Department for Environment, Food and Rural Affairs
Research project final report

**Project title**
Review of growing media use and dominant materials (peat and alternatives) for growing media in other countries (European and international).

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Review of growing media use and dominant materials (peat and alternatives) for growing media in other countries (European and international).

Executive summary

The aims of this project were to evaluate and learn from the ways other countries around the world have developed growing media either in the absence of peat being readily available or where policies are encouraging a move away from the use of peat.

The project found that the pressure for peat reduction in other countries is currently less than in the UK. However the issue is increasing in importance globally as part of the drive for more sustainable use of natural resources. Those countries that have local peat reserves are generally still exploiting them for horticultural growing media (and in some cases also for fuel), however countries remote from peat sources have developed good quality growing media based on locally available resources because peat is too expensive to use. In these countries even crops that are known to be more challenging to grow without peat, such as ericaceous plants, are successfully produced in non-peat media. Mushroom production, however, seems to be reliant on peat for the mushroom casing (surface) layer in all parts of the world. Economics are a key factor; where peat is more expensive there has been investment in alternative growing media ingredients. Where peat is cheap there is less incentive to use other materials because it is a very good growing medium, well researched and relatively consistent in quality.

The types of non-peat materials used in growing media are largely dependent on those raw materials available locally. Some materials can be used to make up the bulk of a growing media in the same way as peat is used (for example woodfibre/bark and coir); others such as compost, loam, perlite, pumice and vermiculite are usually used at a relatively low percentage of the mix (up to 30%) for technical reasons. Inert materials such as perlite and pumice can be used at 100% in hydroponic systems however. In southern Europe (Spain and Italy) mineral materials such as clay and pumice are commonly used in blends with peat and there is ongoing research on the use of composted materials to make up the organic fraction of growing media products. Biosolids (sewage sludges) are permitted for use in these countries (and in the USA) but are not allowed in UK growing media. In France timber industry by-products are important components of growing media, as they are in Australia and the USA, but there is some concern from growing media manufacturers that the energy industry will compete for these in the future.

There is a history of by-products from local agricultural production being used in growing media, for example rice husks, sugar-cane and nut wastes, particularly in countries where peat is expensive. More recent research has focussed on crops that could be grown to produce raw material for use in growing media, such as hemp, flax and kenaf (kenaf is grown in sub-tropical climates as a fibre crop). Some of these crops can be grown in the UK. Research in Denmark suggests that agricultural fibres such as hemp and flax could have a larger future role as renewable raw materials for use in horticultural growing media (Dresbol, 2008, Webber et al., 1999). Cereal straw is not structurally stable enough to be used as a growing media component because of its low lignin content although oilseed rape straw has more potential.

In addition to economic factors, the evidence from research in other countries indicates that growers and gardeners tend to favour the types of growing media that they are accustomed to and know how to manage, hence inertia is a barrier to change. Uptake of new growing media is more rapid where there has been good quality research and development of these (by research stations as well as the manufacturing companies) followed by good knowledge transfer to growers and gardeners.

The case studies in this project demonstrate that alternatives to peat can be effectively used in growing media. In some cases the manufacturer has taken control of the quality and consistency of the material, e.g. green waste compost, to ensure it meets their specifications. In many parts of the world, bark is in plentiful supply and is used in all growing media successfully, including for ericaceous plants. There is the opportunity to develop new materials in the UK from wastes such as green waste compost oversize (the larger pieces of undecomposed woody material in green waste) but the relatively low market price of peat and investment required have been identified as barriers.
Quality standards for growing media, such as those used in Australia, are also beneficial to reduce the incidence of poorly formulated reduced peat/peat-free products being released on to the market which would have a negative effect on the image of non-peat materials. The opinion of the authors of this report is that if a scheme were to be introduced in the UK it would strengthen the public confidence to purchase these media but an independent monitoring system would have to be put in place.
Review of growing media use and dominant materials (peat and alternatives) for growing media in other countries (European and international).

1.0 Introduction

The proportion of peat used in growing media in the UK has declined slightly in both amateur and professional growing media over the last 10 years but the rate of change has been slow (Defra, 2010) with almost 3 million m$^3$ of peat still being used in the UK. Cost implications, the supply of alternative materials, quality, perception and technical barriers have all contributed to the proportion of peat in growing media remaining relatively high. The availability of alternative materials in the UK to replace peat in growing media has been discussed (Defra, 2009). The principal materials considered to be important were bark, wood by-products, green waste compost, mineral materials (including loam), manufactured woodfibre and coir. The availability of these materials was dependent on external factors such as the state of the construction industry (bark), competition from the energy market (timber by-products), rate of investment in processing equipment (woodfibre and coir) and technical issues, including quality and consistency.

1.1 Aims and objectives

The aims of this project were to evaluate and learn from the ways other countries around the world have developed growing media either in the absence of peat being readily available, or where policies are encouraging or have resulted in a change away from the use of peat. If the UK is able to reduce its dependence on the use of peat in growing media then the supply of alternative materials needs to be secure over the long term and so the world markets need to be understood.

The objectives of this project were to:

1. Identify the countries that utilise large volumes of growing media in amateur and professional horticulture and compare with the UK market;
2. Identify the principal materials used especially in countries where peat is not readily available locally or where peat use is being phased out, with details of:
   2.1. Materials used;
   2.2. Domestic sources;
   2.3. Common mixes in growing media;
   2.4. Issues associated with supply, quality and performance;
   2.5. Evaluation of peat use by country and the proportion used in mixes; and
   2.6. How technical uses such as for ericaceous plants and mushroom casing have been dealt with;
3. Collate information, in the form of case studies, as to how the UK could learn from the experience of other countries on the development of peat-reduced and peat-free growing media including regard to barriers and how they have been overcome; and
4. Assess the likely competition for the supply of alternative materials for the UK.

1.2 Methods

The main countries that were selected for this project included those in Europe that manufactured and used growing media in large quantities, the USA, Australia and New Zealand. Information was gathered from existing research. Key manufacturers in each country were also contacted for information such as materials and their proportions used in growing media, as well as case studies of the use of alternatives to peat. The structures of the growing media industry in each country were not assessed but all comprise a combination of international, national and regional companies down to individual local supply companies.

Peat is used in the casing (surface layer) in mushroom growing and this sector has been identified as having particular technical challenges associated with peat replacement. Data on the quantities of
peat used for mushroom casing in other countries and the potential for its replacement with alternatives was investigated.

For the purposes of this report the term ‘growing media’ is used for material used in a container (e.g. pot/trough/bag) to grow plants. The term ‘substrate’ incorporates such growing media and also materials used in hydroponic systems where they are used to support the plant roots only (e.g. rockwool systems for tomato/pepper production).

2.0 Europe

2.01 Background

The amount of crops grown in growing media rather than the soil is increasing within Europe (and globally) due to the need for higher yields and to reduce pest and disease problems where land is used intensively. Researchers in The Netherlands have suggested that it will also be necessary to use water more efficiently in future, particularly in Southern Europe, and this could result in more growing in substrates rather than in the soil because substrate growing wastes less water. Demand for raw materials for growing media is therefore likely to increase (Blok & Urrestarazu, 2010).

