Understanding the barriers and opportunities for eliminating peat from the growing media mixes from the perspective of different supply side stakeholders

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Table of Contents

1. Summary

The amateur horticulture market uses more than 60% of growing media sold in the UK. The purpose of this work is to understand the dynamics of reducing and eliminating peat on the supply side of the growing media supply chain in the amateur gardening market. This has the overall aim to maximise the potential for circular and local economy and to promote the Green Recovery and peat free growing media by using local recycled materials. This research follow-ups from Koseoglu and Roberts, (2021) where we researched the barriers to the uptake of peat-free growing media alternatives on the demand side, investigating the consumer preferences and motivations to use peat-free compost.

Peat has historically been cheaper and more locally available than other growing media alternatives, making it a more attractive growing media input. However, peat is losing its attraction rapidly. Through interviews with stakeholders in the supply side of growing media we identify the need for transition to a peat free growing media supply chain. Combining the information gathered from the interviews and from publicly available sources, we conclude that there are two main drivers (or barriers) for transition to peat-free growing media: economic and environmental impact. Most of the UK's horticultural peat has previously been imported from Ireland (Bain and Goodyer, 2016). The availability of peat to the UK and Irish market, will significantly be reduced in the coming years as Bord na Mona stopped harvesting peat in 2021 (Marshall, 2021). Peat is a relatively bulky material and the need for international transport increases its cost as an input for the growing media producers, driving up costs (England *et al.*, 2021).

However, a problem remains for the industry in the availability and the quality of the alternative material streams, identified by most respondents and yet to be resolved. While the need for change is already recognised through the supply chain, only few large companies have so far been willing to face the potential market risks and losses for early adopters of a peat-free supply chain. For supermarkets, where most volume of growing media is sold in total yet for which growing media mixes are not a critical product according to the interviews, the main motivation would be reducing the overall carbon footprint and the environmental impact of the business.

2. Introduction

Peat has long been considered a valuable resource for gardening and horticulture. However, in recent decades peatlands have also been recognised as an important store of carbon, and extraction of peat leads to release of greenhouse gases, contributing to climate change. This has led to several alternatives to peat in horticulture being developed.

The UK Peat extraction in 2020 alone estimated to release up to 880,000 tonnes of CO_2 into the atmosphere, an amount equal to the annual greenhouse gas emissions of more than 214,000 UK residents (Doar, Science and Trusts, 2022). To meet the target of net zero carbon by 2045 the Scottish Government is committed to protecting and restoring Scottish peatlands. While opening new sites in Scotland is banned, protecting peat in Scotland, two thirds of the peat sold in the UK is imported from mainland Europe. Importing peat is effectively exporting carbon footprint associated with peat use (DEFRA, 2021a). The demand for peat based growing mixes for hobby gardeners is a strong driver for the extraction and import of peat for horticulture.

In our analysis of the demand side of peat in horticulture (Koseoglu and Roberts, 2021), we concluded that hobby gardeners vary in their priorities and preferences in term of growing material. Therefore, if the policy target is to match hobby horticulture market's demand with an entirely peat free growing

media supply chain, then several different aspects (i.e. availability, pricing, performance, standardization of bag content and labels, end users' awareness and familiarity with the use of peat free materials and acceptance of non-peat based products in the online and print media) have to be simultaneously improved in collaboration across the supply chain and with other peat extracting trade partners and countries, especially with the rest of the UK and in the Republic of Ireland. While main peat exports of the UK used to come from the Republic Ireland Fig. 1 (GMA *et al.*, 2021), there are also other mainland European countries such as the Netherlands, Germany, Belgium and in the recent years most increasingly the Baltic countries, that exports peat to the UK (Fig. 2) whose share of exports are expected to increase after the Bord na Mona ceased to extract peat in Ireland in 2021 (DEFRA, 2021a; Holmes and Bain, 2021).

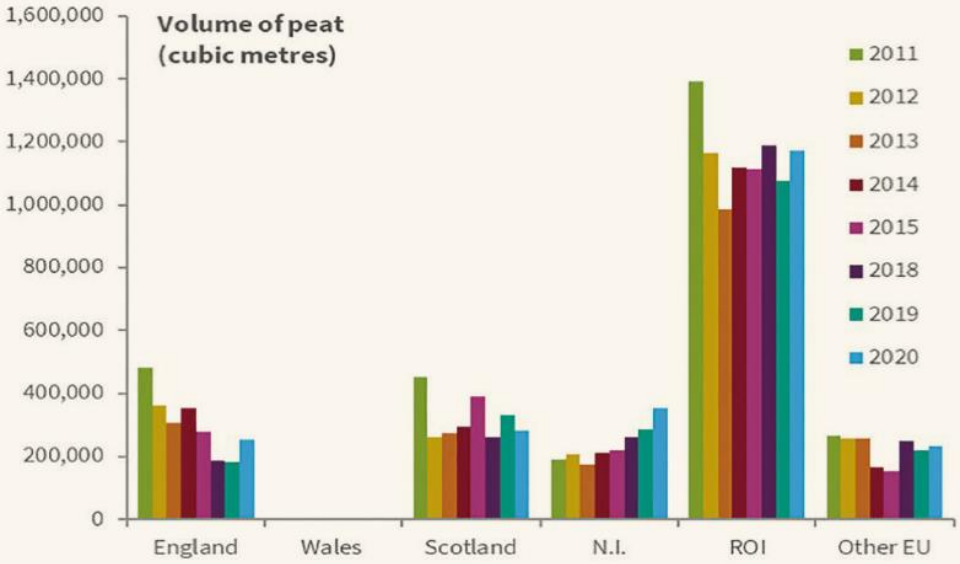

Fig.1 Sources of peat used in the UK horticulture between 2011 and 2020 complied from HTA, GMA, AHDB and DEFRA sources (GMA *et al.*, 2021)[1]. Wales do not commercially extract peat.

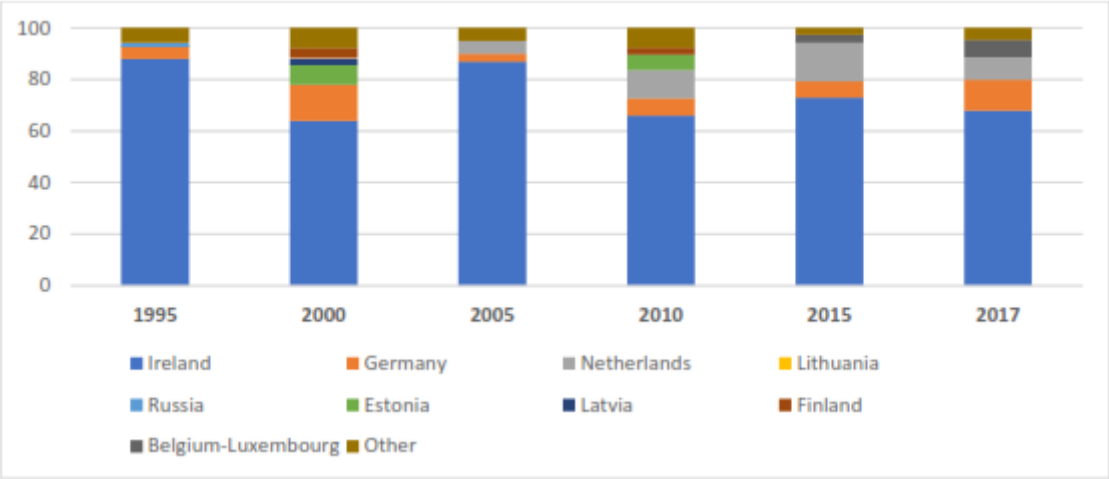

Fig.2 Sources of imported peat in the UK between 1995 and 2017 (Bek *et al.*, 2020).

