single "peat-free recipe", the work showed how different raw materials can be combined to meet defined structural requirements predicted by modelling. Tested blends fell into peat-reduced and peat-free categories and were developed using widely available materials, including:

- Coir (fibre and pith fractions)
- Bark (fine and coarse grades)
- Wood fibre (produced from chipped and processed wood)
- Composted green waste (PAS 100 material)
- Perlite (as a structural/mineral component)
- Other minor amendments (lime and fertiliser additions for pH and nutrient control

To design blends systematically, ADAS grouped materials according to air-filled porosity (AFP):

- High AFP materials: coarser bark fractions, perlite and wood fibre, providing aeration and drainage.
- Medium AFP materials: general purpose components such as bark-coir mixes.
- Low AFP materials: fine coir and peat (in peat-reduced trials), providing higher water retention.

Combining materials across these categories allowed mixes to be tailored to crop requirements for stability, aeration and water supply. The blends tested included:

- Peat-reduced blends: peat combined with wood fibre, bark or coir (e.g. 50:50 or 70:30) to reduce peat content while maintaining handling properties.
- Peat-free blends: mixtures of coir, bark and wood fibre in varying ratios, sometimes with small perlite additions; composted green waste was included at low rates (typically <20%) due to performance variability at higher proportions.
- Crop-specific blends:
    - Propagation mixes with higher coir content for water retention.
    - Nursery stock blends using bark and wood fibre for structure.
    - Short-cycle crops (e.g. herbs, bedding) initially trialled in peat-reduced blends due to greater sensitivity to abrupt substrate changes.

Blends were validated through grower-led trials. ADAS found that formulations combining coir, bark and wood fibre, with minor perlite additions, delivered the most consistent performance across crop types. Overall, the findings demonstrate that well-designed peat-free blends can meet diverse horticultural requirements without requiring advanced technical management, providing a practical and scalable model relevant to Scotland's commercial horticulture sector.

Appendix I Detailed environmental assessment of peat alternatives

This table presents a qualitative synthesis of the environmental performance of peat alternatives used in horticultural growing media, drawing on published life-cycle assessments (LCAs), synthesis studies and industry analyses. Reported greenhouse-gas (GHG) outcomes vary widely across the literature due to differences in system boundaries, allocation methods and assumptions (e.g. treatment of biogenic carbon, avoided waste disposal and transport distances). As a result, exact GHG emission values are not reported here; instead, materials are assessed on a relative basis to support robust comparison of environmental performance. The table should be read alongside Table 31, which provides a higher-level synthesis. Where transport impacts are rated as “low” in the detailed assessment, this reflects typical sourcing and use patterns; corresponding “low–moderate” ratings in Table 2 capture potential variability across supply chains.

Table 30: Detailed environmental performance of peat alternatives used in horticultural growing media

Alternative	Can it be sourced in Scotland?	Production emissions: relative	Transport emissions: relative	Risk of offshoring/environmental displacement
Anerobic digestate (AD)	**Yes** – produced at Scottish AD plants.	**Low** – Small proportion of overall process emissions is attributable to the fibre fraction used in growing media.	**Low** – typically used regionally due to high moisture content, limiting long-distance transport.	**Low** – most environmental burden is attributed to biogas production; use of the fibre fraction in growing media forms a local circular loop with minimal additional upstream impact.
Composted bark	**Yes** – sawmill by-product; widely available.	**Low** – Emissions largely limited to processing; favourable when waste origin and avoided disposal are considered (Stichnothe, 2022; Peano et al, 2012).	**Low** – typically processed and used close to source.	**Low** – domestic residue; impacts retained locally.
Biochar	**Yes** – potential from Scottish biomass.	**Moderate/context-dependent** – Environmental performance varies with feedstock, production conditions and energy source; potential for carbon sequestration exists (Gabryś & Fryczkowska, 2022; Gruda, 2019).	**Low (typically)** – Lightweight material often produced and used locally, though transport impacts increase where production is centralised or feedstocks are sourced remotely.	**Low (currently)** – Typically produced from domestic biomass with impacts retained locally; offshoring risk increases if feedstocks or production are sourced internationally at scale.
Composted bracken	**Yes** – abundant in Scotland.	**Low (indicative)** – Emissions associated with cutting and composting; no dedicated life-cycle assessments currently available (Pitman & Webber, 2013)	**Low** – locally harvested and used.	**Low** – domestic biomass with circular-economy potential, but evidence limited.

Alternative	Can it be sourced in Scotland?	Production emissions: relative	Transport emissions: relative	Risk of offshoring/environmental displacement
Coir and coir pith	**No** – imported, primarily from Asia.	**Moderate** – Processing emissions vary widely depending on retting methods, energy sources and water management (Gruda 2019; Toboso-Chavero et al., 2021).	**High** – long-distance transport (Peano et al, 2012).	**High** – displaces water use, pollution and energy burdens overseas.
Composted green waste (CGW)	**Yes** – municipal composting widely available.	**Low to moderate** – Emissions primarily associated with composting processes; performance varies with treatment of avoided landfill emissions (Peano et al, 2012; Toboso-Chavero et al., 2021).	**Low** – local or regional use.	**Low** – circular local resource.
Composted heather	**Yes** – widespread upland biomass.	**Low (indicative)** – Emissions associated with harvesting and composting; no dedicated LCA currently available (Miserez et al., 2019; Leiber-Sauheitl, 2021).	**Low** – local supply chains.	**Low** – impacts primarily domestic; scalability and land-management constraints remain uncertain.
Hemp fibre (*Cannabis sativa*)	**Potential** – limited but expandable.	**Moderate** – Emissions associated with cultivation and processing; evidence base for horticultural substrates remains limited (Nilsson, 2022).	**Moderate** – local or EU transport.	**Low (potentially)** – Transport and offshoring risks are low where hemp is grown and processed domestically; however, limited current production and processing capacity mean that short- to medium-term supply chains may involve regional or international sourcing.
Loam	**Yes** – limited local extraction.	**Moderate** – Processing emissions are low, but disturbance of soil carbon stocks and primary extraction impacts constrain sustainability (Gruda, 2019).	**Low to moderate** – heavy material.	**Low offshoring risk** – but local environmental impacts limit scalability.

Alternative	Can it be sourced in Scotland?	Production emissions: relative	Transport emissions: relative	Risk of offshoring/environmental displacement
Marine sediment	**Yes** – dredged in Scottish ports.	**Moderate** – Emissions driven by dredging, dewatering and remediation; impacts increase where drying is required (Tozzi et al., 2019).	**Low** – typically used close to dredge site.	**Low offshoring risk** – but local ecological risks and evidence gaps remain.
Peat	**Yes** – but declining and increasingly constrained.	**High** – Extraction and use result in substantial GHG emissions relative to alternative constituents (Gruda, 2019; International Union for Conservation of Nature, 2014).	**Moderate to high** – Impacts vary depending on domestic or import sourcing.	**High** – Contributes to degradation of peatlands domestically and abroad, displacing environmental impacts and conflicting with long-term restoration objectives.
Reclaimed peat	Limited	**Moderate to high** – Avoids new extraction but carbon oxidation during use remains comparable to conventional peat (Peano et al, 2012; Toboso-Chavero et al., 2021).	**Low to moderate** – typically used locally.	**Moderate** – reuse avoids new extraction but does not prevent peat carbon oxidation or support long-term peatland protection.
Rice husk ash (RHA)	**No** – imported.	**Moderate** – Ash is a by-product with low additional emissions at point of use, but production relies on energy-intensive combustion overseas (Ali et al., 2023; Prasara-A and Gheewala, 2017)	**High** – long-distance import.	**High** – displaces environmental impacts to rice-producing regions.
Sheep wool	**Yes** – agricultural by-product	**Low (indicative)** – Minimal additional emissions; slow biodegradation releases biogenic gases; no full LCA available (Gabryś & Fryczkowska, 2022; Hill, 2022).	**Low** – short transport distances.	**Low** – valorises a local waste stream.

Alternative	Can it be sourced in Scotland?	Production emissions: relative	Transport emissions: relative	Risk of offshoring/environmental displacement
Spent mushroom compost	**Yes** – UK-produced	**Low to moderate** – Waste-derived, but peat content contributes indirect emissions (Hashemi et al., 2024).	**Low** – regional distribution.	**Moderate** – sustains peat extraction overseas for casing; does not support a fully peat-free transition.
Farmed *Sphagnum*	**Limited** – trials in UK including Scotland	**Low to moderate (indicative)** – Avoids peat extraction emissions, but early-stage production involves infrastructure and energy inputs; full LCAs remain limited (Gaudig et al. 2017).	**Low** – domestic use.	**Low** – aligns with paludiculture and peatland restoration objectives.
Wood fibre	**Yes** – forestry residues; strong Scottish supply	**Low** overall – Gross processing emissions may be higher, but net impacts are reduced when biogenic carbon storage and avoided waste are accounted for Gruda, 2019; Stichnothe 2022).	**Low** – local supply chains.	**Low** – domestic resource, impacts remain in UK.

Appendix J : Social sustainability of alternatives

Social sustainability in peat-free growing media concerns labour conditions, occupational health, and the distribution of economic benefits across supply chains. While environmental performance dominates substitution debates, the social implications of material sourcing vary considerably between alternatives (Table 31).

Coir (coconut fibre) has attracted the greatest scrutiny. Production is concentrated in India, Sri Lanka and the Philippines and relies heavily on rural female labour, often within small-scale or informal processing systems. Studies report elevated rates of respiratory illness, dermatitis and musculoskeletal disorders linked to prolonged dust exposure and limited access to protective equipment (Sahu et al., 2019). The International Labour Organization (2024) identifies additional risks associated with informal employment structures, low wages and extended working hours. Although coir provides important rural livelihoods, these findings indicate that without mechanisation, formalisation and strengthened occupational safeguards, its supply chains present material social sustainability risks.

UK-derived alternatives – such as composted green waste, wood fibre and anaerobic digestate – operate largely within regulated industrial frameworks but retain occupational hazards. Composting facilities generate bioaerosols associated with respiratory irritation (Lavoie et al., 2006; Pearson et al., 2015). Wood fibre production exposes workers to fine wood dust, classified as a Group 1 carcinogen, requiring effective dust control (Health and Safety Executive, 2022). Anaerobic digestion facilities present additional industrial risks linked to gas exposure and confined-space working (Scarlat et al., 2018). While employment in these sectors is typically formal and regulated, maintaining consistent safety standards remains essential as production scales.