The growing media industry in Europe has a 1.3 billion Euro annual turnover. Each country in Europe has a number of growing media companies who usually manufacture products for both the retail and professional market, although some tend to specialise more in one sector than the other. There is some trade in growing media between countries (for example The Netherlands exports to other countries) but transport costs limit this. The location of growing media factories tends to either be close to their main source(s) of raw materials (for example near peat bogs or forests) or near a port for shipping in materials (for example most of the Dutch manufacturers are in the Rotterdam area).

The UK is unique among European countries in having government targets for the reduction of peat use in horticulture although other countries (such as Germany) have peat protection policies which will limit peat extraction for horticultural use in future. In the UK and Switzerland multiple retailers have put pressure on their suppliers to reduce peat use for their products.

A survey completed in 2006 by the International Peat Society (Schmilewski, 2008) collected data from the thirteen major growing media producing countries in Europe and identified a total production of 35 million m$^3$ per annum with 78% of this made up of peat. Table 1 shows data for professional growing media sold to commercial growers and Table 2 shows data for retail growing media sold to amateur gardeners.

Table 1. Ingredients used for growing media production by country, 2008 – professional growers (volumes ‘000 m$^3$)

<table>
<thead>
<tr>
<th>Country</th>
<th>Peat</th>
<th>Bark</th>
<th>Coir</th>
<th>Wood-fibre $^a$</th>
<th>Wood waste $^a$</th>
<th>Rice husk</th>
<th>Leaf mould</th>
<th>Compost</th>
<th>Mineral*</th>
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<tr>
<td>Austria</td>
<td>32</td>
<td>15</td>
<td>1</td>
<td>5</td>
<td>0</td>
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<td>0</td>
<td>3</td>
<td>6.5</td>
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<tr>
<td>Belgium</td>
<td>750</td>
<td>35</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>38</td>
</tr>
<tr>
<td>Denmark</td>
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<td>5</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3.3</td>
</tr>
<tr>
<td>France</td>
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<td>410</td>
<td>11</td>
<td>33</td>
<td>0</td>
<td>0</td>
<td>65</td>
<td>38</td>
<td>Unknown</td>
</tr>
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<td>20</td>
<td>55</td>
<td>10</td>
<td>2</td>
<td>0</td>
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<td>144</td>
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<tr>
<td>Ireland</td>
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<tr>
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<td>150</td>
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<td>0</td>
<td>0</td>
<td>0</td>
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<td>671</td>
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<td>190</td>
<td>14</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td>28</td>
<td>673</td>
</tr>
<tr>
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<tr>
<td>Spain</td>
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<td>Sweden</td>
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<td>0</td>
<td>0</td>
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<td>0</td>
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<tr>
<td>UK</td>
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<td>203</td>
<td>16</td>
<td>22</td>
<td>4</td>
<td>0</td>
<td>0</td>
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<td>129</td>
<td>64</td>
<td>12</td>
<td>65</td>
<td>210</td>
<td>1,832</td>
</tr>
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</table>
Table 2. Ingredients used for growing media production by country, 2008 – amateur gardeners (volumes ‘000 m³)

<table>
<thead>
<tr>
<th>Country</th>
<th>Peat</th>
<th>Bark</th>
<th>Coir</th>
<th>Woodfibre*</th>
<th>Woodwaste*</th>
<th>Rice husk</th>
<th>Leaf mould</th>
<th>Compost</th>
<th>Mineral*</th>
</tr>
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<tbody>
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<tr>
<td>Finland</td>
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<td>16</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>50</td>
<td>37.3</td>
</tr>
<tr>
<td>France</td>
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<td>867</td>
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<td>113</td>
<td>0</td>
<td>0</td>
<td>52</td>
<td>160</td>
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<tr>
<td>Germany</td>
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<td>5</td>
<td>0</td>
<td>0</td>
<td>150</td>
<td>45</td>
</tr>
<tr>
<td>Ireland</td>
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<td>0</td>
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<tr>
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<td>0</td>
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<td>0</td>
<td>247</td>
<td>230</td>
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<td>2</td>
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<td>0</td>
<td>35</td>
<td>11</td>
</tr>
<tr>
<td>Poland</td>
<td>1,000</td>
<td>50</td>
<td>0</td>
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<td>0</td>
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<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Spain</td>
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<td>0</td>
<td>500</td>
<td>0</td>
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<td>0</td>
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<td>550</td>
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<tr>
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<td>0</td>
<td>0</td>
<td>0</td>
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<td>25</td>
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<tr>
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<td>14</td>
<td>36</td>
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<td>0</td>
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<tr>
<td>TOTAL</td>
<td>12,369</td>
<td>1,305</td>
<td>68</td>
<td>182</td>
<td>547</td>
<td>0</td>
<td>52</td>
<td>923</td>
<td>990</td>
</tr>
</tbody>
</table>

Notes on tables:

*Woodfibre is a manufactured product produced by processing wood chips, woodwaste includes timber industry by-products such as sawdust and furniture and timber construction waste.

**Mineral’ includes rockwool, perlite, vermiculite, clay, loam, pumice, lava, sand and grit. The main ‘mineral’ used in UK is loam (not used much in other countries which have other minerals they can use).


France and UK data excludes substrates used for hydroponic growing (mostly rockwool).

Tables 1 and 2 show that the five European countries with the largest growing media industries are Germany, Italy, The Netherlands, the UK and France. Of these, Germany has by far the largest growing media industry and the most similarities with the UK, having its own peat bogs and a well developed amateur gardener retail market for growing media in addition to that for professional growers. The growing media industry in Germany is still largely based on peat.

The Italian growing media industry is the second largest in Europe and uses a large proportion of peat in growing media but blends it with other local materials such as compost and pumice.

The Netherlands used to have their own peat reserves but they have been depleted and the growing media industry there is reliant on peat imported from Germany, the Baltic and Ireland. In The Netherlands the professional growing media market is much larger than the amateur market. Growing media manufacturers have been able to import peat as well as other materials because they are geographically well placed to import these bulky materials by ship (many are based in the Rotterdam area). As peat is relatively expensive in this country (because there are no local peat reserves) and horticultural operations tend to be very specialised, there is a long tradition of blending it with other materials to create mixes with the optimum properties for particular crops. The use of peat has been replaced with other materials in The Netherlands where there have been technical advantages from doing so, for example rockwool has replaced peat in bags for salad crops and more recently coir has replaced peat for strawberry production and some cut flower production (such as Gerberas).

Of the top five growing media producing countries, France uses the lowest proportion of peat in growing media, probably because it does not have significant local peat deposits it can exploit. Like
the UK, France has a larger amateur than professional growing media market and bark is widely used in amateur gardening growing media products.

Combined professional and amateur media production data for selected countries are shown graphically in Figure 1 to show the relative proportions of the ingredients used within each country. The countries in Europe with the greatest proportion of their volumes of growing media being non-peat are France (56%) and Spain (70%).