In this report, we aimed to understand the needs of the supply side of the gardening and horticulture supply chain and the reasons for their dependence on peat for the hobby horticulture market. To this

[1] NI and ROI on the figure refer respectively to Northern Ireland and the Republic of Ireland

end, we have conducted semi-structured interviews with stakeholders in the growing media supply chain. Our focus is not only limited to peat-free compost producers and retailers but also other direct and indirect players in the supply chain such as councils as collectors of organic waste, recycling companies as producers of compost and anaerobic digestate, peat extractors, NGOs, policy makers and as well as producers and retailers that deal with both peat-based and peat-free products.

This is important for two reasons. First, the expert interviews in the first part of our research last year demonstrated that the peat-free and peat-based growing media supply chains are usually entwined with same producers and retailers dominating both. Second, considering different perspectives in the horticulture market is essential to understand which stakeholders have the most power and possibility to change and to construct intervention options for a transition scenario in which there will be least negative societal, economic, and environmental impacts.

3. Methodology

We followed a parallel methodology to the analysis of supply side of the supply chain reported in Koseoglu and Roberts (2021). We have mapped the stakeholders relating to the supply side of the growing media supply chain and created a script and list of contacts for semi-structured interviews. We aimed to include at least one organisation representing each different type of interest in the growing media market by using publicly available contact information.

We initiated contacts and recruited key stakeholders for interview and used snowballing method relying on initial interviewee's contacts to recruit. Representatives local garden retailers and supermarkets could not be recruited. We conducted total of 10 interviews and assume that those we have interviewed are likely to be those with higher interest in reducing peat use in horticulture, or those which have higher power or autonomy to make such decisions.

At the end of the project, we communicated the draft project report to the research for respondents' feedback and will explore the future possibility of initiating a suitable online community in a social media channel such as a group in LinkedIn.

3.1 Overview of the market and mapping of stakeholders

The UK's amateur sector makes up more than 60% of horticultural peat use (UK Government, 2021) as shown in Fig.3. The UK Government adopted the 2010 Defra proposals for retail supplies in England to be peat free by 2020 and for commercial horticulture by 2030. Despite this commitment, the target was not met, and peatlands in Britain and elsewhere in Europe continue to be exploited for hobby horticultural use in the UK (UK Government, 2021).

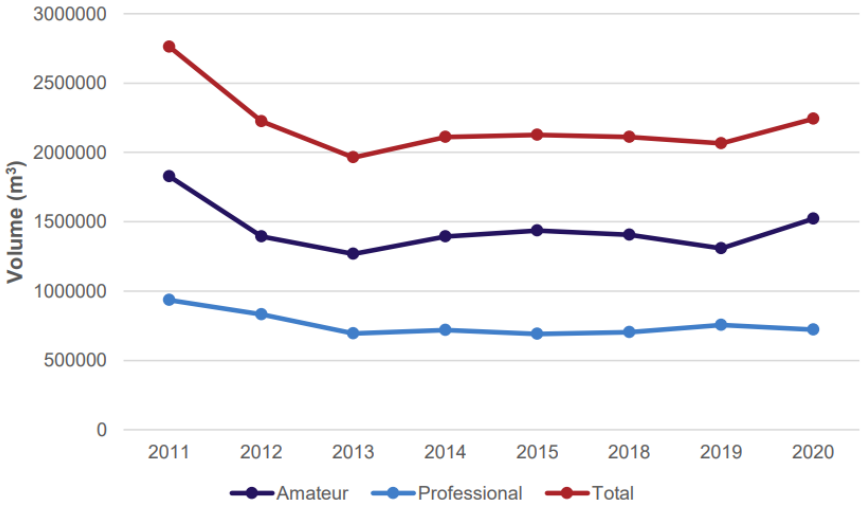

Fig 3. Peat use in horticulture between 2011 and 2020 (UK Government, 2021).

While some progress has been achieved in reducing the peat content in the horticultural mixes they produce and sell (England *et al.*, 2021), voluntary targets have only managed to reduce peat consumption by 25% between 2011 and 2019, as shown in Fig. 3. From 2019 onwards, peat extraction for hobby gardening in the UK has started to rise again as result of increased interest in hobby gardening during COVID lockdown periods, and disruption to the supply chains for imported alternative materials such as coconut coir during the COVID pandemic (Jackson, 2021; UK Government, 2021). As a result, a legally enforceable ban on peat use in hobby horticulture is currently proposed (DEFRA 2021).

In this study we aim to understand the needs and motivations of growing media producers, retailers, and other stakeholders for completely removing peat from the growing media supply chain. In this effort we mapped the peat-free and peat-based growing media supply chains (Fig.4) and the ways in which they overlap. An important detail to recognise is that many organisations simultaneously operate in multiple locations in both supply chains. For example, some councils do not only collect organic waste but also, manage the composting and few, namely Dundee City Council, also have a certification of peat free compost (i.e., Discovery compost) (Dundee City Council, 2020; REAL, 2022). Similarly, growing media producers tend to produce a variety of products with peat-based, reduced peat or no peat content for various outlets and some growing media producers that also operate as peat extractors.