Peat substitution therefore redistributes, rather than removes, social sustainability risks. Imported materials may externalise labour and welfare concerns to overseas supply chains, whereas domestic materials concentrate risk within regulated but industrial settings. From a policy perspective, peat-reduction strategies should be supported by procurement frameworks incorporating social due diligence, traceability, and alignment with International Labour Organization standards, alongside continued enforcement of domestic occupational health regulation. Integrating labour protection and supply-chain transparency into peat-free transition planning will help ensure that environmental gains are not achieved at social cost.

Beyond worker protection, social sustainability also concerns how economic value is distributed across supply chains. Greater use of domestically sourced materials – such as composted green waste and digestate – has potential to support local employment, strengthen circular-economy infrastructure and retain economic value within Scotland. However, realising these benefits depends on stable market signals, regulatory clarity and long-term investment in processing capacity. Aligning peat-reduction targets with wider circular economy and just transition objectives would help ensure that substitution strategies contribute not only to environmental outcomes, but also to regional economic resilience.

Table 31: Social sustainability of commercially available alternatives

Material	Main labour context	Occupational health and safety risks	**Labour equity and social risk considerations**	Overall social sustainability
Anaerobic digestate (AD)	Skilled and semi-skilled plant operators within biogas and waste-management sectors (International Renewable Energy Agency, 2024; Scarlat et al., 2018).	Exposure to biogas (e.g. methane, H_2S), confined space working and pathogens; risks are well characterised and manageable under standard safety and regulatory frameworks.	Formalised employment with training and PPE requirements; no specific labour-equity or offshoring risks identified.	**High** – regulated employment with identifiable risks that are manageable under compliance.
Composted bark	Forestry and industrial composting sectors, with largely mechanised handling and processing.	Exposure to organic dust and bioaerosols during processing and handling; risks are well characterised and mitigated through mechanisation, dust control measures and PPE (Pearson et al., 2015; Waste Industry Safety and Health Forum, 2023).	Formal, predominantly domestic employment with clear regulatory oversight; no specific labour-equity or offshoring risks identified.	**High** – regulated supply chains with manageable occupational risks under UK/EU health and safety standards.
Biochar	Production via industrial pyrolysis or small-scale systems, often localised near biomass feedstocks.	Exposure to fine particulates and pyrolysis emissions during handling and processing; thermal and fire hazards during production; risks are recognised and manageable with appropriate controls (Gwenzi, 2025; Pearson et al., 2015).	Typically formalised, skilled technical roles; no systemic evidence of informal or offshored labour risks.	**High** – risks are well characterised and manageable under standard safety frameworks; supports local skilled employment where operations exist.

Material	Main labour context	Occupational health and safety risks	**Labour equity and social risk considerations**	Overall social sustainability
Composted bracken	Seasonal, manual or semi-mechanised harvesting and handling, typically undertaken in upland or marginal landscapes by estates, land managers or local contractors (Food and Environment Research Agency, 2024).	Exposure to organic dust and spores during cutting and composting; chemical hazards are limited, though naturally occurring toxins (e.g. ptaquiloside) indicate a need for basic risk awareness and standard control measures (Pearson at al., 2015).	Predominantly rural and seasonal employment with variable formalisation; locally based supply chains with no identified offshoring or systemic labour-equity risks.	**Moderate-High** – localised supply chains and a low overall hazard profile, moderated by seasonal and sometimes informal employment.
Coir and coir pith	Labour-intensive processing concentrated in India, Sri Lanka and the Philippines, largely within small-scale or semi-industrial operations and informal or semi-formal employment structures (International Labour Organization, 2024).	Exposure to organic dust during fibre processing and contact with wastewater in retting operations; respiratory and dermatological health issues are reported, with risks heightened where PPE and engineering controls are limited (Sahu et al., 2019).	Workforce often includes high proportion of women employed informally, with variable access to occupational health protections and healthcare; production is offshore relative to end-use markets, externalising social and health risks.	**Low** – livelihood benefits are offset by persistent occupational health concerns, limited worker protections and significant offshoring of social risk.

Material	Main labour context	Occupational health and safety risks	**Labour equity and social risk considerations**	Overall social sustainability
Composted green waste (CGW)	Industrial green-waste composting in UK and EU facilities with formal employment structures (Pearson et al., 2015; Robertson et al., 2019).	Bioaerosol generation during agitation and handling can elevate exposure to airborne bacteria, fungi and endotoxins; some occupational studies suggest respiratory or airway irritation linked to higher bioaerosol exposures, although evidence remains limited and controlled under regulation and PPE (Pearson et al., 2015; Robertson et al., 2019).	Mixed workforce with formal employment and regulatory oversight; roles are often low-skilled but embedded in regulated industrial settings with defined protections.	Moderate-High – industrial regulation and formal employment support social sustainability, although occupational bioaerosol exposure risk persists.
Composted heather	Cutting and collection arising from moorland and heathland management, often linked to conservation or sporting estate practices; work is seasonal and locally organised, with composting typically undertaken on small scale (Moorland Management, 2024).	Low overall hazard profile; potential exposure to organic dust and spores during cutting, chipping and composting, with minimal chemical risk. Material characteristics and processing intensity suggest risks are lower than for industrial composting streams (Pearson et al., 2015).	Rural, seasonal employment embedded in land-management contexts; work is locally based, though short-term or contract-based work may limit employment continuity.	**Moderate-High** – low inherent occupational risk and localised supply chains, moderated by seasonal labour patterns and limited scale of formal processing.

Material	Main labour context	Occupational health and safety risks	**Labour equity and social risk considerations**	Overall social sustainability
Hemp fibre (*Cannabis sativa*)	Mechanical processing of hemp stalks (e.g. decortication and fibre separation) in industrial or semi-industrial facilities; employment is generally formal, with some seasonal roles (Kaur and Kander, 2023).	Organic dust generated during decortication and fibre handling may contain plant and microbial components; elevated dust exposure and respiratory irritation where engineering controls and PPE are limited (Gardner et al., 2020).	Processing typically occurs within regulated industrial settings, with no specific evidence of systemic labour-equity or supply-chain exploitation risks; however, sector-specific occupational health guidance remains limited.	**Moderate** – formal employment and regulatory oversight support social sustainability, moderated by documented occupational dust exposure risks and evolving industry standards.
Loam	Extraction, screening and blending undertaken through mechanised operations; employment is typically formal and based within regulated domestic soil-supply sectors.	Exposure to mineral dust during excavation and processing (Smith and Lee, 2003), alongside risks associated with machinery operation; hazards are well characterised and managed through established occupational health and safety controls.	Formal employment within regulated domestic industries, with no specific evidence of systemic labour-equity or supply-chain risks; minimal offshoring of social risk.	**High** – regulated, mechanised supply chains with well-understood and manageable occupational risks.

Material	Main labour context	Occupational health and safety risks	**Labour equity and social risk considerations**	Overall social sustainability
Marine sediment	Dredging and initial handling are undertaken by mechanised marine contractors under formal labour arrangements in UK/EU dredging sectors; downstream processing for reuse is emerging and not yet widely industrialised (Renella, 2021).	Potential exposure to contaminated dust and aerosolised fine sediments during dewatering and handling stages; risks also depend on contamination status of the source material, requiring careful assessment and controls during reuse preparation (Rangel-Buitrago et al., 2021).	Formalised employment in regulated maritime and dredging sectors; reuse pathways involve complex regulatory frameworks that may restrict development of stable, large-scale supply chains, with variable access to occupational protections across contexts (Renella, 2021).	**Moderate** – regulated formal employment in dredging; emerging reuse opportunities support circularity, but contamination concerns and regulatory complexity moderate sustainability
Reclaimed peat	Manual or semi-mechanised recovery and handling associated with peatland restoration sites, remediation works or legacy peat waste streams; work is typically small-scale and locally based.	Working in wet or unstable ground conditions, with potential exposure to waterborne pathogens and physical hazards associated with restoration environments; chemical risks are generally low, and hazards are manageable under standard health and safety controls.	Small, localised workforce; employment arrangements vary, with generally formal oversight but limited evidence on labour-equity outcomes.	**Low-Moderate** – while labour risks are limited and largely domestic, continued use of peat (even when reclaimed) risks normalising peat extraction and conflicts with peatland protection and restoration objectives (IUCN UK Peatland Programme, 2018), constraining overall social sustainability.

Material	Main labour context	Occupational health and safety risks	**Labour equity and social risk considerations**	Overall social sustainability
Rice husk ash (RHA)	Rice husk collection, combustion and ash handling occur primarily within milling and biomass energy sectors in Asia; employment ranges from formal milling operations to small-scale biomass users, often in contexts with variable occupational health oversight.	Fine particulate and crystalline silica present in RHA can generate respirable dust during handling and transport; potential respiratory exposure risks are documented in occupational literature on silica-rich ash and agricultural residues, warranting dust controls and PPE where processed (Hossain et al., 2024; Sulaiman, 2025).	Workforce is diverse across formal and informal sectors in rice-producing regions; limited evidence exists on labour conditions specific to RHA processing, and access to occupational protections varies by national regulatory context.	**Moderate-Low** – potential respiratory exposure risk and variability in labour protections, especially where RHA handling occurs in informal or poorly regulated settings, moderate social sustainability despite reuse potential.
Sheep wool	Primary production through agricultural shearing, with subsequent preparation and incorporation into growing media undertaken at small-scale, specialist composting operations within domestic supply chains.	Physical strain and minor injury during shearing; organic dust and fibre exposure during handling and processing (Mansour et al., 2014). Sheep can carry zoonotic pathogens which pose a *potential* infection risk if hygiene controls are inadequate. (Department for Environment, Food and Rural Affairs, 2021).	Formal agricultural and small manufacturing employment; no identified systemic labour-equity risks. Wool may contain ectoparasiticide residues (e.g. synthetic pyrethroids) that persist in grease and may leach into soils if untreated, posing broader environmental and ecosystem health concerns (Messori et al., n.d.; Viancelli et al., 2024).	**Moderate-High** – regulated, domestic supply chains with manageable worker risks, moderated by documented pesticide residue concerns and seasonal labour patterns.