**Figure 1 – Growing media ingredients: UK, The Netherlands, France, Germany, Spain and Italy (from Schmilewski, 2008 data) (volumes as proportions of total ingredients used)**
2.02 The Netherlands

The total growing media market in The Netherlands is around 4 million m$^3$, of which 70% overall is peat (including hydroponic crops) and 85% of container growing media is made up of peat. The Netherlands is a significant exporter of container grown ornamental plants and cut flowers as well as edible crops such as salad crops. Substrate use is increasing in The Netherlands and there has been an increase in the area of strawberry and tomato production in hydroponic systems in glasshouses. These systems moved away from peat some time ago because rockwool was found to be more effective, however rockwool has its own associated environmental issues (such as the energy used to manufacture it and the need to dispose of it in landfill after use). There has been a decrease in glasshouse cut flower production due to competition from Africa and South America.

Professional growing media in The Netherlands are 69% peat but the non peat figure includes rockwool used for hydroponics. The amateur market for growing media is relatively small compared to the professional market. Amateur products are on average 78% peat.

Peat is the most important container substrate in The Netherlands for non hydroponic crops although there have been large increases in the use of coir (up 66% 2001-5) and bark. Coir is used for strawberries, cut flowers and pot plants at up to 100% of the substrate. Around 250,000 m$^3$ of coir is used annually in The Netherlands, mostly from India and Sri Lanka, and there could be competition for good quality coir in the short to medium term if use in other countries increases significantly, which would affect availability in the UK. Bark is used for orchids (up 100% 2001-5). Green waste compost use has also increased in The Netherlands with around 70,000 m$^3$ per annum currently used.

Mono-cropping is common in The Netherlands and the structure of substrates is considered very important for the production of uniform high quality crops. Automation is increasing in Dutch horticulture with more use of systems where plants are grown in moving gullies (long narrow gutters/troughs with the plants growing in substrate), which increases the importance of water distribution in substrates used (Blok & Verhagen, 2009). A high initial air content and good re-wetting are important in such systems. Stability of growing media is considered very important in Dutch systems; green compost and wood fibre are not always so good for this. Coir and some green composts have been found to aid re-wetting of mixes (experience mirrored in the UK). There is some interest from Dutch researchers in the use of fibres in growing media in the Netherlands, for example flax and hemp, but no research data on this are available yet. A small amount of rice husks are used in growing media (imported by ship).

New Growing Media project in The Netherlands

The New Growing Media project in The Netherlands was initiated by researchers and plant exporters in response to customer demands for peat reduction (e.g. Marks & Spencer plc and the Swiss supermarkets, which are important customers and have introduced peat reduction policies). A large percentage of Dutch horticultural production is exported to other countries and therefore Dutch growers/exporters are very responsive to customer demands and trends.

The project ran from 2003 to 2005 and was a good example of co-operation between stakeholders as it involved Dutch research stations, growing media producers, growers, the auction and exporters (Intergreen). This type of project is easier to set up in The Netherlands than in other countries because the main growing media manufacturers, the research stations, auctions and growers are all concentrated in a fairly small geographic area. Growers also tend to specialise in certain crops and can therefore ‘fine-tune’ their growing systems and growing media to the crops they grow, for example a Dutch grower may only grow a few types of ornamental plant whereas a UK bedding plant grower grows many different lines.

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1 Data is reported in The Netherlands inclusive of rockwool as this has replaced peat.
The project included trials with 16 ornamental horticultural crops to investigate if reduced peat or peat-free growing media could be used instead of peat and to test the level of peat replacement possible and management changes needed for each crop. The overall requirement was that the materials used had to be available in economic quantities at an acceptable price and all had to be approved by RHP (the Dutch accreditation organisation for growing media). The RHP have quality standards for the different types of raw material used in growing media (such as peat and coir) and samples are compared to this to determine if they can be approved by RHP. If growers do not use RHP approved substrates they may not be able to get insurance cover for their crops.

In phase 1 new formulations were screened by research stations. These contained various combinations of peat, bark, woodfibre, coir, green compost, rice husks and rockwool granules. The most promising mixes were then used by growers in phase 2. The mixes trialled had a peat reduction of 77-30%. 100% reduction was not considered to be necessary at the time as the emphasis was on researching new blends using non peat ingredients, not on phasing out peat altogether.

**Results:**

It was found that the water holding capacity was lower for some mixes. For mixes with a peat content of 10-20% lower than standard the growers noticed that irrigation systems had to be adjusted. No differences in the shelf life of plants were found with the different mixes.

The growing trials showed that for two species (Hedera and Schefflera) better results were achieved with the new mixes than with traditional peat based mixes. With eight species (Azalea, Guzmania, Poinsettia, Rosa, Saintpaulia, Adiantum, Crassula and Ficus) plant quality with the new mixes was not as good as with the established peat mix but it was felt that with some adaptations to management and slight amendments to the mixes it would have been possible to produce acceptable plants. For one species (Begonia) growers felt that the performance with the new mixes was inferior and they were not confident that it could be improved easily. For the other species tested (Anthurium, Chrysanthemum, Gerbera, Spatiphyllum and Castanospermum) at least one of the new mixes trialled gave equal performance to traditional peat mixes.

Feeding had to be adapted for some mixes due to higher pH and/or higher electrical conductivity. Some mixes were found to need more nitrogen due to nitrogen immobilisation during microbial breakdown of ingredients. Many growers involved in the project are still using the new mixes instead of 100% peat. The project did find that a premium was needed for some of the reduced peat plants to cover the extra cost of the raw materials and slightly higher management cost. The project identified that in The Netherlands the most popular alternative to peat was coir, which also required least crop management changes compared to peat.

The conclusion of the New Growing Media project was that peat reduction/replacement was technically possible for most species but that economics were a barrier to change. The project involved the supply chain from the end market down to individual growers and demonstrated that change could be effected through good communication.

Horticulture is an important industry in the Netherlands and the professional sector is continually looking to improve the substrates used. Where there have been technical and economic benefits associated with the change to new growing media these have been adopted, for example the replacement of peat bags with hydroponic systems for salad crops and the replacement of peat with coir for strawberry production in bags and some cut flower and pot plant production.

**2.03 France**

Approximately 4 million m³ of growing media are used in France per annum (including substrates for hydroponic crops) (Riviere et al., 2008). Most of the peat used is imported from northern Europe.
France has one of the lowest peat percentages in growing media of all European countries, probably because it has limited raised bog peat reserves and imported peat is relatively expensive. Forestry by-products are important in France, for example bark, wood fibre and leaf mould. There is an extensive pine forest area (Forêt des Landes) in south western France which produces a large volume of these by-products. However availability of bark is reducing due to the trend for timber to be de-barked in the forest (which is cheaper as the bark can be left there and not disposed of separately) and competition from the energy industry; hence bark prices have increased significantly in recent years.

Woodfibre has been produced in France for about 20 years (for example ‘Hortifibre’) and about 150,000 m$^3$ is used per year in mixes with peat. Leaf mould (leaf litter on the forest floor) has traditionally been used in France for ericaceous species such as Rhododendron and Azalea but supply is reducing with pressure not to remove organic matter from forest soils. Peat is being used as an alternative for these species.