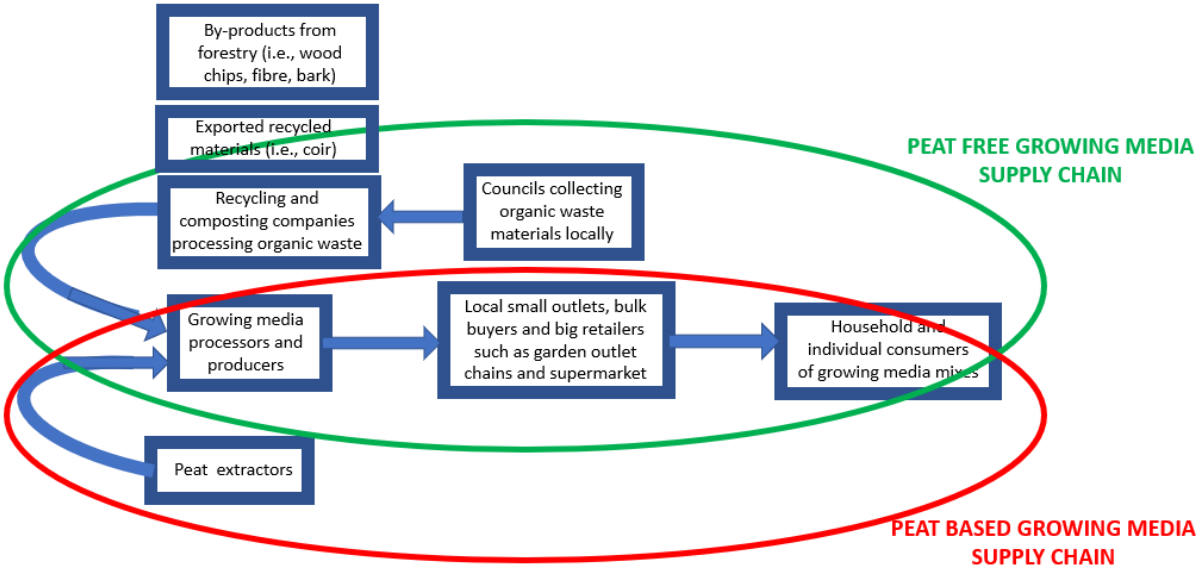

Fig.4 Growing media supply chain

3.2 Policy makers, NGOs, Trade organisations

Policymakers, NGOs and professional associations are indirect stakeholders, that are not operating in the growing media supply chain actively but have significant influence on the supply chain. Therefore, we started our stakeholder engagement with these organisations and benefited from their industry level insights, higher level overview, and leads in terms of industry contacts to interview. Here we include the names of the specific organisations to indicate why we have picked to interview them over other alternatives assuming that there is no conflict of interest, though note we were also limited to those that had time to participate in our research. We refer to all interviewees' as "they" to reduce the possibility of identifying the individuals interviewed and represented each participating organisation.

- Zero Waste Scotland (ZWS)

ZWS is a non-profit organisation funded by the Scottish Government that provides practical support to promote the circular economy in Scotland (ZWS, 2022b). They have expertise and experience working with organic waste and various industries. We interviewed a policy marker who works with compost and digestate producers. They also spoke about engagements they held with the growing media industry in early 2010s. At the time they observed the growing media industry to be quite pro peat and the current interest for transition was not there at the time and ZWS stopped the programme 5 years ago.

The participant from ZWS pointed out several problems in terms of economics of the transition to peat free growing media that kept coming up in the later interviews with growing media supply chain producers. The growing media industry demand light and inert materials for replacing peat, yet digestate and compost are bulkier and heavier compared to peat. This makes transport costs higher and requires the distances between the recycling and growing media production sites to be small for the costs to remain competitive. The weight of the materials is also a concern in term of bulking up the bag content. The high electrical conductivity and the nutrient content of green compost and anaerobic digestate makes them more complicated to be mixed with other materials for land application compared to peat, which is an inert material.

Contamination is a major concern in land applications. ZWS highlighted that buying from certified recycling companies with higher quality output can reduce this risk and can allow the growing media producers to control for physical contaminant content such in metals and plastics. If growing media producers are interested in making a transition and accept paying more for higher quality compost, then the certification process can be modified for higher and tighter restrictions according to their input demand requirement. This was also an essential change identified by the review of (Bek *et al.*, 2020) in terms of reducing risk of plastic contamination in PAS certified recycled products. ZWS suggested that we interview the certified composters and anaerobic digestate companies in Scotland (REAL, 2022) to understand the price dynamics better.

ZWS also observed that while local authorities collect the garden and organic waste and supply this organic input to recycling companies, they do not all use the resulting green compost on the premises they manage, and so fail to lead by example. The efforts for replacing peat-based or peat containing products with locally produced and certified green compost can be led by councils themselves. While a few councils reprocessing their own organic waste materials and advertise on their website how local residents can access the green compost they produce, this is not a common practice. The number of people able to access green compost locally could be improved through the better communication from councils. This was a suggestion also made in the interviews we held last year with the members of the local gardening associations.

- Responsibly Produced Peat Foundation (RPP scheme)

There are various international, UK wide and local charitable foundations promoting the ban of peat use and peat extraction on the environmental grounds (DEFRA, 2020; Plantlife, 2021). However, there are also others that look into improving the current conditions of peat extraction. There are only two certification schemes: Veriflora developed in Canada and Responsibly Produced Peat (RPP) foundation's RPP scheme developed in the Netherlands (Rieley, 2011), which is the only sustainability certification scheme for peat extraction in Europe. We engaged with the more relevant Responsibly Produced Peat Foundation from the Netherlands.

As an industry initiative RPP aims to respond the Dutch government on the use of peat for growing media in the Netherlands. They defined principles and criteria for responsible sourcing of peat and have drawn up a certification scheme for responsible extraction to which companies can demonstrate compliance. The foundation is not involved in direct management of peatlands or production of peat-products. The involvement of companies and other stakeholders in the certification scheme is transparently reflected in the policies as defined by the Board and the requirements of the scheme. The companies seeking RPP certification are "the peat producers who are closely connected to the market, e.g., as growing media producer, are most motivated to apply for RPP-certification, as they best understand the wishes of their customers and market-requirements". The full list of RPP certified companies is publicly available in their website.

The volume of peat produced with RPP certified locations adds up to roughly 11 million m^3, estimated 35% of the European volume of peat extraction for growing media. The number of sites certified between 2016 and 2021 is approximately 70, in Germany, Sweden, Poland, Lithuania, Latonia, and Estonia. With the new applications still in progress, the number of sites is expected to reach 90 with a total acreage of 22.000 ha in 2022. The certification mainly regulates the way the site is maintained after-use. A new version of the RPP-scheme (3.0) is issued recently, including new and stricter requirements. While the RPP secretariat has insight into specific conditions in licenses, they did not

disclose us whether there is any volume limitation for peat abstraction in the licences for a set time frame (e.g., per year, per licence period etc.) on basis of confidentiality of individual and company-specific situations.

RPP does not have a policy for phasing out the use of peat or discouraging the use of peat. They state "A basic principle of RPP is that when peat is needed for growing media, it must be sourced in a responsible manner. RPP strives for 'no impact on High Conservation Values' and after-use; best possible destination with maximum environmental benefits including climate change mitigation". Further the growing media industry does apply RPP-peat to implement their sustainability policy. The application of RPP requirements can be stimulated by wide acceptance of the RPP scheme and a longer-term perspective on the role of peat in cultivation media. Complying with RPP requires investments by companies that ultimately have to be recouped".

A key-value of RPP is preserving biodiversity. To this end, only degraded peatlands may be selected under RPP and possible negative impacts on High Conservation Values (HCV) in adjacent areas, shall be avoided and/or mitigated. Peat-excavations as such results in carbon emissions, eventually the total carbon content of the peat materials applied in growing media will oxidise and be emitted as CO_2. However degraded, unmanaged peatlands also do emit carbon at an average level 10 tons of CO_2 per year (IPCC). Emissions are calculated for peat degradation until the water table is reached.

RPP advocate that small-scale peat extraction can accompany large-scale rewetting and restoration by the peat-industry and stop release of further CO_2 emissions. To this end, they claimed that RPP contributes to large scale restoration and provides constituents for growing media coming from paludiculture[2]. RPP concluded that d*ue to the importance of* growing media in the horticulture supply-chain, a responsible production chain is important (e.g., those certified by RPP). In sustainability, all aspects must be considered, the impact of other materials (Lifecycle assessments) must also be assessed and the quality and safety of constituents in growing media have to be assured.

- Horticulture Trade Association (HTA)

HTA, is trade organisation that represents organisations that are involved in the horticulture sector, such retailers, manufacturers, professional gardeners and other tradesmen in the gardening industry. They have an extensive understanding of the horticulture market and industry as well as the perspectives of different horticulture supply chain stakeholders.