Material	Main labour context	Occupational health and safety risks	**Labour equity and social risk considerations**	Overall social sustainability
Spent mushroom compost (SMC)	Recovered from regulated mushroom production systems and incorporated into growing media within formal horticultural manufacturing environments.	Organic dust and bioaerosol exposure can occur during compost handling and agitation in mushroom production; risks are well characterised and manageable under established ventilation and PPE controls, with lower hazard expected once material is stabilised for reuse (Molde, 2011; Pearson et al., 2015).	Formal employment within regulated agricultural and horticultural sectors; no identified systemic labour-equity or supply-chain risks specific to SMC use.	**High** – regulated, domestic supply chains with well-understood and controllable occupational risks, and minimal structural social risk.
Farmed *Sphagnum*	Micropropagation and glasshouse bulking followed by field-scale cultivation and harvesting within specialist horticultural and agricultural enterprises; currently small-scale and project-supported within domestic supply chains.	Low biological hazard; risks relate primarily to machinery use (e.g. steam sterilisation, gel application), manual handling and agrochemical use during weed control (Macdonald, 2024); managed under standard agricultural health and safety frameworks.	Formal employment within regulated UK agricultural and horticultural sectors; emerging industry with limited long-term labour data; production supports peatland restoration knowledge transfer but requires land-use transition and government support to scale sustainably.	**Moderate-High** – domestic, production with low inherent worker hazard, moderated by mechanisation pressures, herbicide use and early-stage sector development.

Material	Main labour context	Occupational health and safety risks	**Labour equity and social risk considerations**	Overall social sustainability
Wood fibre	Produced through mechanised sawmill and defibration processes within regulated forestry and wood-processing industries, typically using softwood feedstocks for horticultural growing media.	Exposure to fine wood dust during cutting and defibration; while hardwood dust is classified as carcinogenic, growing-media fibre is predominantly softwood, though dust control and extraction remain essential (Health and Safety Executive, 2022). Machinery-related injury risk is present but managed under established safety standards.	Formal employment within regulated forestry and manufacturing sectors; no identified systemic labour-equity or supply-chain exploitation risks in domestic production contexts.	**High** – regulated, mechanised production with well-characterised and controllable occupational risks and limited structural social risk.

Appendix K : Responsible Sourcing Scheme (RSS) – Methodology and scoring framework

The Responsible Sourcing Scheme (RSS) provides a structured framework for assessing the environmental and social sustainability of bulk ingredients used in growing media. The scheme applies to structural components that constitute more than 5% by volume of a product formulation.

Scope and system boundaries

The RSS evaluates impacts across defined upstream lifecycle stages, including:

- Extraction or harvesting of raw materials
- Primary processing
- Transport to the growing media manufacturer
- Material preparation and blending

The assessment does not extend to downstream stages such as packaging, retail distribution, consumer transport, product use, or end-of-life disposal.

Sustainability criteria

Each eligible ingredient is assessed against seven sustainability criteria:

- Energy use: Energy consumption associated with extraction, processing and transport.
- Water use: Water consumption during material production and preparation.
- Social compliance: Labour standards, worker welfare and ethical sourcing practices.
- Habitat and biodiversity impact: Effects on ecosystems at source locations.
- Pollution: Risks of air, soil or water contamination and waste generation.
- Renewability: Rate and conditions under which a material can be replenished.
- Resource-use efficiency: Material efficiency, waste reduction and valorisation within production systems.

Scoring methodology

Each criterion is scored on a 0–20 scale, based on evidence provided by the manufacturer and assessed against scheme guidance. Scores reflect performance within each category rather than absolute environmental impact. Individual criterion scores are aggregated to produce a total sustainability score for each ingredient. Ingredient scores are weighted according to their proportion within a growing media formulation to generate a composite product score.

Responsibility index

The aggregated score is translated into an overall Responsibility Index grade, designed to facilitate comparability between products and to support informed sourcing decisions:

- A – Most responsible
- B
- C
- D

- E – Least responsible

Data verification and audit

Manufacturers are required to submit supporting documentation for assessment. Submitted data are subject to independent auditing to ensure consistency, transparency and adherence to scheme requirements.

Treatment of climate-related factors

Climate-related impacts are incorporated within criteria such as energy use, pollution and renewability. The RSS does not directly model greenhouse gas emissions or carbon sequestration as discrete outputs but evaluates relevant inputs within its multi-criteria framework.

Appendix L : Knowledge gaps in sustainability assessment of alternatives

Limitations of Life Cycle Assessment (LCA)

LCA provides the most comprehensive structured approach currently available for assessing environmental impacts of peat and its substitutes (ISO 14044). It has been applied to materials including coir, wood fibre, composted green waste and biochar (Hirschler et al., 2022; Toboso-Chavero et al., 2021). However, several constraints limit its reliability and comparability in the context of peat substitution.

1. Data variability and methodological inconsistency

LCA results vary depending on:

- Software platforms (e.g., SimaPro)
- Databases (e.g., Ecoinvent)
- Characterisation factors
- System boundaries
- Allocation methods for co-products

This variability reduces comparability between studies and complicates policy interpretation. For peat alternatives with heterogeneous feedstocks (e.g. CGW, digestate, biochar), data uncertainty is particularly high.

2. System boundary differences

Many LCAs apply differing cradle-to-gate or cradle-to-grave boundaries. Downstream impacts – including soil carbon persistence, long-term decomposition dynamics, and agronomic performance – are often excluded or modelled inconsistently. This is especially significant for materials such as biochar and compost, where post-application carbon behaviour may materially alter overall climate outcomes.

3. Biogenic carbon and temporal dynamics

Peat and several alternatives involve biogenic carbon flows. However:

- Time horizons vary across studies.
- Carbon storage permanence is difficult to model.
- Soil sequestration effects are under-evidenced.
- Delayed emissions from peatland drainage are treated differently across models.

This creates uncertainty in comparing materials with fundamentally different carbon dynamics.

4. Transport and energy assumptions

Transport emissions significantly influence results for imported materials (e.g. coir, rice husk ash). However, assumptions regarding shipping distance, fuel type and logistics vary widely across studies. Small modelling changes can shift materials between favourable and unfavourable categories.

5. Geographic concentration of evidence

Most peer-reviewed LCAs focus on European and UK production contexts (e.g. Germany, Latvia). Evidence from other producing regions is limited, particularly for emerging biomass streams. This restricts generalisability and may underestimate region-specific environmental impacts.

Gaps in social sustainability evidence

While occupational health and labour risks are identifiable for many materials, social sustainability evidence remains uneven:

- Data on labour conditions in overseas supply chains (e.g. coir, rice husk ash) are fragmented.
- Quantitative social metrics are rarely integrated into environmental assessments.
- There is limited longitudinal evidence on how scaling peat alternatives may affect rural employment patterns in Scotland.
- Informal labour contexts remain difficult to systematically evaluate.

Social Life Cycle Assessment (SLCA) exists but is not widely applied in growing media research, limiting holistic sustainability comparison.

Limitations of the Responsible Sourcing Scheme (RSS)

The RSS provides a multi-criteria sustainability framework; however, it also presents methodological constraints:

- Climate impacts are incorporated indirectly rather than quantified through full GHG modelling.
- Downstream impacts (e.g. end-of-life, soil carbon persistence) are excluded.
- Scoring is categorical rather than impact-weighted.
- Comparability with LCA-derived carbon metrics is limited.
- While the RSS supports transparency and market signalling, it does not replace detailed environmental modelling where carbon accounting is central to policy decisions.

Emerging and data-limited materials

Several promising alternatives identified in this report – including composted bracken, farmed *Sphagnum*, composted heather and sheep wool – lack robust life-cycle evidence at commercial scale. Their sustainability profiles are currently based on:

- Small-scale trials
- Extrapolated data
- Proxy comparisons
- Assumptions about transport and processing intensity

As such, sustainability signals for these materials remain provisional.

Implications of evidence gaps

These knowledge gaps present several risks:

- Over-reliance on incomplete carbon comparisons.
- Potential for offshored environmental burdens to be underestimated.

- Difficulty aligning peat-reduction policy with quantified climate targets.
- Risk of sustainability claims outpacing empirical evidence.
- Challenges in comparing materials with fundamentally different carbon dynamics and supply-chain structures.

Addressing these gaps will require harmonised methodological standards, improved primary data collection across supply chains, and greater integration of environmental, social and economic assessment tools.

Appendix M : Availability of alternatives

Scotland-specific growing media consumption data are not published separately from UK totals. Accordingly, this appendix models material availability against the most recent UK-wide baseline for peat use. In 2023, total peat consumption across the UK horticultural market (retail and professional combined) was 761,479 m³ (Defra, 2025b), representing the remaining volume to be displaced in a fully peat-free transition. Scotland accounts for approximately 8% of the UK population; while horticultural demand does not scale directly with population size, this provides a broad contextual indicator of relative market scale.

This appendix examines the four most widely adopted peat alternatives – wood fibre, composted bark, composted green waste and coir/coir pith – and assesses their scale relative to this benchmark. These materials were selected because they currently underpin the majority of peat-free and peat-reduced growing media formulations in the UK market and therefore represent the most realistic near-term substitutes.

The modelling below (Table 32) compares reported 2023 UK market volumes with the remaining peat volume to illustrate order-of-magnitude replacement capacity. It does not assume that all alternative volumes are directly interchangeable with peat; rather, it indicates whether overall market supply is of sufficient scale to displace remaining peat demand.

The assessment uses 2023 UK growing media market data expressed in cubic metres. For each material:

- Reported 2023 UK market volume is used as the baseline.
- This volume is compared directly with 2023 peat use (761,479 m³).
- Where relevant, indicative inclusion rates are considered qualitatively to reflect that materials are used in blends rather than as one-to-one substitutes.
- No Scotland-specific demand scaling is applied due to the absence of data.

All comparisons should therefore be interpreted as indicative of relative scale rather than precise replacement modelling.

Table 32: Peat alternatives: sourcing context and scale relative to 2023 UK peat demand

Alternative	Can it be sourced in Scotland	2023 UK Market Volume (m^3)	Volume relative to 2023 peat use	Indicative scale vs need
Bark (composted)	Yes	365,792	48% of remaining peat volume	Significant contributor but insufficient alone; dependent on sawmill co-products and composting infrastructure (Forest Research, 2025; Scottish Forestry, 2025).
Coir and coir pith	No	495,172	65% of remaining peat volume	Substantial component of peat-free blends; import-dependent and exposed to freight, geopolitical and carbon risk (Koseoglu and Roberts, 2025).
Composted green waste (CGW)	Yes	189,992	25% of remaining peat volume	Meaningful supplementary volume; constrained by contamination and consistency concerns (Scottish Environment Protection Agency, 2025a; 2025b).
Wood fire	Yes	1,055,510	138% of remaining peat volume	Already exceeds total peat volume at UK scale; primary bulk substitute in retail and professional sectors (UK Growing Media Monitor, 2023; HTA, 2024). Expansion constrained by processing capacity and competition with biomass and fibreboard markets (Forest Research, 2025; Wood Recycler's Association, 2025).