Green compost is used in growing media in France, mainly for amateur gardening products, in blends with peat (compost at up to 30%). Small volumes of coir are used but it is expensive to import. Some expanded minerals are used locally (for example volcanic material in the South of France and in the Massif Central). Transport costs are a limiting factor for these types of bulky mineral materials.

Rockwool is used for cut flower and vegetable production in hydroponic systems in France although there are concerns about disposal issues for rockwool after use. Coir fibre dust from India and Sri Lanka has been trialled as a replacement with some success.

The French example demonstrates that if good alternative materials are available at a lower price than peat then they will be used by the market. There is also less of a tradition of using media with a high proportion of peat in France because there are only very limited peat reserves and imported peat is relatively expensive. However there is less professional growing media production in France than in the UK (with its associated higher technical specification requirement). This shows that the amateur market is likely to be more amenable to a change away from the use of peat and could indicate the way the industry might initially change in the UK.

2.04 Germany

The horticultural growing media industry in Germany is the largest in Europe (around 9 million m$^3$ per annum) and has similarities to that in the UK as both have developed using high quality sphagnum peat from local peat bogs. The industry is dominated by a few large manufacturers (for example Klasmann Deilmann), as in the UK, and these are mainly located near the peat reserves in Lower Saxony (north west Germany). Peat for growing media is also imported from Lithuania. There is some pressure from conservation bodies in Germany to limit domestic peat extraction for environmental reasons, although this is not yet linked to government targets as in the UK. There is a mature market for amateur gardening products in Germany due to gardening being a major leisure activity, as it is in the UK. Professional growing media are still 93% peat in Germany and retail products have an average peat content of 94%. Peat reduction is less advanced than in the UK, however the major growing media companies in Germany, such as Klasmann Deilmann, have been investing in research on peat alternatives over the last 10-15 years.

There is a well established composting industry in Germany and about 250,000 m$^3$/year of compost is used in growing media, mostly in amateur gardening products.
Timber industry by-products are readily available in parts of Germany and the production of man-made wood fibre from wood chips from timber off-cuts was established in Germany and France before being adopted in the UK more recently. Wood fibre is made from wood chips, mostly spruce, that have been defibrated using thermo-mechanical processes (the wood fibres are blown apart by steam under pressure). Fertiliser can be incorporated in the production process to counteract nitrogen immobilisation by micro-organisms breaking down the material which would otherwise cause a problem for plants grown in wood fibre mixes. Wood fibre has been marketed in Germany for about 20 years however it has not been widely adopted as a raw material for growing media because its price compared to peat has increased as energy prices have risen and there has not been any requirement to reduce peat use (German peat has just been replaced by imported peat).

Coir is used to a small extent in Germany, mostly in growing media for the propagation of young vegetable plants and for floriculture. As in the UK it is more expensive than peat which has limited its use but its physical properties, such as good air filled capacity, makes it an ideal material for propagation. The majority of coir used in Germany, as in the rest of Europe, comes from India but coir is also produced and sourced from Sri Lanka, the Philippines and Mexico.

A small volume (3000 m³) of locally produced flax is reported as being used each year in growing media in Germany. Research in Germany has indicated that flax straw has disease suppressive qualities (Wohanka et al., 2008).

The growing media industry in Germany is the largest in Europe and has a similar structure and history to that in the UK. It has developed based on exploitation of local peat reserves, hence the growing media companies (as in the UK) were mostly peat companies originally. Germany is also similar to the UK in having a mature amateur gardening market because gardening is a very popular leisure activity. However, in Germany there has not been as much of a focus on peat replacement as in the UK and the use of peat alternatives in growing media is limited.

2.05 Italy

Italy has a large growing media industry (around 5 million m³ per annum) and mineral materials including pumice, perlite, clay and vermiculite make up a significant proportion. Pumice alone accounts for 450,000 m³ per year. These materials are used more widely than in other European countries, particularly as component ingredients in professional growing media, because they are available locally so their relatively high transport costs are not prohibitive. The container tree sector is particularly important in Italy with large specimen trees being exported to the rest of Europe.

Retail growing media products only make up 27% of the total growing media used because gardening is not a major leisure activity in Italy and these products are on average 64% peat. The professional growing media market is much more significant and is 78% peat. There is much interest in the use of composted materials and mixes with 25% green waste plus sewage compost have out-performed 100% peat for a range of bedding plants in trials (Grigatti et al., 2007). However, higher rates of green waste compost use have been found to reduce crop growth. The Italian growing media manufacturers are interested in the technology being developed to utilise green compost oversize material in the UK (see 2.08 European case study 2) as a potential locally derived material derived from their well developed waste recycling industry. The extrusion equipment being used as part of this process is Italian technology.
2.06 Spain

Spain has a relatively small growing media market (1.6 million m³ per year) with most of this being made up of amateur gardening products as the majority of horticultural crop production is soil based. Spain is an interesting case study, however, as it does not have any peat reserves and there is significant use of other ingredients for growing media, including mineral materials such as sand and clay, particularly in amateur gardening media. Composted wood waste is also a major component of retail products. A national inventory of organic wastes that could be used in ornamental potted plant production has been carried out in Spain because peat is not readily available and is expensive. This showed that there are many alternative sources of organic material but only a minority are suitable for use in growing media. Research has been carried out on leaching of composted wastes to reduce salts levels (Tapia et al., 2007) and this has shown that this can be partially effective. In Spain composted brewery waste, lemon tree prunings and olive wastes have been trialled (Garcia-Gomez et al., 2001) and found to be satisfactory when blended with peat to lower the salt levels.

Spain has a relatively small growing media industry mostly supplying the amateur growing media market. Peat is expensive in Spain, as there are no significant local reserves, so mineral materials such as sand and clay are used in retail products blended with composted wood waste. Research and development of peat alternatives in Spain has been important in the search for suitable alternative materials.

2.07 European case study 1

Bord na Móna, growing media manufacturer in the Republic of Ireland

In 2009/2010 the Horticulture Division within Bord na Móna reported a turnover of €49,239,000, and an operating profit of €3.4 million in 2008/2009. This division supplies peat and non-peat based products to the retail and professional markets in Ireland, the UK and across Europe. Growing media and decorative products are produced under the Shamrock and Growise brand, as well as a private label within the UK.

Bord na Móna has an integral company policy based on sustainability and while peat is an excellent growing medium renowned for its qualities and reliability, the company recognises that it will be increasingly replaced by more sustainable alternatives. The UK is the main market for retail products within the horticulture division, therefore Bord na Móna must be compliant with UK government peat dilution targets. In addition, one of the major UK customers of the company requests yearly increases in the volume of peat alternatives used within this market. With these drivers in mind, the company set up a research and development programme in the early 1990s, to investigate the conversion of Irish wastes into horticultural products. In 2005, the largest composting facility in Ireland was opened by Bord na Móna, composting up to 96,000 tonnes of botanic based materials per annum, to be used in the retail horticulture market. The set up costs of this facility were €4.5M, with a further €1M spent on equipment upgrading.