We interviewed two representatives from HTA, who also highlighted a recent consumer study (HTA, 2021). Via this survey, HTA have identified different segment of the consumers based on which criteria the consumers use when they make purchase decisions. Their findings are consistent with those of our surveys (Koseoglu and Roberts, 2021) that hobby horticulturalists tend to buy their growing media from local garden centres and DIY stores, and they prioritise availability of the products in the outlets they buy from. This results in retailers having the power to influence the consumer behaviour, such by stocking more peat free growing media in the stores, providing growing advice with peat free growing media mixes and use clearer and more consistent labels.

HTA interviewees acknowledged DEFRA's proposed deadline by 2024 to remove peat containing materials from retailers in England (DEFRA, 2021a) and stated that the growing media industry is also

[2] Paludiculture, also referred as the wet agriculture and forestry on peatlands, is the productive use of wet and rewetted peatlands in an attempt to preserve the peat soil and thus, minimising nutrient runoff, CO_2 emissions and subsidence (De La Haye, Devereux and van Herk, 2021).

intending to remove peat from their product. HTA has chaired a growing media taskforce recently and they can comment that depending on the government support the elimination target could be achieved by 2025 to 2028 in the retail market (Mcquilliam, 2021).

The respondents from HTA identified the lack of suitable alternative material flows as the main problem for the industry to replace peat. They have mentioned the challenges with the local alternative materials such as wood fibre being high in demand from other industries and exported alternative materials like coir not being sustainable when all aspects are assessed. They envision some knock-on effects in the case of elimination of peat such as some amateur gardeners dropping out of gardening because of unfamiliarity with peat-free products. HTA further commented that the COVID lockdown increased the interest in hobby gardening and the existing demand for growing media, making alternative materials more costly due to competition and the increase in prices is bound to be reflected to the consumers as result.

HTA highlighted that there is no silver bullet intervention that would enable a full transition to peat-free growing media supply chain, and policy decisions have to be considered not at Scottish but the UK level due to the interconnectedness of the supply chains. HTA highlighted several possible policy solutions, such as establishing a secure access to different sources of alternative materials for the growing media industry and improving the quality of the alternative recycled materials such as green compost by reducing contamination. The content of glass, stone, and other physical contaminants such as plastic has to be minimised, which could be achieved through subsidising recycling companies to improve infrastructure through tax breaks and planning permissions.

Additionally, the growing media production industry requires the time and the funding to test the alternative mixes. This especially applies to the part of the industry that cater for plants that grow better in peat. HTA also highlighted some solutions that the industry can develop itself such as knowledge transfer and joint investment in trials, giving the example of automotive industry collaborations for moving away from fossil fuels.

3.3 Peat extractors

According to the figures featured in the report of the British Geological Survey (Cameron *et al.*, 2014) 63% of peat extracted in the UK is extracted in Scotland (0.5 million of 0.8 million m^3) and the majority of Scotland's peat extraction (0.47 million m3 out of 0.5 million) is used for horticulture (IUCN, 2016). Seven contractors in Scotland peat extraction provide employment to 85 people directly and 57 people in directly. In 2016, International Union for Conservation of Nature (IUCN) conducted a review to identify the number of active commercial peat extraction sites in Scotland and the environmental status of these active sites using the Renewal of Minerals Permissions (ROMPs), which occur every 15 years after permission to extract peat has been granted. The results of the ICUN review are summarised in Fig. 4 (IUCN, 2016).

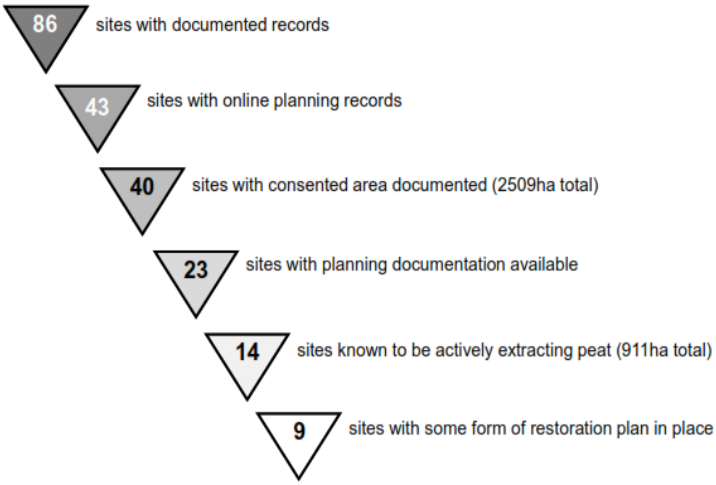

Fig. 4 Peat extraction sites in Scotland (IUCN, 2016).

While the plans for further peat extraction in Scotland seems unlikely (McNairney, 2019), there is no update on the count of active sites after 2016 and peat is still commercially extracted (e.g., Moy near Inverness that majorly caters to the mushroom growers) in Scotland and these active sites are expected to be affected by the proposed ban on sale of peat-based growing media products ban to come in affect in 2024 in England and Wales (Keane, 2021).

We engaged with a company that operates peat extraction sites in Scotland among other commercial activities such producing growing media products including substrate or potting soil and other horticulture inputs. The company provides mainly for the horticulture professional and food producers. According to the interviewee, 50% of their business is peat extraction, and they have reduced the amount they harvested in the last years. However, they did not disclose a percentage or the volume of the reduction.

The company's peat extraction sites are in Scotland only, and they provide peat exclusively to the UK market. The peat-based products they produce contain between 60 and 70% peat. They also have a full range of peat free professional and landscape products as well a range of peat reduced professional products. The company does actively research for suitable raw materials that sufficiently meet the needs of the professional grower market across the UK, though alternative materials tend to have limitations such as high conductivity, poor cation exchange capacity (CEC), poor water retention characteristics etc. when compared to peat. Although they also stated that most of these can be overcome with technologies, the availability of high-quality professional grade raw material alternatives to peat is the main barrier for transition.

The peat extractor respondents also commented that time is required for the transition to peat-free, and estimated this period required, including finding suitable alternative high quality raw material in sufficient volumes to produce consistent product from alternative materials for professional horticulture industry in the UK will be around 8 years. As they do not cater of the hobby horticulture market, they did not provide an estimate in that regard.

They pointed out that the growing media manufacturers need the support in not just in the development of new raw materials, but also in accessing the volumes required. Particularly in the case of wood based the key raw materials are burnt in biomass sector. The biggest difference that would contribute to the reduction or removal of peat from their mixes is to reduce the high cost and long

registration for the end of waste process surrounding trials and use of materials currently seen as a waste product so that additional material supplies suitable for substituting peat would be become available.

The interviewee also stated that the provision of a level playing field to all manufacturers, meaning everybody moving away from peat at the same time by controlling for peat imports and imported finished peat based growing media supplied from low-cost European producers. A possible ban or restriction of the peat-based products would need to include imported and potted plants in order to protect the UK market. Currently low-cost plants grown in peat can be imported into the UK without restriction and this makes it difficult for the UK based companies to compete.