At 2023 volumes, wood fibre alone exceeds remaining UK peat use, while bark and coir each represent substantial but partial contributions. Composted green waste provides smaller but meaningful supplementary capacity. Collectively, these four materials represent more than three times current peat use at UK scale, indicating that overall market supply is not the primary limiting factor in the transition. Instead, constraints relate to processing infrastructure, quality assurance, blending requirements, supply-chain coordination and competition with other end uses. The transition challenge is therefore less one of absolute material scarcity and more one of optimisation, infrastructure and market stability.

Appendix N : Supply chain risk assessment of peat-free raw materials

This appendix provides a material-by-material assessment of competing industrial uses and geopolitical and supply-chain exposure affecting peat-free raw materials (Table 33). It supports the synthesis presented in Section 5.4.2 and underpins the categorisation of materials according to supply-chain risk profile.

Materials were evaluated through literature review and stakeholder evidence against two criteria:

- Competing industrial demand: the extent to which alternative sectors (e.g. bioenergy, construction, agriculture) compete for the same feedstock.
- Geopolitical and supply-chain exposure: dependence on imports, vulnerability to international trade conditions, regulatory constraints, and infrastructure capacity within Scotland and the wider UK.

The assessment focuses on availability and resilience rather than technical growing performance.

Table 33: Risks to raw material availability

Alternative	Competing industrial uses	Geopolitical and supply issues	References
Anaerobic digestate (AD)	Predominantly applied to agricultural land as fertiliser and soil conditioner.	Produced domestically at UK and Scottish AD plants; minimal geopolitical exposure. Market use subject to PAS110 quality certification and environmental permitting requirements.	Anaerobic Digestion and Bioresources Association (2025); Victor (2020); Waste and Resources Action Programme (2017).
Composted bark	Residual bark from sawmilling is widely used for biomass energy generation and landscaping markets, creating cross-sector competition.	Primarily domestically sourced; low geopolitical exposure. Supply linked to Scottish forestry outputs and composting infrastructure capacity.	Forest Research (2025); Koseoglu and Roberts (2025); Schmilewski (2008).
Biochar	Used in soil carbon sequestration markets, livestock feed additives and environmental remediation, creating cross-sector demand.	Can be produced domestically from biomass residues; minimal import reliance. Commercial scaling constrained by production costs and limited processing capacity.	Ahmad et al (2014); Lehmann and Joseph (2015); Shackley et al. (2014).
Composted bracken	Limited established commercial markets (e.g. small-scale animal bedding and biomass use); largely under-utilised as a resource.	Widely distributed in Scotland; no import dependence. Availability influenced by upland management policy and conservation priorities.	Food and Environment Research Agency (2024); Marrs & Watt (2006); Pitman and Webber (2013).
Coir and coir pith	Coir fibre has established non-horticultural markets (e.g. mattresses, matting	Fully import-dependent (primarily India and Sri Lanka); exposed to freight volatility, export controls and regional supply-chain disruption.	Department for Environment, Food and Rural Affairs (2025b); International Coconut Community (2023); Koseoglu and Roberts (2025); Stelte et al. (2022).
Composted green waste (CGW)	Agricultural soil improvement and large-scale landscaping/amenity use represent established bulk markets; horticultural media use competes with these outlets.	Produced domestically; no geopolitical exposure. Supply constrained by PAS100 quality certification, contamination thresholds and municipal waste policy.	Aspray and Tompkins, 2019; Litterick (2025); Scottish Environment Protection Agency (2025a; 2025b).

Alternative	Competing industrial uses	Geopolitical and supply issues	References
Composted heather	Managed primarily within moorland systems; harvested material may be used for small-scale biomass or left in situ, limiting availability for horticulture.	Widely distributed in Scottish uplands; no import reliance. Supply influenced by peatland restoration policy, biodiversity protection and moorland management objectives.	Fielding et al. (2025); Miserez et al. (2019).
Hemp fibre (*Cannabis sativa*)	Established markets in textiles, insulation, construction materials and bio-composites create cross-sector demand for fibre.	Limited current cultivation in Scotland; expansion possible but dependent on agricultural policy and licensing frameworks. Not inherently import-dependent.	Amaducci et al. (2015); Neacsu et al. (2025).
L**oam**	Used in landscaping and construction as topsoil; supply allocated across multiple local end uses.	Extracted locally in limited volumes; no geopolitical exposure. Availability constrained by soil protection policy and planning controls.	Environmental Standards Scotland (2024); Scottish Government (2009); Scottish Government (2023a).
Marine sediment	Typically allocated to coastal defence, land reclamation or licensed marine disposal.	Domestic source (Scottish ports); no geopolitical exposure. Reuse for horticulture requires contaminant remediation and compliance with waste classification and environmental permitting regulations.	Ferrans et al. (2022); Fratini et al. (2025); Scottish Environment Protection Agency (n.d.).
Reclaimed peat	Limited commercial market; no significant cross-sector industrial demand.	Derived from sediment captured in upland drainage systems; inherently small, site-specific volumes. Although not newly extracted, it remains a peat product and may conflict with peatland restoration objectives. No geopolitical exposure	Ferrans et al. (2022); Fratini et al. (2025); Scottish Environment Protection Agency (n.d.). Chambers (1996); Scottish Government (2025a).
Rice husk ash (RHA)	Widely used as a supplementary cementitious material in concrete and construction products.	No domestic production; dependent on imports from major rice-producing regions (India, China, SE Asia). Exposed to international freight costs and trade conditions.	Ganesan et al. (2008); Habeeb and Mahmud (2010).

Alternative	Competing industrial uses	Geopolitical and supply issues	References
Sheep wool	Used in insulation, textiles and packaging; declining fibre prices have led to under-utilisation of low-grade wool.	Fully domestic resource; no geopolitical exposure. Supply constrained by collection infrastructure, processing costs and compliance with Animal By-Products Regulations.	Hill (2022); Legislation.gov.uk (2013).
Spent mushroom compost (SMC)	Applied to agricultural land and sold as landscaping/garden soil conditioner, limiting availability for specialist growing media.	Produced domestically; majority of commercial mushroom production located in England. No geopolitical exposure, but availability geographically constrained.	Othman et al. (2020); Scotland's Rural College (2020).
Farmed *Sphagnum*	Currently prioritised for peatland restoration and paludiculture trials; limited	UK cultivation trials (Scotland, northern England); not import-dependent. Commercial scaling constrained by slow growth rates, land availability and restoration policy priorities.	Gaudig et al. (2017); Scottish Government (2025a).
Wood fibre	Strong cross-sector demand from bioenergy (pellets and combined heat and power (CHP) plants) and panel board manufacture, where residues are often allocated to energy and construction markets.	Primarily domestically sourced; supply linked to UK forestry outputs and processing capacity, with lower direct geopolitical exposure than imported alternatives.	Forest Research (2025); Koseoglu and Roberts (2021); Bek et al. (2020); Schmilewski (2008); Sdao et al. (2025).

Materials exhibiting the highest exposure to international volatility include coir and rice husk ash, both of which are fully import-dependent and sensitive to freight costs, export controls and global demand fluctuations. While these materials are technically well established in horticulture, their supply resilience is influenced by factors beyond Scottish or UK policy control. By contrast, wood fibre, bark and composted green waste demonstrate limited geopolitical exposure but face significant competition from bioenergy, construction and agricultural markets. In these cases, availability is shaped less by absolute resource scarcity and more by cross-sector price signals and infrastructure capacity.

Emerging Scottish resources, including bracken, heather residues, sheep wool and anaerobic digestate fibre, present comparatively low external risk but remain constrained by regulatory frameworks, conservation priorities and processing logistics. Their contribution to peat-free supply chains therefore depends on policy alignment and investment rather than raw material abundance.

Overall, supply resilience across peat-free alternatives is determined by the interaction between domestic infrastructure, regulatory coherence and cross-sector competition. The relative balance of these factors differs substantially between materials and has implications for long-term strategic planning.

Appendix O : Peat-free growing media biosecurity considerations

This appendix provides technical detail supporting Section 5.4.3 and summarises the mechanisms by which plant pathogens may be introduced, persist or spread within peat-free growing media supply chains. The analysis draws primarily on Elliot et al. (2023), Frederickson-Matika et al. (2024), Litterick et al. (2025), Vandecasteele et al. (2018), Benavent-Celma et al. (2023), Guidoni et al. (2025) and Wichuk and McCartney (2007).

Mechanisms of pathogen introduction and persistence

Plant pathogens may enter or persist within growing media through several pathways:

- Contamination of raw materials during harvesting or processing.
- Importation from multiple small-scale producers where traceability and process validation vary.
- Reuse or recycling of substrates (e.g. coir following soft-fruit production).
- Inadequate or uneven thermal processing during composting or fibre treatment.
- Post-treatment contamination during storage, handling, blending or transport.

Empirical studies demonstrate that some peat-free growing media can contain oomycete pathogens including *Phytophthora*, *Pythium* and *Elongisporangium* spp., detected through baiting assays or DNA metabarcoding (Frederickson-Matika et al., 2024). DNA of broad-host-range *Phytophthora* taxa has also been detected in composted green waste samples, although viability was not confirmed in all cases.

Although peat has historically been regarded as comparatively low risk due to limited biological activity, experimental evidence shows that peat-based substrates can support long-term survival of pathogenic oomycetes where contamination occurs (Benavent-Celma et al., 2023), and pathogenic *Fusarium* populations have been documented in peat-based nursery media under certain conditions (James, 2005). The biological safety of both peat-based and peat-free media therefore depends on source integrity, treatment efficacy and post-processing controls rather than substrate type alone.

Processing controls and sanitisation parameters

Thermal treatment is a primary mechanism for pathogen reduction in organic growing media constituents. Processing approaches described in the literature include:

- Windrow composting.
- In-vessel composting.
- Steam treatment.
- Kiln drying or heat-defibration (for bark and wood fibre).
- Critical variables influencing pathogen inactivation include temperature, exposure. duration, moisture content and uniformity of heat distribution.