The compost produced is used in retail growing media at up to 20% but not in professional media.
The main issues relating to peat alternatives are based around availability and cost. Several alternatives to peat are being investigated by the company, namely coir (which is costly), indigenous Irish waste (the composting of which requires compliance to stringent legislation and high processing costs compared to peat), wood based alternatives (also costly, with stocks being drawn on by other industries such as the energy industry) and other alternatives such as rockwool, perlite and vermiculite (which have sustainability and disposal issues, for example used rockwool or perlite cannot be composted and usually have to be disposed of in landfill).

Bord na Móna is primarily a peat company and their investment in green compost as an alternative to peat demonstrates that peat reduction is a serious issue for them. This case study demonstrates the benefit of the growing media manufacturer controlling the quality and availability of a material such as compost for inclusion in the growing media they produce. Significant capital costs are required to be invested, supported by a research and development programme.

2.08 European case study 2

Development of new materials, Freeland Horticulture Ltd, UK

The development of local materials to replace the imported peat in growing media is essential if the amount of peat used as a component is to be reduced significantly. An initiative that has been tried and tested by Freeland Horticulture is the use of green waste compost oversize (the larger woody fraction) as a raw material. The requirement for a peat replacement material is that it has a low bulk density and a low electrical conductivity. These characteristics are being achieved by shredding and grading the oversize, screening out the fines, removing the light plastics, metal and stones, washing and then taking out the heavier plastics before extruding the clean, woody fraction that remains using Italian woodfibre extrusion technology. This is screened into various fractions for different uses, one being as a peat alternative once it has been stabilised to ensure nitrogen is not locked up after blending and bagging.

The site near Basingstoke, where the production line has been successfully demonstrated, is being expanded to take in 12,000 tonnes of oversize materials a year produced from 100,000 tonnes of green waste arisings in Hampshire. As the bulk density of the final product is only 230 g/litre, 52,000 m³ of material will be produced a year from this one site.

The amount of oversize produced in England is in excess of 600,000 tonnes so there is the potential to produce 2.6 million m³ of this peat replacement material a year in England, enough to substitute all of the peat used in retail growing media. Considerable investment would be required to realise this potential. A higher price of peat would make the economics more favourable, as in Italy where this technology may also be implemented.

This case study indicates that, with suitable research and investment, alternatives to peat can be derived from locally available waste materials in quantities that could make an impact on the amount of peat used in the UK.
2.1 USA

2.11 Peat production and usage

Ten percent of total global peat production occurs in North America. Canada currently accounts for about 75 percent of this production with about 7.3 million m³ of peat harvested per year (Hood and Sopo, 2000). Canada produces approximately 22 percent of the world’s horticultural peat, making it first or second among nations, depending upon Germany’s production in a given year. Most of this peat is baled and sold into the USA. The USA itself generates only small volumes of sphagnum peat, although Florida possesses huge reserves of reed sedge peat. There have been no national peat reduction policies to date in North America. Huge volumes of peat are still used in nursery production, more in glasshouse production than in nursery (outdoor containers) production. Unfortunately, neither peat consumption nor commercial and retail growing media production are monitored in the USA so data similar to that reported for European countries are not available. However, information is available from horticultural sales census data on the relative values of the components of the horticultural industry. Peat is also still used as a component of mushroom production substrates in the USA.

2.12 Nursery industry (professional horticulture)

The USA possesses a large horticultural (nursery) industry, which generates over $10 billion dollars in nursery stock and bedding plant sales. The major plant production categories, as broken down within the 2007 Census of Agriculture (US Department of Agriculture, National Agricultural Statistics Service), are found in Figure 2. Interestingly, each category of ‘growers’ listed below uses peat and peat alternatives to some extent. Note that mushroom production is also included in this data.

Figure 2 USA 2007 Census data – horticultural sales

Although nursery production is spread throughout the USA, California on the west coast and Florida on the east coast dominate most production categories (see Table 3) including some of the soil-based growing systems. This is likely to be related to their favourable weather conditions. Other west coast states, such as Washington and Oregon are also large nursery production states, as are specific Mid-Atlantic (e.g., New York and Pennsylvania) and Mid-West states (e.g., Ohio, Wisconsin and Michigan). Texas is also a significant nursery production state, while Pennsylvania has led USA mushroom production for decades. These states are likely to be the largest consumers of peat and peat alternatives.
Table 3 USA 2007 Census of agriculture – state data ranked by sales volume

<table>
<thead>
<tr>
<th>Ranking:</th>
<th>1&lt;sup&gt;st&lt;/sup&gt;</th>
<th>2&lt;sup&gt;nd&lt;/sup&gt;</th>
<th>3&lt;sup&gt;rd&lt;/sup&gt;</th>
<th>4&lt;sup&gt;th&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floriculture Overall</td>
<td>CA</td>
<td>FL</td>
<td>MI</td>
<td>TX</td>
</tr>
<tr>
<td>• Bedding plants</td>
<td>CA</td>
<td>MI</td>
<td>NC</td>
<td>OH</td>
</tr>
<tr>
<td>• Cut flowers</td>
<td>CA</td>
<td>FL</td>
<td>WA</td>
<td>HA</td>
</tr>
<tr>
<td>• Foliage plants</td>
<td>FL</td>
<td>CA</td>
<td>TX</td>
<td>HA</td>
</tr>
<tr>
<td>• Potted flowering plants</td>
<td>CA</td>
<td>FL</td>
<td>TX</td>
<td>MI</td>
</tr>
<tr>
<td>• Other floriculture</td>
<td>OR</td>
<td>CA</td>
<td>WA</td>
<td>NY</td>
</tr>
<tr>
<td>Glasshouse vegetable and herbs</td>
<td>CA</td>
<td>FL</td>
<td>PA</td>
<td>IA</td>
</tr>
<tr>
<td>Mushrooms</td>
<td>PA</td>
<td>CA</td>
<td>OR</td>
<td>WI</td>
</tr>
<tr>
<td>Nursery stock</td>
<td>CA</td>
<td>FL</td>
<td>OR</td>
<td>TX</td>
</tr>
</tbody>
</table>

CA = California; FL = Florida; HA = Hawaii; IA = Iowa; MI = Michigan; NY = New York; NC = North Carolina; OH = Ohio; OR = Oregon; PA = Pennsylvania; TX = Texas; WA = Washington; WI = Wisconsin.

It is worthy to note that while the value of the nursery industry continues to grow, the number of nursery operations decreased slightly between 2002 and 2007.

2.13 Major manufacturer data

In order to determine trends in the usage of peat and peat alternatives in the USA interviews were completed with 15 commercial and retail growing media producers; including some of the largest producers in North America. Of the 15, five operate or own peat bogs (three sphagnum, two reed sedge peat). Compost producers, which have entered the growing media industry, try to maximise the volume of compost utilised in their mixes because it is a lower cost ingredient. Almost every company is trying to use less peat, and more ‘peat alternatives’ (Table 4). However this is because peat is more expensive than the most popular peat alternative products (e.g., softwood bark and compost). The use of peat alternatives, such as coir, perlite and vermiculite, has not increased as they are more expensive than peat. Where media companies produce multiple product lines (e.g. professional vs. retail, protected vs. outdoor nursery), their higher value or higher cost lines always contain greater volumes of peat. Further, commercial nurserymen and media companies supplying them still seem to be more comfortable with peat and its characteristics for the highest value glasshouse applications. Softwood bark is by far the most popular peat alternative, because of its lower cost and favourable characteristics (e.g. lower pH, electrical conductivity, and bulk density than compost). All of the companies surveyed use some type of compost in one or more of their mixes. Green waste (yard trimmings) compost is the most popular, followed by biosolids (sewage sludge) compost.