3.4 Recycled alternative material sources

There are several alternatives to replace peat in the gardening mixes such as coir, wood bark, wood fibre, and composted organic waste (Barrett *et al.*, 2016; Bek *et al.*, 2020). Coir, or coconut husks, is defined as the perfect replacement to peat due to similar properties to peat (England *et al.*, 2021). However, it has to be aged and washed several times in fresh water and be treated with calcium nitrate to avoid the release of phytotoxic levels of sodium and potassium during use (Schmilewski, 2008; Carlile and Coules, 2013). The water intensity in its processing, the need for chemical treatment and the transport of the final product from tropical locations adds to its environmental footprint and the economic cost (Bek *et al.*, 2020). The length and unreliability of its supply chain is also another barrier to coir use (Jackson, 2021; Marshall, 2021).

Forestry industry by-products such as wood chips and bark are locally available with less environmental impact. However, these materials are in high demand, subsidised for the use of biomass industry and traded at a higher price (Marshall, 2021). Although they are used by few companies in composting (Aspray, Menzies and Dimambro, 2019) and in growing media production sector (Bek *et al.*, 2020) their overall share is around 4% in total volume of growing media used in the UK (Denny and Waller, 2016). Mainstreaming forestry by-products for an affordable, sufficient, and constant supply for growing media industry will be a challenge due to competition. Therefore, despite the problems with higher bulk density and pH, we chose to focus on composted organic waste, as locally available and low-cost option with a high responsible sourcing score (Bek *et al.*, 2020; RSS, 2022), that is most likely to be in line with a circular economy approach[3] and the amended Landfill (Scotland) Regulations 2003 (SEPA, 2021).

- *Local councils*

Councils collect garden and food waste from households and other facilities as part of their municipal waste collection commitment. There are two different ways of organic waste collection: separate containers for garden and food waste; or co-mingled organic waste in one bin (Aspray, Menzies and Dimambro, 2019).

The council we interviewed has 3 streams of organic waste: co-mingled food and garden waste collected from households at the kerbside; green waste collected in recycling center skips; and food waste collected from commercial customers. Food waste from commercial customers is processed in an anaerobic digestor to produce energy and liquid fertiliser for agriculture. Green and co-mingled

[3] A local recycled material alternative for partially replacing peat in the growing media mixes that we have not explored here is biosolids and other recycled materials from water treatment plants. Information about the possibility and the risks of using biosolids on land can be found in the recent CREW report on Phosphorus recycling possibilities considering catchment and local agricultural system benefits: a review and regional Scottish case study.

waste from households is treated in an in-vessel composter, producing 500 tonnes of compost per annum for householders to pick up for free from recycling centres.

The councils do not make any profit from the organic waste supply chain management. The objective of the local councils is to minimise landfill use for the disposal of waste they collect (Aspray, Menzies and Dimambro, 2019). Councils count their organic waste fully recycled if the waste processing output achieves PAS 100[4] status.

The council representative stated that they communicate with householders and businesses as to what can and cannot go in their brown bin to minimise the contamination and improve the consistency of the organic waste materials. When collecting the waste, the council checks for contamination and later the waste processors remove contamination.

Contamination raises costs down the supply chain. The recent waste analysis the council interviewed conducted shows that many householders do not use their brown bin for recycling their food waste and almost one third of the waste in the general waste bin is classified as food waste. They think the council needs to persuade more householders to recycle food waste. The council will soon publish a survey about the barriers people have recycling their food waste.

The council also commented on possible increase in contamination limits. Over time SEPA has revised their regulations for plastic limit in the green compost, between December 2018 and 2019, plastic limit reduced from 0.08% to 0.06% (66% to 50% of current PAS100 limits). This means that waste processors have to invest in machinery in order to achieve the output within the limits and these investments create additional costs.

- *Waste processing companies*

We interviewed two waste processing companies. One specialised in ex-situ composting that they produce and directly sells their own green compost, and the other is a biogas company that works with the council we interviewed that operates aerobic digestor and in-vessel composting processes. Both are currently certified companies under the compost and bio-fertilisers certification scheme (REAL, 2022) and have the relevant PAS accreditation for their products for land application.

Certified biogas company

Anaerobic digestion (AD) is a profitable way of municipal organic waste management as it produces energy as well as liquid used bio-fertiliser in agriculture and solids which are either directly applied to land or further processed for compost (ZWS, 2022a).

The company we interviewed operates anaerobic digestors, close vessel waste composting process and manufactures an agricultural bio-fertiliser. In interviews with recycling companies, we learnt that the household and commercial food waste is collected separately according to the regulation and businesses are charged based on the bin type, bin size and frequency of the collection in Scotland. The company we interviewed stated that they additionally use organic waste from paper mills and distilleries.

Our respondents find that the use of single bin for both garden and food wastes reduces the cost of organic waste collection as the required number of trips for collection is halved. However, the value

[4] As also stated at a later interview with a composting company, PAS100 is the PAS specification indicating suitability for compost (REAL, 2022) and PAS110 is the PAS specification for the anaerobic digestate (WRAP, 2022) to be suitable for land application.

of resulting waste for the recycling companies is lower, thus the councils are charged a higher gate fee for disposing the co-mingled organic waste streams. Co-mingled waste has to be composted in closed-systems (i.e., in-vessel composting) due to its higher microbial content and cannot be used in anaerobic digestor for electricity and biogas generation unlike separated food waste and it cannot be composted ex-situ, which is a less costly process, like separate garden waste can be. They provided average gate fee figures for processing different waste streams: in-vessel composting of co-mingled food and green waste at £50/tonne; £25/tonne for both food waste for anaerobic digestor and green waste for ex-situ composting.

The company representative also commented that the digestate is high in nutrient content and conductivity thus in its current format more suitable and certified for agriculture rather than for horticulture, it is particularly not suitable as a prospective constituent for bagged growing media content. They currently sell directly and deliver in bulk to farmers. They have interest to dilute this product and sell in smaller packages to the horticulture market and increase their profit margins. However, they are aware that both commercial and hobby horticulturalists might not have high trust in a new product with much stronger concentration and they would benefit from help in terms of formulation and market research.

Certified composting and recycling company

Input tonnage green compost in Scotland has slightly reduced since 2014 due to the increase in co-mingled green and food waste from local authorities and the corresponding decrease in green only waste. The main end-uses of the green compost produced in the Scottish composting sector ranked by tonnage is agriculture (38%) and land restoration (27%). On the other hand, the highest £ per tonnage end uses of green compost are landscaping (12% generating £281,895) and bagged product sector (3%) earning the highest average price (mean of £16.88/tonne, generating £129,149), though also highly variable (Aspray, Menzies and Dimambro, 2019).

The latest survey of Scottish composting sector looks into 24 sites in Scotland and total of 27 composting process. Seven of these systems in-vessel system and the remainder being ex-situ (Aspray, Menzies and Dimambro, 2019). According to the survey, the processes collectively work below their permit capacity, in-vessel (at 77% capacity) and ex situ sites (at 58% capacity) and more compost can be created if more efficient waste streams can be provided and if more demand is created for compost. Currently, 112 full time staff is employed in the composting processes (Aspray, Menzies and Dimambro, 2019).