Composting literature indicates that thermophilic conditions (commonly ≥ 55 °C, and for some organisms sustained exposure near 70 °C) are associated with substantial reductions in many plant pathogens (Guidoni et al., 2025; Wichuk and McCartney, 2007). Importantly, effective pathogen reduction depends on all material reaching and maintaining critical temperatures, rather than peak temperature alone.

Experimental evidence illustrates this relationship. In a composting study of green bio-waste, *Phytophthora cinnamomi* was readily detected in woody bulking agents at the outset using both baiting and molecular methods but was no longer detectable following completion of a properly managed thermophilic composting regime (Guidoni et al., 2025). This demonstrates that untreated green waste and bulking materials may carry viable pathogens prior to processing, but validated composting can substantially reduce or eliminate pathogen viability.

Molecular techniques may, however, continue to detect residual pathogen DNA even where viable propagules are no longer present. This distinction between DNA detection and organism viability highlights the importance of clearly defined diagnostic criteria in biosafety assurance. Reviews also highlight variability in how time-temperature-moisture relationships are defined, monitored and documented across supply chains, particularly among smaller or non-accredited producers (Litterick et al., 2025). Post-treatment storage and blending stages may present additional opportunities for recontamination.

Certification and assurance

Relevant UK standards for organic growing media constituents include:

- BSI PAS 100 (composted materials)
- BSI PAS 110 (anaerobic digestate)

These frameworks primarily address human health criteria, physical contamination thresholds and process validation requirements. Explicit plant-pathogen testing requirements are limited within these standards (Litterick et al., 2025; Noble and Roberts, 2004). Consequently, plant health assurance is generally inferred from process compliance rather than direct biological screening. International schemes, such as Dutch RHP certification, incorporate additional traceability and process-verification elements relevant to imported substrates, particularly coir.

Indicative biosecurity characteristics of selected constituents

Biosecurity risk varies according to source, processing consistency and traceability. Table 34 summarises literature-reported characteristics for widely adopted alternative constituents. Relative risk classifications reflect literature interpretation rather than statutory categories and are influenced by processing consistency and supply-chain transparency.

Table 34: Indicative biosecurity risk characteristics for widely adopted alternative constituents

Constituent	Indicative risk drivers identified in literature	Literature	Relative risk (literature-based)
Composted bark	Potential pathogen presence where thermal treatment is insufficient; bark aggregates have yielded live oomycetes in baiting assays.	Elliot and Frederickson (2025); Guidoni et al. (2025) Litterick et al. (2025)	Variable (processing-dependent)
Coir and coir pith	Variable producer standards; limited traceability; DNA of *Phytophthora* spp. detected in recycled coir; pathogen signatures identified via metabarcoding.	Elliot et al. (2023; Frederickson-Matika et al. (2024); Litterick et al. (2025)	Higher (where traceability limited)
Composted green waste	DNA of broad-host-range *Phytophthora* taxa detected; feedstock variability; pathogen presence influenced by composting efficacy.	Frederickson-Matika et al. (2024); Guidoni et al. (2025)	Moderate–variable
Wood fibre	Risk dependent on processing method; mechanically produced fibres may retain microbial populations; heat-treated fibres considered lower risk.	Guidoni et al. (2025)	Variable (treatment-dependent)

In contrast to organic constituents, inert inorganic materials such as perlite are generally considered negligible biosecurity risk due to their non-biological origin and limited capacity to support pathogen survival (Litterick et al., 2025). Loam is typically regarded as low risk where appropriately sourced and handled, although, as a field-derived material, it may contain soil-borne pathogens if collected from contaminated land. Biosecurity considerations for loam therefore depend primarily on provenance and prior land use.

Frequently reported pathogen taxa in peat-free media

Studies investigating peat-free growing media and associated organic constituents have identified the following plant-pathogenic taxa:

Oomycetes

- *Elongisporangium undulatum*
- *Phytophthora cactorum*
- *Phytophthora cinnamomi*
- *Phytophthora citrophthora*
- *Pythium dissocotum*
- *Phytophthora hibernalis*

Fungal pathogens

- *Fusarium* spp.

- *Verticillium* spp.

***Heat-tolerant or persistent organisms (reported in compost literature*)**

- *Plasmodiophora brassicae*
- *Macrophomina phaseolina*

Detection of pathogen DNA does not necessarily indicate viability or infectivity; however, it demonstrates that plant-pathogenic taxa may be present in some untreated or insufficiently processed organic materials.

Methodological considerations

Relatively few published studies examine individual growing media constituents (e.g. pure coir, composted bark, wood fibre or composted green waste) in isolation for pathogen presence or survival. Much of the available empirical evidence relates to blended commercial growing media or composting systems in which multiple organic components are combined. Consequently, pathogen detections are frequently reported at the level of finished substrate mixtures rather than attributed to specific constituent materials. This limits the extent to which findings can be attributed to individual feedstocks and introduces uncertainty when assigning constituent-specific biosecurity risk. Interpretations of relative risk must therefore consider the composite nature of most tested materials and the influence of blending, processing and storage conditions on observed outcomes.

Evidence gaps identified in the literature

Current research limitations include:

- Limited large-scale comparative surveillance of baseline pathogen loads across peat and peat-free substrates.
- Variability between molecular and culture-based detection methods, complicating cross-study comparison.
- Limited Scotland-specific pathogen surveillance data for commercially distributed growing media.
- Incomplete definition of validated time–temperature–moisture thresholds for each major constituent type.
- Limited published evidence regarding post-treatment contamination during storage and blending.

Appendix P : Barriers for professional growers

While many growers demonstrated commitment to trialling and innovation, workshop and interview data identified recurring structural, technical and economic barriers constraining full transition to peat-free production. These challenges were reported across sectors and business scales (Table 35).

Table 35: Professional growers interviewed in Phase 2

Grower sector	Ornamental	Trees for forestry and woodland	Fruit and vegetables (incl. mushrooms)	Potato mini-tubers
Number of growers interviewed	8	3	4	3

Cost and resource pressures

Higher input costs

Rising input costs were identified as the most immediate barrier to peat-free production. Across sectors, peat-free and peat-reduced media were reported to be 20-40% more expensive than peat-based products, reflecting higher freight, processing and raw-material costs (Bek et al., 2020; Koseoglu and Roberts, 2025). Bulkier mixes reduce transport efficiency, increasing per-load freight costs.

Local authorities and retailers increasingly request peat-free plants, yet growers reported limited willingness within the supply chain to absorb associated price increases. Fertiliser costs were also cited as rising (Reidy, 2025), and nutrient loss through runoff was described as compounding financial strain. One nursery reported a £76 differential between bales of shrub mix with and without incorporated feed, equating to £1,370–£1,600 per full load. A large soft-fruit cooperative noted that the Fruit and Veg Aid Scheme covered approximately 25% of their projected £2 million expenditure on coir in 2025.

Capital and infrastructure investment

Transition was also reported to require investment in infrastructure and machinery. The shift from loose to baled formats necessitated new bale-breaking equipment in some cases (estimated at £15,000). Growers also cited the need for expanded storage and handling capacity for bulkier materials such as coir and wood fibre. These findings reflect wider concerns regarding capital investment constraints within horticulture (National Farmers' Union, 2023; Growing Media Taskforce, 2022).

Incompatibility between peat-free substrates and existing automated systems was frequently reported. High wood-fibre blends were described as clogging or flowing unevenly through filling and transplanting equipment. Some mixes were considered "too fluffy" for small plug trays, while drier blends disrupted conveyor and transplant systems. These challenges illustrate the interdependence between substrate characteristics and production technology.

Labour and productivity impacts

Peat-free systems were widely associated with increased labour demand. Growers reported more frequent watering, closer crop monitoring and additional manual interventions during establishment phases. One grower observed: “I’ve doubled my work but I haven’t doubled my output.” Labour already represents a substantial proportion of production costs (around 60% in some businesses), and tightening margins limit capacity to absorb additional inputs. Some crops were reported to take up to one month longer to reach marketable size, extending production cycles and increasing space, water and fertiliser requirements.

Media quality, consistency and adapted practices

Variability in peat-free media performance was identified as a persistent barrier. Several growers reported satisfactory first-year performance but declining stability in subsequent seasons, as wood-based components decomposed and structure deteriorated (Koseoglu and Roberts, 2025). This contrasts with literature suggesting that appropriate processing and nitrogen buffering should improve wood-fibre stability (Schmilewski, 2008; Maher et al., 2008).

Batch-to-batch inconsistency was also frequently cited. Variations in raw materials – such as tree species, bark age and processing method – were said to affect drainage, texture and nutrient retention. Smaller businesses described disproportionate financial exposure to performance variability. Concerns were also raised regarding shelf life, especially among nurseries that store media for extended periods. Bulrush (2023) acknowledges limited understanding of physical and chemical changes during storage and recommends testing media stored for more than two months. Certain feedstocks, particularly composted green waste, were described as unsuitable for professional use due to contamination risk and nutrient variability (Chen et al., 2023).

Transition also requires adaptation of irrigation and crop management practices. Peat-free substrates were described as less forgiving, with greater sensitivity to over or under watering. Growers reported moving toward “little and often” irrigation approaches to minimise leaching. The Royal Horticultural Society (2024) similarly emphasises that improved irrigation efficiency supports nutrient retention in peat-free media. However, older irrigation systems were often considered inadequate for fine-tuned management. In one case, a flood-bed system was associated with increased slug activity and losses of £800–£900 in seed stock.

Industry support and representation

Some growers reported feeling underrepresented within existing industry structures and disconnected from UK-wide peat-free initiatives. High membership costs, limited regional engagement and a perceived emphasis on retail rather than commercial production were cited as barriers to participation. Participants noted reduced availability of practical workshops and technical guidance compared to previous years. Several stakeholders also described a sense of geographic marginalisation, particularly in relation to England-focused initiatives. These perspectives highlight the need for stronger grower-focused networks and technical communication channels within Scotland.

Skills shortages and knowledge gaps

Growers identified limited technical understanding of peat-free substrates as a barrier to consistent performance. Uncertainty regarding composition and management was linked to avoidable crop failures, particularly during establishment. Some nurseries also reported post-sale plant losses where end-users lacked awareness of altered watering requirements.

More broadly, stakeholders described a perceived shortage of production horticulture skills within Scotland (Horticultural Trades Association, 2022b). While five institutions formally offer horticultural qualifications, several operate multi-campus models (e.g. Scotland's Rural College and the University of the Highlands and Islands), meaning that horticulture is delivered across multiple Scottish regional centres. The issue therefore appears less related to the number of learning locations and more to ensuring consistent quality, sector relevance and progression pathways across centres.