Most media producers are not concerned about shrinking peat supplies because they do not see it happening, but they are concerned about the shrinking supply of bark. This is being caused by its popularity within the nursery and landscaping industries, as well as its expanded use in bioenergy production. Aside from peat and coir, almost all of the media components are purchased locally or regionally. Many of the media producers use green compost where they can, with its greatest limiting factors being technical in nature (e.g. pH, high electrical conductivity and bulk density, and lack of consistency).

There has been some research in the USA on the use of by-products of agricultural crops in growing media, for example kenaf (Webber et al., 1999). Kenaf is a member of the hibiscus family (Hibiscus cannabinus L.), related to cotton and okra, and grows well in many parts of the USA. It is used for paper production and grows quickly, achieving heights of about 4 metres in 4 to 5 months.
Table 4 Popularity of growing media components (by use out of the 15 companies)

<table>
<thead>
<tr>
<th>Organic material</th>
<th>Glasshouse Nursery</th>
<th>Container Nursery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peat – sphagnum (Canadian)</td>
<td>14</td>
<td>10</td>
</tr>
<tr>
<td>Florida peat - sedge</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Softwood bark – pine, fir</td>
<td>14</td>
<td>11</td>
</tr>
<tr>
<td>Compost – biosolids compost</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Compost – yard trimmings</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Compost – stable bedding</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Compost – mixed feedstocks – leaves, manure, yard trimmings, food</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Compost – spent mushroom soil</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Coir</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Perlite</td>
<td>15</td>
<td>3</td>
</tr>
<tr>
<td>Vermiculite</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Other – sand</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Other – wood-based products</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Other – rice hulls</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Other – manure digestate fibre</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Other – pumice</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

Experience in the USA has shown that locally available materials, at prices that are favourable, will be utilised in preference to peat especially in media that are used to grow lower value crops or in the retail sector.

2.14 USA case study

Use of recycled softwood bark in container media in USA

Based on 2007 figures, the USA nursery industry produces over $6.5 billion of nursery stock annually. The majority of these shrubs and trees, and some herbaceous plants, are grown in larger containers which are typically managed outdoors. Although nursery production occurs throughout the USA, the states of Florida and California are the largest areas of production, primarily because of their mild climate. Since nursery stock is grown in larger containers (e.g. 4 litres) larger volumes of growing media are required, when compared to glasshouse crops. For this reason, for over 30 years sphagnum peat moss usage volumes have been supplanted by softwood bark in nursery media. Softwood barks are roughly half the cost of sphagnum peat moss in the USA.

Research and field experience has shown that because they are low in cellulose and high in lignin, soft wood barks can be used either fresh or composted and do not decompose rapidly. However, only coniferous barks with less than 10% cellulose (white wood) can be used fresh. Coniferous bark with 10% or more cellulose must be composted first to reduce the chance for nitrogen drawdown. Bark based container media are primarily derived from pine bark in south eastern USA, and fir and hemlock barks in north western USA. Since these materials are lightweight in nature they can be transported for hundreds of miles more economically than heavier substrates.

For optimal plant growth, when used as a growing media component, bark products should be milled to particle sizes no greater than 10-12mm diameter. Unlike sphagnum peat or sedge peat, the cation exchange capacity of softwood bark improves with age. Similar to peat, softwood barks possess a lower pH and electrical conductivity and, unlike compost, media containing high percentages of these barks typically drain very well.
While softwood barks are often included in container media (by volume) at rates of 25 to 50%, media produced for ericaceous plants (e.g. azaleas) in south eastern USA can be close to 100% pine bark.

This case study from the USA shows how knowledge of the properties of the materials available is important and this, coupled with price, influences in which media and in what proportion they can be utilised.

2.2 Australia and New Zealand

2.2.1 The growing media industry and usage

The value of growing media and mixes in Australia in 2009 was AU$142M, which had grown by 5% on the previous year (Australian Garden Market Monitor, 2009). Australia does not have large reserves of peat and peat has not been used in significant quantities in growing media for many years. Some peat is imported and used in seedling mixes, for example, although mostly blended with bark.

Volume data for Australia was supplied by the Nursery and Garden Industry Queensland (NGIQ) (J McDonald 2010, pers. comm., 20 October). Retail growing media generally consists of composted pine bark, green waste compost and coir and an estimated 9 million 30 litre bags are produced containing:

- 108,000m³ pine bark
- 108,000m³ green waste compost
- 54,000m³ coir

Nursery growing media mainly contain bark (80%), sand (10%) and coir (10%) (Table 5). Green waste compost is not encouraged due to variability. Composted sawdust and pumice are little used.

Table 5. Approximate annual volumes of growing media used in Australian nursery production.

<table>
<thead>
<tr>
<th>Australian State/Territory</th>
<th>Bark</th>
<th>Sand</th>
<th>Coir</th>
<th>Total volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Queensland</td>
<td>96,000</td>
<td>12,000</td>
<td>12,000</td>
<td>120,000 m³</td>
</tr>
<tr>
<td>New South Wales</td>
<td>165,984</td>
<td>20,748</td>
<td>20,748</td>
<td>207,480 m³</td>
</tr>
<tr>
<td>Australian Capital Territory</td>
<td>2,952</td>
<td>369</td>
<td>369</td>
<td>3,690 m³</td>
</tr>
<tr>
<td>Victoria</td>
<td>143,640</td>
<td>17,955</td>
<td>17,955</td>
<td>179,550 m³</td>
</tr>
<tr>
<td>South Australia</td>
<td>42,560</td>
<td>5,320</td>
<td>5,320</td>
<td>53,200 m³</td>
</tr>
<tr>
<td>Western Australia</td>
<td>60,116</td>
<td>7,514.5</td>
<td>7,514.5</td>
<td>75,145 m³</td>
</tr>
<tr>
<td>Northern Territory</td>
<td>4,256</td>
<td>532</td>
<td>532</td>
<td>5,320 m³</td>
</tr>
<tr>
<td>Tasmania</td>
<td>16,492</td>
<td>2,061.5</td>
<td>2,061.5</td>
<td>20,615 m³</td>
</tr>
<tr>
<td>Total Australian volume</td>
<td>532,000</td>
<td>66,500</td>
<td>66,500</td>
<td>665,000 m³</td>
</tr>
</tbody>
</table>

Therefore, the combined nursery production and retail volumes are:

Composted Pine Bark: 640,000m³ (produced in Australia)
Washed River Sand: 66,500m³ (produced in Australia)
Green waste compost: 108,000m³ (produced in Australia)
Coir: 120,500m³ (all imported)
Total: 935,000m³

There are no government policies in respect to growing media inputs themselves although influences on waste recycling are resulting in more waste derived materials, such as compost, becoming available. The Nursery & Garden Industry Australia (NGIA, 2009) sustainability position does not
mention materials for growing media, probably because little peat is used and the major material used, pine bark, is a co-product of the forestry industry.