The safety of the compost for use in horticulture is guaranteed by PAS100[5] and requiring the material to be separated from other types of waste at source (Royal Society for the Protection of Birds English Nature, 2001). Therefore, the contamination is great problem for composting sites and the main reason for compost sites to refuse loads their customer deliver. As of 2017, a total of 21 out of 27 compost processes were PAS100 certified and these facilities process 87 % of input waste material and produces 83% of overall compost in Scotland (Aspray, Menzies and Dimambro, 2019).

[5] Publicly Available Specification 110, which is the British Standards Institution's specification for anaerobic digestion and composting systems that accept source segregated biowastes. PAS specifies minimum quality of the output content in terms of concentration of critical contaminants, information is required to be provided to the recipients of the output material and controls on input materials and the process management system.

Some common challenges are identified for composting industry. Planning and licensing problems are often cited as holding back the development of composting industry in the UK. Green compost, and woody diluents, have higher bulk density than peat and transport costs are some 90 per cent and 45 per cent higher respectively (Royal Society for the Protection of Birds English Nature, 2001). From the perspective of the recycling companies, price of compost in the bagged product is very variable compared to other uses and ranges between £2.50 and £50 £/tonne (Aspray, Menzies and Dimambro, 2019) and from perspective of the producers the PAS100 criteria might not be sufficient in the area of plastic contamination (Bek *et al.*, 2020).

The recycling company interviewed operates 10 sites for ex-situ composting of garden cuttings, additional to their in-vessel compost process. They sell the green compost they produce directly, and their major customers are landscapers, golf courses and households, sold online and at sites. The growing media industry is not a big customer for them at the moment because they tend to pay very little compared to the other type of customers as the growing media industry buy in bulk and as an input material for their mixes rather than a final product.

The growing media industry also need a better-quality compost with no contamination which needs to be screened finely and that is something only the best recycling companies might be able to offer, and at an increased cost. As well as PAS100 status, the screening size also matters in terms of removing contamination. The smaller the screening size gets, the higher the value of the green compost will be, and horticulture requires a small screening size, driving up price. For example, a 6mm green compost is a seaweed blend and a premium product sold around at £30/tonne, compared to 20mm screen size sold at £3.50/tonne. For the green compost to be finely screened (i.e., 6mm) it also has to be dry, and this immediately and prohibitively increases the cost of operations for the composting companies. Usually, compost is kept outside, and it can get wet, business rates apply when sheds are built. This is a long-term investment that could be made but council contracts are short (e.g., 2+1, 3+2 years) and waste processing companies are disincentivised to make longer term investments. The respondent commented that “growing media producers are used to cheap inputs like peat and they are not willing to pay for a premium for the premium quality green compost”.

The manager of the company we interviewed identified limitations for the certified composters such as seasonality, contamination, infrastructure issues for reducing contamination. In vessel compost containing garden cuttings and food fibres are the best for reducing the seasonality of the compost blends. However, similar to wood barks, food waste is in demand from biomass industry and due to this competition, it is rare to acquire them for composting purpose (Aspray, Menzies and Dimambro, 2019).

The company stated that the commercial horticulturalists refrain from using green compost due to liability risks and penetrating the market of the bagged content sold at retailers is difficult for composting and recycling companies due to the current structure of this market. Especially small local garden retailers benefit from the deals they have with the UK level suppliers in terms of flexible payment terms (i.e., “they receive the products in January and can pay back up to in June”) and these large suppliers also produce their own growing media mixes, which is usually peat-based. They concluded that there is little room or incentive for both these local stores and their suppliers to leave peat use unless they have to.

The recycling company representative also provided us some useful insights about how things could be improved. Their opinion is that policy change is not enough and industry both recycling companies and growing media producers are dictated by market forces. They suggested that a new way of procuring with longer term contracts is required for the recycling companies to cost competitively produce the green compost at a quality required by the growing media industry. Having longer contracts with councils at 10, 15, 25-year periods will reduce the stress of retendering and doing things at the cheapest way possible and incentivise producers to invest in infrastructures.

3.5 Growing media producers

According to HTA, manufacturers produce more peat-free and peat-reduced growing media than ever, and the industry has full support for the transition (Mcquilliam, 2022). This statement is confirmed by our interview with a UK based growing media company. Their primary customers are the professional growers; however, they also cater to the hobby horticulture market with retail products. While the company was historically established to harvest peat, now they are comparatively less engrained in the peat use compared to the market average with the half of product volume they sell being peat free.

The growing media producer interviewed stated that the transition to peat-free is inevitable and envisions a lot of change in the next few years as Ireland's Bord Na Mona, which used to extract 1.5M m^3 peat annually, stopped peat extraction in 2020 (GMA *et al.*, 2021) and the price of peat in the UK has been going up, due to the need to use imports, (e.g. Baltic peat). However, peat is still cheaper than other imported alternatives like coir, which the company interviewed reported as costing them 5 times more than peat, due to increased demand.

The interviewee stated wood chip and bark is in high demand from the biomass industry, therefore not as accessible in sufficient supply to growing media producers. Green compost is cheaper, but has to be free of physical contaminants, most importantly glass, which is not covered by insurance, and be consistent in content so that it could be added in the mixes in a set ratio. This requires use of specialist equipment and covered space to keep the material dry for finer screening in composting sites. Anaerobic digestate (AD) fibre is another alternative and in AD process that cater to them, usually purpose grown crops are used in feedstock.

Respondent from growing media producer identified costs of input materials as determining the product choices in growing media production, as we have also reported from interviewees across different parts of the supply chain (e.g., waste processors). Growing media producers feel that the retailers have potentially more flexibility in terms of pricing and can create a bottle neck pushing everyone else in downstream in the supply chain to produce at as low costs as possible not to reflect price increases to their customers. Therefore, while consumers have become more accepting of the higher prices for peat-free media in recent years, the retailers appear less willing, but we recognise they are driven by other factors and the end consumer demand. Until 2-3 years ago, peat was much cheaper and the growing media bags stocked in this period might still be in circulation in retail. They also state that retailers are very sensitive to physical contaminants such plastics in the mixes.

Growing media producers suggested that with peat alternatives becoming more cost competitive due to the increase in peat price, the right type of advertising can create a behavioural change and stronger demand for peat-free products among hobby horticulturalists. Consistent labelling also matters. Consumers tend not to read the ingredients or other the small print at the back of the bag. More straight-forward and uniform indicators like the Responsible Sourcing Scheme logo could be

promoted. The respondent commented that some garden centres and DIY stores are very good at directing consumer choices and that large DIY chains can possibly afford to take more risk and leadership in promoting peat free products than the smaller retailers. However, they recognise that supermarkets also have a role in this as they sell significant volumes of growing media and potted plants and so policy and intervention may be better focused here.

Growing media producer representative provided us two main insights about how things can be improved at their end. First, to store alternative materials like AD fibre and coir which are not inert like peat and needs to kept dry, the growing media producers, like green compost producers, require more covered spaces. Also support in developing equipment for processing new mixes would be useful. These technical aspects could be subsidised. Second, not only quality of current alternatives but also the availability of new alternatives (e.g., mainstreaming centralised AD supply from Europe) should be improved to help replace the annual large input supply gap that the Bord na Mona peat operations stopping has created in the UK horticulture industry.