Participants frequently characterised new entrants as lacking production-specific skills; however, this reflects stakeholder perception rather than systematic evidence. General horticultural qualifications have long been the norm in Scotland, with sector-specific expertise traditionally developed through workplace experience. Sector-wide evidence indicates that horticulture faces ongoing recruitment difficulties and skills shortages, with employers reporting challenges in attracting and retaining suitably skilled staff (Horticultural Trades Association, 2022b; House of Lords Library, 2023). These pressures are not unique to Scotland but reflect broader labour-market constraints affecting commercial horticulture across the UK.

Apprenticeship provision presents a further structural constraint. While interest among prospective apprentices and training providers remains evident, sector commentary highlights limited employer uptake, often linked to financial pressures, constrained margins and limited incentives for long-term training commitments (House of Lords Library, 2023). Stakeholders suggested that rising input costs and uncertainty surrounding peat transition further reduce capacity to recruit and support apprentices.

Taken together, these findings indicate that the skills gap is shaped less by educational supply alone and more by recruitment dynamics, employer participation and the relative attractiveness of production horticulture as a career pathway. As peat-free systems require more precise irrigation, nutrition and substrate management, these workforce pressures may intensify during transition.

In this context, access to continuing professional development is particularly important. While online resources for amateur gardeners are widely available, professional-level provision is evolving. The Royal Horticultural Society provides a dedicated peat-free industry portal, and recent initiatives led by the Horticultural Trades Association (HTA) include nationwide projects to improve peat-free knowledge across the supply chain, alongside grower-focused workshops aimed at strengthening technical understanding and confidence (HortNews, 2025; Horticultural Trades Association, n.d.). However, current workshop delivery appears primarily concentrated in England, with more limited evidence of structured, regionally accessible provision within Scotland. Several growers emphasised the value of in-person technical demonstration and peer exchange, suggesting that geographically accessible training opportunities may be particularly important for supporting consistent adoption of peat-free systems across Scotland.

Business scale and geographic constraints

Business size and location were identified as significant determinants of adaptive capacity. Smaller nurseries reported limited purchasing power, restricted supplier choice and difficulty commissioning bespoke mixes. Minimum pallet orders and delivery costs (up to £60 per shipment) discourage small-scale experimentation. For remote growers, transport costs and climatic conditions further constrain media choice. Wetter regions, for example, require more free-draining substrates to reduce root disease risk.

Micro-scale businesses described limited capacity to invest in equipment such as moisture meters, and seasonal labour constraints restricted time available for experimentation. These factors demonstrate how scale and geography intersect to shape transition trajectories.

Biosecurity and regulatory constraints

Plant-health regulations were identified as an additional structural constraint. One large bedding-plant grower supplying the UK and Northern Ireland reported being unable to use wood-fibre media produced in Northern Ireland due to restrictions on re-entry once exported (Forestry Commission, 2021), contributing to continued reliance on peat. This illustrates the interaction between biosecurity regulation and environmental policy objectives.

Crop-level biosecurity considerations also limit the use of certain alternative materials. A soft-fruit grower reported that PAS 100 compost, while suitable for many crops when blended 50:50 with coir and bark, could not be used for raspberries due to pathogen risk. Noble and Roberts (2003; 2004) note that composted green waste may contain soil-borne pathogens including *Phytophthora* species. Biosecurity requirements therefore continue to shape both the pace and direction of peat-free adoption, particularly in sensitive sectors such as potato mini-tubers.

Appendix Q : Barriers for media manufacturers

Researchers conducted interviews with 11 growing-media manufacturers to examine barriers affecting the availability and scalability of peat-free products (Table 36). Three are based in Scotland. Of the original respondents, one had not yet entered the market and one has limited UK market presence; these are excluded from the tables below. Interviewed businesses vary in scale and market focus (retail, professional, or mixed). Some manufacturers – including Dalefoot Composts, Melcourt, and RocketGro – have operated peat-free since inception, embedding this approach within their business models.

Table 36: Growing media manufacturers interviewed and markets served

Company name	Market
Bulrush Horticulture Ltd	Retail and professional
Dalefoot Composts	Retail
Forth Resource Management (FRM)	Retail (through Caledonian Horticulture). Retail. Used by professional landscapers, garden designers and local authorities, mainly as soil improver and mulch.
Garden Solutions	Retail. Used by professional landscapers, garden designers and local authorities, mainly as soil improver and mulch.
ICL	Professional
Klasmann-Deilmann	Retail and professional
Melcourt	Retail and professional
RocketGro	Retail
Sinclair	Retail (Westland) and professional

The manufacturers most frequently used by interviewed growers are Sinclair, Bulrush, Klasmann-Deilmann and ICL (Table 37). While these companies have historically specialised in peat-based media, they are investing in the research, development and scaling of peat-free alternatives. Several continue to produce peat-containing products alongside expanding peat-free ranges.

Table 37: Manufacturer use among interviewed growers

Company	Sinclair	Bulrush	Klasmann-Deilmann	ICL	Melcourt
Number of interviewed growers using manufacturer's media	6	5	4	3	1

Raw material availability and supply chain constraints

Stakeholders consistently identified domestic supply limitations of key raw materials – particularly bark and wood fibre – as a principal bottleneck in peat-free production. Although UK forestry and sawmilling generate substantial bark arisings, only a proportion consistently meets the quality, particle size, and phytosanitary standards required for professional growing media. Manufacturers therefore reported continued reliance on imports, particularly for bark and coir.

Dependence on imported materials exposes producers to international market volatility, including shipping costs and climate-related production risks in exporting regions (Pathmeswaran et al., 2018). Competition for wood-based feedstocks from the biomass energy sector (Bek et al., 2020; Drax, 2025), as well as from pulp and construction industries, further constrains availability. As these materials are by-products of other industrial processes, supply is influenced by fluctuations in those sectors rather than horticultural demand (Office for the Internal Market, 2023). Tightening biosecurity regulations were also cited as a factor increasing sourcing complexity and cost, particularly in relation to bark imports (Litterick et al., 2025).

Global demand for growing media is projected to increase substantially by 2050 (Bek et al., 2020; Blok et al., 2021), intensifying pressure on established peat substitutes. Figures 6 and 7 illustrate increasing reliance on wood fibre across both retail and professional markets, alongside sustained demand for coir and bark. This concentration of demand on a limited number of substitute materials reinforces the supply pressures identified by manufacturers. anufacturers identified securing sufficient volumes of suitable alternatives as a primary logistical barrier, often exceeding cost concerns (Koseoglu and Roberts, 2025). While large-scale shortages are not considered inevitable, stakeholders noted that localised or prolonged supply gaps could generate commercial pressure where viable alternatives are constrained (Office for the Internal Market, 2023).

Figure 6: Key peat alternatives used in UK retail horticultural market, trend 2018-2023 (Defra, 2025b)

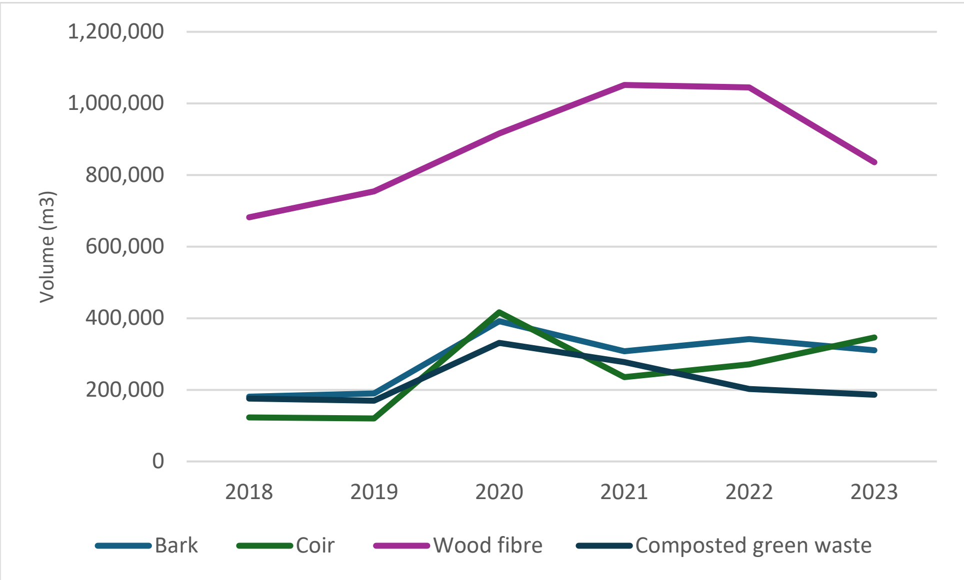
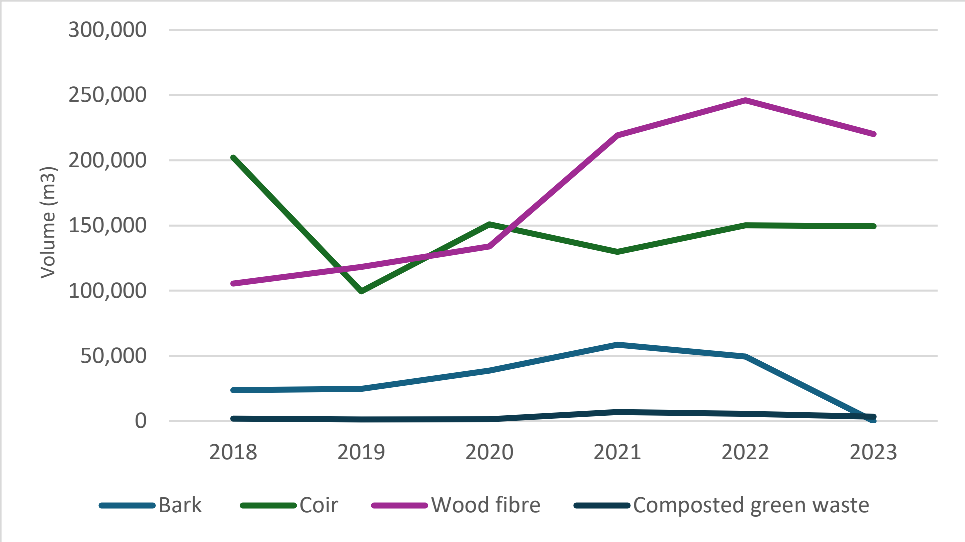


Figure 7: Key peat alternatives used in UK professional market, trend 2018-2023 (Defra, 2025b)



Logistics, processing and infrastructure gaps

Stakeholders emphasised that constraints extend beyond material availability to include limitations in grading, processing, blending and transport infrastructure. Participants reported difficulties in securing materials of appropriate grade at suitable locations, reflecting structural weaknesses further up the supply chain.