Sand is becoming expensive due to restrictions on dredging from rivers and streams. Bark supply is stable with little pressure from power generation. Coir usage has been encouraged within the industry as an alternative material for some types of media with reasonable success (but is more expensive than bark) and supply is stable. Coir usage in Australia is a relatively small amount of the global market.

Estimates of the retail and professional market from the manufacturers are in reasonable agreement with the NGiQ data. However, the manufacturers’ data are slightly higher (20 to 30%) perhaps due to the inclusion of a much greater range of materials used than indicated above, and this is discussed below.

2.22 Manufacturing in Australia

The ingredients used in growing media depend on price, availability, quality and consistency. Manufacturers are willing to experiment with new materials and work closely with growers. A small amount of peat is used but mainly in speciality mixes and for propagation by professional growers due to its relatively high price. Peat is imported from Canada, Lithuania and New Zealand; some growers use it as they are reluctant to change.

Use of coir products, sourced from Sri Lanka, India and Brazil, has increased as pine bark prices have risen due to the slowdown in the construction industry (now recovering). Some manufacturers use up to 30% coir in mixes. Coir products include the fibre and also a chip made from the coconut trees. Pine bark is the most commonly used material in Australia due to its availability and low price. Hardwood bark is generally not available; sawdust gives problems with nitrogen immobilisation and so is not favoured. However, hardwood sawdust is used by some manufacturers despite the drawbacks. Only small amounts of soil are used. Some producers include coir in retail products rather than nursery mixes due to possible plant diseases, but others do use it in professional mixes; a proportion of soil is used in large containers for trees.

Green waste compost is used at 20 to 30% in some mixes but tends to have a lower air filled porosity and to be heavier than bark. There are issues with its consistency but where a good, clean source is available it is incorporated into mixes. Sand is used in many mixes; perlite and vermiculite are used but are expensive. Zeolite, although it adds cost to mixes, is used in some specialty media due to the improvement in cation exchange capacity and plant growth. Clinker ash has also been used, as well as bagasse (from the sugarcane industry) and rice husks, where available.

Pine bark and coir are likely to remain key ingredients and supply appears to be stable although there is growing competition from power generation for timber by-products, especially in more remote areas. The key to the growing media industry is adaptation as products change in price and availability. Australia is probably more susceptible to supply and demand issues than European countries due to the limitation of suitable resources internally and the relatively high importation costs of other materials. Due to the large distances involved within Australia, transport adds cost so local materials are used wherever possible. Coir is approximately twice the price of pine bark, sawdust and sand, with peat three times the price of these materials.
Australia does not have a significant local supply of peat to exploit and the industry has therefore developed around the use of non-peat materials, although some peat is used in speciality mixes or where growers are reluctant to change away from peat-based mixes. There is good technical knowledge about the alternative materials and, coupled with experience by growers, confidence in their usage. The industry appears to be ready to adapt to the pressures of supply, logistics and economics and to use materials that are available locally that can be blended together to produce fit-for-purpose growing media.

2.23 Australian case study

Ericaceous growing media in Australia as made by two manufacturers in different states

As peat is imported into Australia from Canada, Europe or New Zealand, it is only used in any significant proportions in propagation systems. The growing media industry has developed potting mixes for ericaceous plants using alternative materials. Go Grow in New South Wales base their mixes on 80% composted pine bark fines 0-10mm, 10% coir and 10% coarse river sand.

The Go Grow target pH is in the range from 5.1 to 5.5 and is adjusted through small amounts of agricultural lime and dolomite. Other nutrients such as controlled release fertiliser and trace elements are also added. The amount of the nutrients is adjusted for each nursery and their growing conditions such as pot size, watering regime and microclimate.

Go Grow custom mix for their professional growers but also make six bagged formulations for the retail sector. They use a range of materials. In addition to those named above, they also use a coir chip made from chipped coconut trees, some green waste compost and hardwood sawdust. Inorganic materials used include perlite, vermiculite and zeolite. Go Grow produce 300 to 500 m³ per week. Their standard formulations can also be used for ericaceous plants when the pH is reduced through the use of iron sulphate.

Green Fingers is a potting mix manufacturer in Queensland, Australia which has an ericaceous potting mix designed for plants that require acidic conditions, such as azaleas and camellias. The mix is a blend of composted pine bark (0-12mm) media with added crushed sandstone (coarse sand), liming agents, iron sulphate, copper sulphate and chelated trace elements. The pH is 5.0-5.5. Feedback from growers is that they like the mix and plant growth is good.

These examples indicate that ericaceous growing media can be developed using alternatives to peat. It is not known if they are as productive as peat based media but they appear to be a cost-effective solution for the Australian market.

2.24 Manufacturing in New Zealand

The growing media market in New Zealand is estimated to be 300,000 to 350,000 m³ per annum, of which no more than 15% is peat, distributed equally between professional grower and retail growing media. In New Zealand and there are extensive sources available although the manufacturers are sensitive to the environmental issues related to its extraction and use. However, many growers are accustomed to using peat and are reluctant to change (as in the UK) even though comparable ingredients are available. Sedge peat is available in the North Island and sphagnum in the South. Small amounts of peat are imported from Europe. Pine bark is extensively used in mixes (50 to 60%) due to the large, sustainable forestry industry and it is relatively cheap. Hardwood bark, sawdust and soil are not used. There are consistency issues with green waste compost and so it is little used. Coir is used at about 20% of mixes but is more expensive than bark, although comparable in price to some peats depending on transport costs. Coir supply is of good consistency and stable. Little
perlite and vermiculite are used but local sand and pumice are both used (at up to 15 to 30% of mixes) for technical and cost reasons.

Novel materials are being developed in New Zealand such as a fibre created from tree ferns (from sustainable sources in forestry) and an expanded bark fibre which is made between two rotating toothed, steel plates. Both of these materials are more peat-like in appearance and in some of their technical properties. These projects are at early stages of their development requiring further study and have been instigated by researchers mindful of environmental issues.

In New Zealand a range of materials are being used including peat as this is available locally. However, the industry appears to be sensitive to environmental issues and is actively researching and using suitable alternatives.

2.3 Other countries

2.31 Japan

Peat is expensive in Japan and research has been carried out using synthetic aggregates (sandy soil plus paper and starch waste) combined with composts made from cattle manure or sewage sludge and sugarcane trash (Jayasinghe et al., 2009, Jayasinghe et al., 2010). These substrates have been trialled against 100% peat and some of the non-peat blends out-performed peat for ornamental plant production.

2.32 South America

Cut flowers in Columbia are grown in mixes with burnt rice husks and coconut fibre.

2.33 Kenya

For cut flowers the most commonly used substrate is locally mined pumice. Peat moss from Singapore is also used in growing media as well as rice husks, macadamia husks and forest soil.