3.6 Retailers and supermarkets

To tackle peat based growing media at the point of sale, the UK Government introduced a voluntary target in 2011 to remove peat from sale to gardeners by 2020 (HM Government, 2018), with recent plans to strengthen this to ban sale a peat based growing media by 2024 (DEFRA, 2021b). While there are some supermarkets like Coop and Waitrose and garden retailers like Travis Perkins showing leadership in voluntarily committing to stocking only peat-free bagged compost (Torr, 2021; Clemens, 2022), a recent survey of top retailers by The Wildlife Trusts has shown the 2020 voluntary target to end peat sales in retail had been missed by the majority.

According to the survey only 3 three more national level garden retailers (Dobbies in 2022, B&M in 2023 and Wickes in 2025) have plans and dates for when they will sell only peat free compost while 3 others (B&Q, Hillier, and the Blue Diamond group) have expressed a commitment to remove peat from all their products without pronouncing any date. Morrisons also commits to go peat free completely by the end of 2024 (Morrisons, 2022). Some of the surveyed garden retailers and supermarkets expressed their wish to reduce peat content in the bagged growing media they sell but still do not have any pledge or plan to go peat free in the foreseeable future (The Wildlife Trusts, 2021; Doar, Science and Trusts, 2022).

The comprehensive list of peat free products and campaigns launched by the UK retailers can be found in (Bek *et al.*, 2020) and the details of current commitments of the 22 UK retailers for going peat free can be found in the recent survey of the Wildlife Trusts (2021). The Wildlife Trusts review was published prior to the announcement of the DEFRA's proposal to ban retail peat sales by 2024. If this is accepted, we expect more retailers going peat free by 2024.

In conversation with other stakeholders such as trade organisations, growing media producers, waste recycling companies we have concluded that the price and the supply structure may differ among different types of outlets such as small and local outlets (including bulk buyers), garden centres and big garden chain stores and supermarkets and other unspecialised outlets. Based on their public statements we can conclude that for supermarkets, the main motivation is to eliminate the use of peat is the need for reducing the overall greenhouse gas emissions and improve their sustainability credentials as a business. While the independent and local garden stores have limited negotiation power and sell products that come with more flexibility for delivery payments, chain garden and DIY stores have more influence both upstream on the producers and downstream on the customers.

Unfortunately, despite our attempts to engage with all different types of outlets, we heard back from only 2 companies, one supermarket chain who has already committed to selling peat free compost and one DIY chain. By the time of the writing of this report, we only received responses from the DIY chain and below is the summary of our exchange. This was particularly valuable insight considering there was little information publicly available about dynamics effecting garden and DIY chains and no other company was willing to participate.

Retailer we interviewed recognises that it is not sensible or sustainable long term to be reliant on a single material. Their decisions to stock and sell growing media mixes is based on several factors including environmental, quality, supply chain, availability of material and cost effectiveness. They have their own blends, including peat free compost that has received awards and is a popular product. They test the products independently and their composition is jointly developed with the growing media producers. The company is in the process of going peat free in their own brand lines and expect to achieve this by the end of April 2022.

There is a profit margin difference between peat-based and peat free products. The margin changes throughout the season based on pricing and promotions, but the company operates in general on a lower margin in peat free alternatives to ensure these are sold at the similar prices to a peat-based alternative to incentivise consumers for choosing peat-free products. Promotion focuses on the right products for the time of the season, e.g., at the start of the season, topsoil and farmyard manure are promoted for digging into beds, borders and raised beds to make sure customers use the appropriate product to get the best results, rather than just reach for the default option of multi-purpose compost.

They observed customers are becoming more aware of the environmental impacts of peat through increased media coverage and high-profile industry figures bringing it to their attention. Importantly though, replacements need to be of the high quality to match consumer expectations. Some customers are yet to be convinced that they will also get the good results with peat-free alternatives. For this, the challenges around hydration and feed in peat free products are yet to be overcome.

4. The current state of peat use in Europe

Peatlands have a vital role in both climate resilience and ecosystem services provision (Tanneberger *et al.*, 2021). The EU peat policy has improved since peatland have been recognised as a valuable carbon store and the role of peat restoration has been accepted as crucial in achieving net zero emission targets. The EU is, after Indonesia, the second largest greenhouse gas emitter from drained peatland in the world (O'Brolchain, Peters and Tanneberger, 2020; Tanneberger *et al.*, 2020) and almost half of the peat extraction in the mainland EU was for horticulture in 2017 (Lukjanova, Odinokova and Zahars, 2020).

While healthy peat is a valuable carbon sink, when degraded peatlands contribute disproportionally to global GHG emissions (Wehrheim, 2016). The commitments to the Paris Agreement and the EU 2030 climate and energy framework, might be driver for the peat extracting EU countries to limit or reduce peat use in near future to allow allocation of their national GHG emissions budget to more profitable activities (Niitlaan, Kriiska and Paat, 2019). However, the proposed Land Use, Land Use Change and Forestry (LULUCF) Regulation only cover certain aspects of emissions from peatland. No comprehensive scheme for the accounting of GHG emissions from peat extraction and, importantly from abandoned peat extraction sites exist in the EU. An EU Peat, Peat Extraction and Horticulture

Framework is needed to introduce provisions on extraction, processing, marketing and use of peat do not exist in the EU (Peters and Von Unger, 2017).

Although the recognition of peatlands and their importance has yet to be translated into policies at the EU level (DEFRA, 2022) there are few European states that are openly taking action to reduce their reliance on peat and their resulting national GHG emissions, including Germany, (Internatioanl Peatland Society, 2019; DEFRA, 2022) Switzerland (the Federal Office for the Environment, 2019) and Ireland (Government of Ireland, 2019; Bord na Mona, 2021).

Despite this progress to reducing peat use, there is also another, larger, camp which plan to continue the extraction and use of peat. Their emphasis is on doing it as sustainable way as possible and mostly on the already drained and degraded peatlands. This approach could particularly be suited to the countries with long-term peatland drainage, where most of the former peatland has been already removed or oxidized. Two such examples are the Netherlands and Denmark, where >50% and 30% of the land area of the country used to be covered with peatlands and the current respective shares are only 3% and 2% (Tanneberger *et al.*, 2021). There are also associations like Growing Media Europe (GME) which still promotes the use of peat both in hobby and professional horticulture market.

The policy commitment in the UK is stronger than the EU. DEFRA estimated the annual carbon emissions in the UK from peat extraction at 0.55MtCO_{2e} in 2019 and predicted the cost of GHG emissions from 2021 to 2042, when all the current peat extraction permits will expire, at £993M. This figure does not include the other negative externalities such as reduced water regulation and flood defence and their associated social costs. Impact analysis based on this data has included economic assessment of 4 policy options for peat use in horticulture both for amateur and professional horticultural users (DEFRA, 2022). Both the English and Welsh Governments launched consultation to end the use of peat in the retail sector by 2024 (IUCN, 2017). The possible developments regarding the peat ban are likely to affect the horticulture supply chain in Scotland.