Certain feedstocks, including digestate fibre, require extended maturation periods and specialised handling facilities, necessitating investment in storage and stabilisation capacity. Manufacturers also identified a need for advanced screening and blending equipment to ensure uniformity at commercial scale. The Growing Media Taskforce (2022) similarly highlighted the scale of infrastructure expansion required to meet anticipated demand under peat-reduction scenarios.

Input quality, consistency, and industry standards

Manufacturers reported significant variability in component quality, particularly in wood fibre and composted green waste. Differences in production methods and grading standards were cited as contributing to inconsistent performance. In the case of green waste compost, contamination – including herbicide residues, sharps and pathogens – remains a concern for commercial producers (Barrett et al., 2016). Such variability continues to undermine confidence in recycled inputs (Litterick et al., 2025).

Koseoglu and Roberts (2025) emphasise the importance of clearly defined physical and chemical parameters, alongside stable supply, in enabling infrastructure investment and product development. The absence of harmonised grading systems and industry-wide technical standards was identified as a structural gap within the sector. The reformed Growing Media Association (Bragg, N., 2025, pers. comm; HortWeek, 2025a) has acknowledged this issue and is working towards the development of standardised technical frameworks. Manufacturers also reported limited availability of coordinated, independent trials to validate product performance at scale, particularly for emerging materials such as digestate fibre and farmed *Sphagnum* moss. Further collaborative research and transparent data were identified as necessary to support confidence and long-term investment.

Economic and investment barriers

Stakeholders consistently identified rising production costs as a major constraint. Replacing peat requires significant capital investment in processing infrastructure and quality control systems. Koseoglu and Roberts (2025) note that green-waste processors must invest in improved screening technologies to meet contamination limits under PAS 100 standards, while finely screened compost must be dry, necessitating additional covered storage capacity.

Industry estimates suggest substantial capital investment is required to process wood fibre at scale, with typical facility equipment often cited in the mid-hundreds of thousands of pounds. A respondent to the Office for the Internal Market (2023) reported that expanding coir supply capacity could require additional processing facilities costing approximately £0.8–£1.2 million per large plant. Smaller and regionally based manufacturers were considered particularly exposed to financial risk, given more limited capital reserves and reduced capacity to absorb volatility in material and energy prices.

Transport costs represent a significant component of total production cost. Materials such as composted green waste and wood-based substrates have higher bulk density than peat, increasing haulage costs per unit volume (Koseoglu and Roberts, 2025; Hirschler et al., 2022). Bek et al. (2020) suggest that relocation of processing facilities closer to feedstock sources may be necessary to mitigate transport costs. Earlier industry estimates indicate that transport costs for composted green waste and wood waste may be approximately 90% and 45% higher, respectively, than for peat (RSPB & English Nature, 2002), reflecting the economic disadvantage of heavier, bulkier materials.

Policy uncertainty and legislative inconsistency

Stakeholders identified uncertainty surrounding the timing, scope and alignment of peat restrictions across UK administrations as a significant barrier to investment. Manufacturers reported that inconsistent policy signals and unclear timelines complicate long-term planning and discourage capital expenditure on new infrastructure. Participants emphasised that clear, harmonised policy direction across UK nations would reduce market uncertainty and support strategic investment decisions. Legislative clarity and coordination were therefore viewed as critical to enabling a stable and scalable transition to peat-free production.

Appendix R : Barriers for plant retailers

Researchers engaged with ten retail businesses and two wholesalers to examine barriers facing the sector (Table 37). Seventy per cent of participating retailers also operated as growers, indicating exposure to both production and retail transition pressures.

Table 38: Retailers engaged for stakeholder engagement

Wholesalers with retail facilities	Growers with on-site retail	Garden centres	Major retailers	Total
2	7	2	1	12

Retailers occupy a central position within the horticultural supply chain, mediating between growers, consumers, wholesalers and growing-media manufacturers. Their transition away from peat-based media is shaped by structural, economic and behavioural constraints that affect both supply availability and consumer demand. Analysis of Scottish Government (2023b) consultation responses indicates that around half of retail plant organisations anticipated negative impacts from a ban on peat sales in Scotland.

Supply chain and infrastructure constraints

Retailers reported ongoing challenges relating to the reliability and consistency of peat-free supply chains. Limited domestic processing capacity and variable product availability restrict the ability of some businesses to offer a fully peat-free range. Larger retailers expressed concern that peak-season shortages may intensify competition for limited volumes, potentially disadvantaging smaller outlets (Office for the Internal Market, 2023).

Storage requirements were also cited as a practical barrier. Stakeholders reported that some peat-free substrates deteriorate more rapidly in storage than peat-based equivalents, necessitating dry, covered conditions and faster stock turnover. For smaller garden centres and wholesalers with limited infrastructure, this increases space and handling pressures.

Economic barriers

Price differentials remain a significant constraint. Stakeholder interviews indicated that peat-free products are typically more expensive than peat-based equivalents. The Office for the Internal Market (2023) reported that many retailers maintain price parity between peat and peat-free media, absorbing margin reductions on peat-free lines. Retailers noted that widening cost differentials could reinforce reliance on peat-based products. Consumer affordability reinforces these dynamics: Koseoglu and Roberts (2025) report that 48% of respondents cited the price of peat-free products as a key reason for continuing to use peat-based media, echoed by stakeholder feedback that higher peat-free costs limit uptake among budget-conscious customers (Dahlin et al., 2019). Smaller independent retailers face additional constraints, lacking the purchasing leverage of national chains and often negotiating supply contracts based on financial terms rather than substrate composition. In the absence of expanded domestic processing capacity, sourcing peat-free products from UK suppliers was described as more expensive than importing from EU producers.

Quality and consistency issues

Variability in product quality was widely reported. Stakeholders described inconsistencies between batches, including variation in nutrient balance, pH stability and contamination in composted green waste (e.g., plastics or glass fragments). Trials conducted by the Stockbridge Technology Centre graded 44% of 32 tested retail peat-free products as unacceptable (HortWeek, 2025b). Such variability presents reputational risks for retailers, as negative consumer experiences reduce repeat purchases and erode trust (Koseoglu and Roberts, 2025).

One large bedding-plant grower-retailer reported shorter shelf life, increased irrigation requirements and reduced visual quality in some peat-free crops, affecting saleability during peak trading periods. Reports from industry groups suggest that some retailers have reintroduced peat-containing lines following adverse customer feedback.

Cultural and consumer barriers

Despite increasing environmental awareness, consumer demand for peat-free products remains inconsistent. A national survey reported that 60 per cent of respondents considered access to peat-free growing media to be a preference or essential factor (Office for the Internal Market, 2023). However, stakeholder sales data indicated contrasting trends. One retailer reported a 56% decline in peat-free bagged media sales between 2023 and 2025, while electronic point of sale (EPOS) data from March 2025 recorded two peat-based products among the top twenty garden retail items by turnover, compared with one peat-free alternative (HortWeek, 2025c).

Retailers attributed this disparity to a gap between environmental attitudes and purchasing behaviour. Some gardeners remain sceptical of peat-free media performance, particularly where slower establishment occurs. Koseoglu and Roberts (2025) note that successful use of peat-free media often follows a period of adaptation and learning, suggesting that experience influences repeat adoption. Retailers reported limited opportunity for in-store education during peak seasonal sales periods. Industry-led initiatives have sought to address this through accessible guidance materials aimed at hobbyist gardeners (Chartered Institute of Horticulture, 2025).

Industry standards and regulatory context

Retailers and trade bodies highlighted the absence of a unified certification or labelling framework for peat-free growing media as a barrier to procurement and consumer communication. Variation in quality and environmental claims complicates assurance and marketing (HortWeek, 2025b). Regulatory divergence was also raised as a concern: imported plants grown in peat are not currently subject to equivalent domestic restrictions, potentially creating competitive imbalance for UK retailers.

Appendix S : Sector and crop specific barriers

The following analysis synthesises stakeholder interview evidence alongside relevant published research cited in Section 6.2.4.

Ericaceous Crops

Ericaceous crops present distinct transition challenges due to the interaction between substrate chemistry, production system duration and supply chain configuration. While Section 6.2.4 outlines the strategic significance of this crop group, stakeholder evidence highlights several system-specific constraints that intensify transition risk at operational level.

Substrate chemistry and pH stability

Ericaceous species are highly sensitive to substrate pH and nutrient dynamics. Growers reported that reducing peat content below approximately 50% in some commercial systems was associated with reduced vigour and lower fruit quality, particularly in blueberries. The primary challenge was not simply achieving low pH at mixing, but maintaining pH stability and nutrient buffering over extended production cycles. Peat-free blends incorporating coir and bark have demonstrated technical potential, however, performance was described as highly formulation-dependent. Minor inconsistencies in batch composition or irrigation management were reported to produce disproportionate impacts on crop performance. For slow-growing species, this increases exposure to cumulative substrate drift over time.

Production cycle duration and financial exposure

Many ericaceous crops, particularly rhododendrons and blueberries, have comparatively long production cycles; slower growth rates limit the opportunity to correct early-stage substrate deficiencies. Stakeholders emphasised that even modest reductions in uniformity or fruit quality can translate into significant financial losses, particularly in high-value fruit production systems. As a result, tolerance for experimentation is lower than in short-cycle ornamental crops. Transition risk is therefore magnified not solely by plant physiology, but by the economic structure of production.

Embedded peat within the supply chain

A further constraint arises from the sourcing of imported starter plants and plugs. Several ericaceous growers rely on overseas suppliers for larger blueberry plants or specialist rhododendron material. Where these are already rooted in peat-based substrates, complete elimination of peat at nursery level becomes technically impractical under current supply arrangements. This embedded peat dependency limits the feasibility of full substitution within Scottish production systems unless parallel transition occurs within European propagation supply chains.

Evidence gaps and trial scale

While short-duration trials and small-scale demonstrations have reported encouraging results in peat-free ericaceous production, stakeholders questioned the transferability of such findings to multi-season, commercial-scale systems. The long production cycle of many ericaceous crops means that short-term trials may not capture longer-term structural or nutritional instability.

In ericaceous systems, the principal barrier is not proof of technical impossibility, but risk concentration. High-value crops with long production cycles and strict pH requirements amplify the consequences of substrate variability. Transition therefore depends less on demonstrating short-term growth feasibility and more on achieving reliable, multi-season performance under commercial-scale conditions, alongside alignment within upstream propagation supply chains.

Potato mini-tuber production

Mini-tuber production operates within a uniquely constrained technical and regulatory environment. While Section 6.2.4 outlines its strategic importance within the seed potato supply chain, stakeholder evidence identifies several interrelated barriers that intensify the complexity of peat-free transition in this sector.

Biosecurity and regulatory rigidity

As the first stage in certified seed multiplication, mini-tuber facilities operate under strict phytosanitary controls. Scottish seed stocks must originate from nuclear material certified by Science and Advice for Scottish Agriculture (SASA), and production systems are designed to minimise any risk of pathogen introduction. Within this framework, tolerance for substrate variability or contamination is extremely low. Stakeholders expressed concern that certain alternative feedstocks – particularly green waste-derived materials – may present unacceptable phytosanitary risks, including potential exposure to potato cyst nematode (PCN) or powdery scab (*Spongospora subterranea)*. Even materials considered comparatively stable, such as wood fibre or coir, were associated with uncertainty regarding treatment standards, provenance and cross-contamination controls.

Novel feedstocks including farmed *Sphagnum* and hemp fibre were viewed cautiously unless cultivated under tightly controlled biosecure conditions. Although sterilisation could theoretically mitigate pathogen risk, growers noted that this may alter substrate biology in ways that affect crop performance. Importantly, independent research indicates that peat-free substrates do not inherently pose greater plant health risk than peat (McGrann et al., 2020). However, awareness of this evidence remains limited, and precautionary approaches dominate decision-making. The regulatory environment, while essential for safeguarding seed integrity, therefore constrains experimentation and slows adoption.

Substrate consistency and processing standards

Beyond biosecurity, growers identified physical and compositional consistency as a critical barrier. Mini-tuber systems depend on uniform tuber size, predictable growth rates and stable moisture dynamics. Stakeholders reported variability in peat-free media, including inconsistent particle size distribution, the presence of undecomposed wood fragments or foreign material, and irregular wetting behaviour. Hydrophobicity and difficulty rewetting once dry were recurrent concerns. In some cases, surface mycelial growth or biological activity reduced confidence in substrate stability.

Trial data from both stakeholder experience and published research suggest that while mini-tubers can be produced in peat-free media, yields may be reduced and tuber size distribution more variable compared to peat-based systems. In high-health, high-uniformity production environments, even modest yield reductions are commercially significant. Collectively, these factors reinforce the perception that peat-free substrates introduce greater operational variability into a production model designed around consistency

Varietal sensitivity and media compatibility

Growers emphasised that substrate performance is strongly genotype-dependent. Across highly diverse varietal portfolios, responses to peat-free media varied considerably. Short-maturing, compact varieties were generally reported to adapt more successfully, whereas later-maturing cultivars were more prone to yield reduction under alternative substrates. This heterogeneity complicates formulation development and limits the feasibility of universal peat-free mixes. The implication is not that peat-free production is unachievable, but that compatibility testing must account for varietal diversity at commercial scale. Without coordinated, multi-variety trials, growers remain cautious about system-wide adoption.

Market structure, scale and investment constraints

The mini-tuber sector is small and highly specialised. Stakeholders described limited leverage over substrate manufacturers and restricted access to bespoke formulations. As a niche customer group, producers often rely on commercially available blends rather than media tailored to mini-tuber requirements. Cost premiums for peat-reduced or peat-free substrates were reported to be substantial, with limited capacity to pass additional costs downstream. At the same time, market demand for peat-free seed material remains weak, and sustainability requirements are not yet embedded within wider seed procurement standards. Policy uncertainty further compounds investment hesitancy. In the absence of clear legislative timelines, growers reported difficulty justifying major infrastructure or trial expenditure. Given the limited number of facilities operating in Scotland, stakeholders expressed concern that significant yield reductions during transition could not easily be absorbed elsewhere within the sector.

In combination, these barriers illustrate that mini-tuber transition is constrained less by absolute technical impossibility and more by the interaction of biosecurity rigidity, low tolerance for performance variability, genotype sensitivity and limited market leverage. Effective transition in this sector is therefore likely to require coordinated, centrally supported trials, clearer regulatory guidance on substrate testing, and targeted engagement with media manufacturers to ensure processing standards align with certified seed production requirements.

Propagation systems

Propagation represents a structurally sensitive stage in horticultural production, where small inconsistencies in substrate performance can result in disproportionate crop losses. While Section 6.2.4 outlines the general technical sensitivity of peat-free propagation, stakeholder evidence highlights additional operational and supply-chain constraints.

Early-stage moisture dynamics and germination sensitivity

Stakeholders consistently identified seed germination as one of the most vulnerable stages in peat-free transition. Difficulties were most pronounced in small-seeded species, where rapid surface drying in coarse or fibre-rich substrates reduced establishment rates. Larger-seeded species, sown deeper into more stable moisture zones, were reported to perform more reliably. These findings indicate that peat-free substrates often require recalibrated irrigation regimes to maintain uniform moisture gradients across shallow tray systems. In smaller operations, the need to sieve mixes to remove coarse particles or manually adjust watering practices increased labour demand. Evidence from independent trials similarly demonstrates wide variability in germination performance across commercially available peat-free composts, with outcomes highly dependent on both formulation and watering practice. This suggests that successful transition at propagation stage depends not only on substrate refinement but also on technical guidance and irrigation adaptation.

Plug plant supply-chain dependency

Unlike in-house seed propagation, plug production is frequently outsourced. Many Scottish growers source plugs from European propagators, limiting direct control over substrate composition. While performance of peat-free plugs was generally reported to be satisfactory in ornamental systems, supply-chain capacity and licensing constraints were identified as more significant barriers than plant growth outcomes. Plant Breeders' Rights (PBR) restrict propagation of certain varieties to designated suppliers; if those propagators have not transitioned to peat-free systems, growers have limited alternatives.

In UK forestry production, biosecurity regulations prohibit the import of plug plants from Europe, requiring domestic propagation. This increases exposure to UK substrate supply constraints and places additional importance on the development of reliable peat-free systems within Scotland. Some stakeholders argued that the peat fraction within plugs represents a relatively small proportion of total container volume once transplanted. However, reliance on peat-containing plugs remains structurally embedded in current supply chains, limiting the feasibility of complete substitution without upstream alignment.

Pressed block systems: mechanical compatibility and water management

Pressed, unwrapped growing blocks present distinct technical challenges. While certain peat-free media perform adequately in modular trays, achieving sufficient cohesion for mechanised block formation has proven difficult. Stakeholders reported that peat-free blocks required significantly more frequent irrigation prior to transplanting, increasing nutrient leaching and operational input costs. In some cases, blocks were prone to structural failure during mechanical transplanting, reducing placement accuracy and crop uniformity. For highly mechanised field vegetable systems, this fragility represents a substantial barrier to commercial scalability. Targeted research programmes are actively addressing these constraints, focusing on improving block cohesion, moisture retention and compatibility with existing machinery. Early-stage results are promising, but fully peat-free, commercially scalable formulations remain under development.

Appendix T : Standards for growing media

11.1.1 Stakeholder requirements in Scotland

This appendix provides qualitative evidence underpinning Section 7.1, illustrating how variability in peat-free growing media is experienced across different horticultural sectors. Across interviews and workshops, participants consistently identified the absence of consistent performance standards as a structural barrier to transition. Concerns centred on material reliability, biosecurity assurance and accountability across supply chains.

Ornamental growers

Ornamental nurseries reported variability in both physical and biological properties of peat-free media. Key concerns included:

- Immature compost components arriving before full stabilisation, affecting crop performance.
- Excess fines in wood-based materials, reducing drainage and air-filled porosity.
- Biosecurity risks linked to raw material provenance, including susceptibility of certain bark sources to pathogens such as *Phytophthora*.

Growers supplying the retail market emphasised a perceived quality gap between professional and retail-grade products, attributing this largely to price pressure within supermarket supply chains. Inconsistent quality in some retail peat-free composts was described as damaging consumer confidence, with poor early experiences continuing to shape public perceptions of peat-free performance.

Commercial-scale growers operating under tight margins stressed that consistency is critical when bulk purchasing. Variability between batches increases financial exposure, particularly where entire crop cycles depend on a single substrate delivery. While some stakeholders supported external regulation, others argued that responsibility for consistency should remain with manufacturers, provided quality parameters are transparent and enforceable.

There was broad agreement that standardisation at the level of individual raw materials may be impractical given supply-chain diversity. Instead, stakeholders favoured defined performance thresholds for finished growing media products.

Tree growers for forestry and woodland

Tree producers highlighted challenges in applying consistent standards to novel or regionally sourced materials. Environmental credentials provided by manufacturers were viewed as insufficient substitutes for defined quality benchmarks. Several producers indicated that while in-house green waste might be available, variability and biosecurity concerns limited its safe deployment without external oversight. Given long production cycles and high-value planting contracts, reliability over multiple seasons was considered essential.

Potato mini-tuber producers

Mini-tuber producers emphasised the need for peat-free media to replicate peat's uniform moisture retention and predictable physical structure. Given the sector's high biosecurity requirements and certification controls, stakeholders called for:

- Defined water-holding capacity thresholds.
- Mandatory sanitisation standards.
- Clear pathogen-testing protocols for media.

Views diverged regarding governance. Some growers supported government-led oversight given the strategic importance of seed potato production, while others favoured manufacturer-led self-regulation within a clearly defined and auditable framework.

Overall signal from stakeholders

Across sectors, appetite for strengthened quality assurance was high. Participants consistently linked inconsistent media performance to increased commercial risk, particularly in propagation, plug production and high-value certified systems.

Stakeholders identified the following elements as essential to building confidence:

- Clear performance thresholds for finished products.
- Transparent labelling and disclosure of composition.
- Defined sanitisation and pathogen-testing standards.
- Independent verification or audit mechanisms.

While opinions differed on the appropriate governance model, there was broad consensus that current variability and limited accountability undermine confidence in peat-free media. Strengthened and coordinated standards were viewed not as additional regulatory burden, but as a mechanism to protect growers, maintain productivity and secure the environmental benefits of peat substitution.

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