The commitment of the Scottish Government to the conservation and restoration of peatlands and support for eliminating peat from horticulture started with National Peatland Plan in 2015. In the programme for Scotland 2019-2020, the Scottish Government committed to phase out the use of horticultural peat by increasing the demand for alternative growing media mixes. Since 2012, Scotland has also been investing considerable funds through the Peatland Action initiative and restored 25,000 ha of degraded peatland across Scotland (NatureScot, 2020). The Scottish Government dedicated an increased amount of £20 million to peat restoration in their 2020/21 Budget. They will also invest more than a quarter of a billion pounds in large-scale peatland restoration projects over the next ten years to achieve up to 0.8 million tonnes of annual GHG reduction by 2032 (DEFRA, 2022).

5. Conclusions and policy implications

This research aims to identify and realise the barriers and possibilities for replacing peat in the horticultural growing media mixes and reduce the resulting GHG emissions. This may be achieved in part through creating circular and local flows of organic waste materials in Scotland. Supporting an early switch to peat-free products and leading the transition in Europe would place Scotland in a better position to meet its carbon emission commitments. The UK gardening retail and horticulture industry has recognised the need for change (Alexander *et al.*, 2008) and can lead in the international innovation in more sustainable technologies and products that accounts for environmental costs

(IUCN, 2017). This will also contribute to delivery of recycling and waste reduction targets through increased use of recycled peat-free products. In the interviews, we have identified that there are two main reasons for failure to phase peat out in the UK horticulture retail market.

The first issue is establishing a sufficient flow of alternative materials at right quality to sustain the current demand in the horticulture industry. The risk of contamination, various product categories and unpredictable behaviour in the mixes were identified by growing media producers, though the possibility for these to be solved by technology was identified, and their main effect is therefore on profitability. The second issue is that prices are controlled at the retail end and the retailers do not want to reflect the price increases to customers, making every other stakeholder downstream having to produce at minimum cost. These could be linked with the lack of customer demand and preferences for peat free products. There are some further commonly identified bottlenecks experienced by specific stakeholders in the stakeholders in the supply chain that limits the possibility for phasing out peat in horticulture sector, some of which we have also heard from our interviewees during the project summarised in Fig 5.

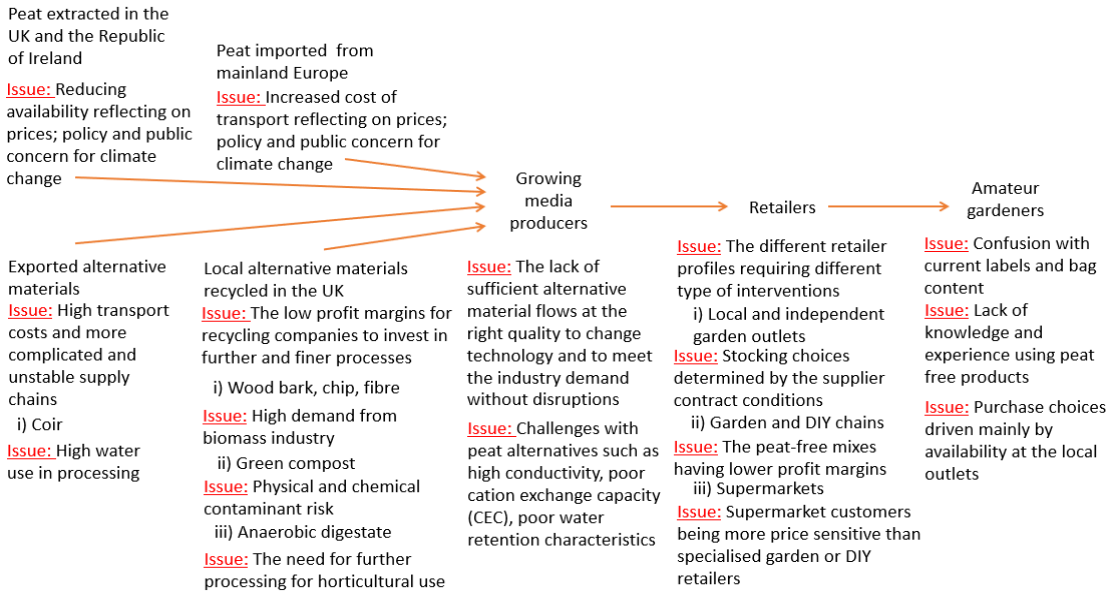

Fig 5. The overview of barriers for different stakeholders across the growing media supply chain

The so far limited progress in ending peat use demonstrates the need for targets to be accompanied by more firm and holistic measures and the clear market signals to facilitate a shift away from peat. However, such requirements should come with adequate support to the UK horticulture industry for innovation. We describe below three main categories recommendations, i.e., for policy, industry, and demand creation, identified in the interviews conducted and by publicly available resources.

We have several specific insights based on the interviews:

- While all development planning proposals for commercial peat extraction in Scotland is vital, the interventions in the form of bans or taxes would also benefit from a focus on the content of peat in growing media alongside extraction. Ending peat extraction in the UK while continuing to use peat in the horticulture mixes sold in the UK will only lead to increased export of peat from mainland Europe and create destruction of peat ecosystems elsewhere. Government policies should consider the peat use, extraction and peatland restoration more

holistically to include the full costs of using peat containing products, including environmental damage and GHG emissions (Bain and Goodyer, 2016).

- Achieving higher quality alternative outputs with contamination levels fit for the growing media mix requires adherence to guidelines stricter than PAS (e.g., Wrap and SEPA guidelines for plastic contamination (Bain and Goodyer, 2016; Bek *et al.*, 2020) and this means increased production costs. The cost competitiveness of the peat alternatives could be increased with the carbon taxation of the bag contents. Fiscal measures such as tax relief and other incentives can be provided for the development and production of sustainable peat-free products and R&D to develop peat alternatives (Bain and Goodyer, 2016; Bek *et al.*, 2020). Public-private co-investment in research can drive improvements in innovation to reduce costs and improve quality of alternatives.
- Establishing collaboration with local councils and waste processors can help with the provision of the local peat alternatives. Green compost being bulky, the source needs to be within an economic transport distance from the growing media manufacturing facilities (Bek *et al.*, 2020), moving growing media production facilities in densely populated areas with large waste streams such as the Central Belt would reduce the cost of transport. New local material streams such as anaerobic digestate, sheep wool etc. can be developed (Bek *et al.*, 2020) for manufacturers in more rural and dispersedly populated areas.
- The state of Scottish composting and AD sectors are being monitored by periodical sector surveys. This information is valuable to assess potential to increase supply of good quality green compost and can inform in the later years on the barriers of the mainstream uptake of green compost and anaerobic digestate in the bagged horticulture mixes.
- Wholesale woodchip prices due to the demand from the subsidised biomass market are high for the horticulture market. Changes to subsidies here may improve wood chip supply for horticulture industry (Appelby and Raskin, 2021).
- Apart from policy interventions and support, industry also has an active role and responsibility. This is beginning to be achieved, such as in 2021, HTA started coordinating a taskforce to encourage collaboration in the industry to tackle shared obstacles for removing peat from growing media.
- Government and local councils can set a procurement example and commit to only using only peat-free compost in the parks, gardens and other green areas that are publicly managed. There are already organisations that are committed to using peat free products already e.g., Forestry England or in the near future, e.g. Royal Botanic Gardens by 2025 (Bain and Goodyer, 2016).
- Clear labels and standards help consumers' choice and inform them of the bag content(Bain and Goodyer, 2016).

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