2.34 Vietnam

Soil-less culture is being used to grow fruit and vegetables because of issues with metals e.g. lead due to pollution and to reduce pest and disease problems. Coir is the main substrate used, sometimes mixed with sugar cane waste (bagasse), peanut husks, soybean, peat or volcanic rock. Some wastes have been found to give high lead levels in fruit however.

2.35 China

The Peoples Republic of China does not have a large growing media manufacturing industry. Where crops are grown in substrates, rather than the soil, locally sourced materials are used, including mineral materials and rice husks.

2.4 Summary of international experience

In Europe, peat is the dominant material used in growing media due to its technical properties and low price. There are differences between mainland European countries in the proportion of peat used in media due to the distance, and hence transport cost, for peat and the availability of alternatives locally. Germany has a ready supply of peat and uses a high proportion; The Netherlands imports peat relatively short distances and uses less as a proportion than Germany. In southern Europe,
France and Spain use even lower ratios of peat due to the higher cost and availability of alternatives, and Italy is actively researching alternatives.

These economic pressures are mirrored around the world. Where peat is relatively limited in availability locally, such as Australia and regions of the USA, bark is the dominant material used. The transported peat (which costs more) is being used in smaller proportions in blends and often in the more technically demanding professional mixes. However, even ericaceous growing media have been developed as cost-effective alternatives to peat-based mixes in many countries on a relatively large scale.

Research and development has been a key requirement for the successful use of alternative materials in growing media. The capital costs for the equipment to process peat replacement materials from wastes, and to overcome their technical shortcomings, are a barrier to their widespread use due to the low returns when the price of peat remains low.

3.0 Standards

Some EU states have enacted regulations in relation to horticultural peat, others have not – there is no coherent legislative framework across the EU. CEN/TC 223 – Soil Improvers and Growing Media (European Committee for Standardisation, Technical Committee 223) has developed a number of standards for soil improvers and growing media but these have only been incorporated into French and Belgian law – they are applied voluntarily in other states, and feed directly into many standards for example BSI (UK) and DIN (Germany). Most member states use national laboratory specific methods or methods agreed by national quality assurance associations to regulate growing media. Criteria for packaging and labelling also vary across the EU (Gallagher, 2008).

There is no specific legislation on horticultural peat in Ireland, Latvia or Sweden. The trade of growing media is regulated only within fertiliser regulations in some countries e.g. Estonia (Fertilisers Act) and Finland (Danish Plant Directorate – regulatory body for compost products). Legislation is under review in Denmark and will potentially be based on CEN standards. Legislation was being revised in some European countries including Belgium and Germany (Gallagher, 2008).

The main purpose of CEN/TC 223 is to remove barriers to trade in soil improvers and growing media. They do this by establishing a set of ‘horizontal methods of test for determination of the values of the characteristics in soil improvers and growing media’, e.g. determination of pH, sampling and determination of quantity. These would then provide a level playing field for business trading in this area and businesses would not have to meet different criteria in different EU states. The group considers that countries outside Europe may adopt or modify their existing standards, i.e. use them as the basis of their own standards. Links are maintained with various organisations to facilitate this – International Society for Horticultural Science (ISHS), the Association of Official Analytical Chemists International (AOAC International) and with ISO/TC 190 Soil Quality, European Compost Network, the European Perlite Association and participation by the CEN Associate ECOS.

In Germany there are RAL standards (RAL-GZ 251) for composted biowastes. In The Netherlands, RHP Horticulture is the quality mark for growing media and substrates, developed by Stichting RHP (Regeling Handels Potgronden), accredited by ECAS, and certificated by the Certification Institute (CI). Substrate components produced to the RHP standard include bark, lime, perlite, RHP compost, vermiculite, rice hulls, potting soil fertilisers, clay, clay granules, woodfibre, coir products, pumice stone and peat. There is also a standard for potting soil. The RHP standards appear to have been adopted by companies in other countries, although that may be because they supply the Netherlands – for example a number of coir producers in India and Sri Lanka. In Italy they produce substrates or growing media to the standard of Annex 4 of legislative decree 75, 2010. Annex 4 stipulates basic chemical and physical parameters for basic growing media and mixed growing media.

There appears to be few standards that relate to the composition, specification or performance of the final growing media. There are potting mix standards in Australia (AS 3743) for regular and premium products. In addition, there are specifications for specialist media: seedling, orchid, low phosphorus, acid, African violet, bulb and hanging baskets. The standard provides limits for physical, chemical and biological parameters.
4.0 Review of peat use in mushroom casing

4.1 Background

The casing layer in mushroom production is a thin (50-55mm) capping of peat applied to the colonised mushroom compost. Without this layer no mushrooms can be produced. To function as an initiation zone, this layer must be nutritionally inert and microbiologically suitable. It also provides a reservoir of water for the developing crop. Its influence is profound in that it dictates yield, crop quality and the timing of the crop. The cost of using casing of less than optimum characteristics is, in the present economic climate, commercially unviable. Casing material is also potentially a primary source of many mushroom diseases. The substitution of peat by other materials is, therefore, a considerable challenge.

4.2 Current level of use

Estimates of peat use in mushroom casing in England, Wales and Scotland vary slightly and range from 92 to 100,000 m³ per year; 85 to 90% of this consists of peat, the balance being mainly lime for pH adjustment. The total volume of peat used is, therefore, less than 0.1 million m³ per year compared with peat use in growing media of almost 3 million m³ (equating to 3.3%).

Home production of mushrooms now accounts for approximately one third of consumption. Estimates for 2010 are:

- Home production: 56,000 tonnes
- Imports: 110,000 tonnes

Imports are primarily obtained from Ireland, Holland and Poland where the casing material used is peat.

4.3 Peat replacement

Peat is the sole substrate used in mushroom casing in mainland Europe; use of alternate materials was considered unnecessary when discussed with six of the larger UK-based producers and there is no driver to change this mind set. Consequently there appears to be little research into the use of alternatives.

In the UK, Horticultural Development Company (HDC) funded research investigating peat substitution in mushroom casing (Project M 38\(^2\), 2000) found that composted bark fines were a promising peat substitute that merited trials on commercial mushroom farms, but has not been adopted by industry to date. Two projects due to report in 2011 are a review of the potential alternative materials to peat for use in mushroom casing (Project M 55) and developing new sustainable mushroom casings, including availability of supply of raw materials and the effect on mushroom cropping and quality (Project M 53). The driver for this work is the pressure on the UK mushroom industry to reduce its consumption of peat in mushroom casing. The work was being undertaken at HRI (Horticulture Research International, Wellesbourne) and will continue at East Malling Research following the closure of HRI.

Some positive progress has been made and satisfactory substitution has been accomplished using up to 30% Multiroll Filtercake (MRF). This is clay recovered from various types of mining and gravel operations. Some coir substitution, at a lower level, has also been achieved. Green waste compost was also tested but, because it is not nutrient-free, it has been discounted as a viable material. The use of MRF has reached commercial uptake by some growers but despite its potential it is currently little used due to the barriers outlined in section 4.4.

\(^2\) The report from Project M38 is held by the HDC and is only available to HDC members
There is no research activity in Poland (now a major European producer of mushrooms). One small project in Ireland is examining the use of recycled casing material as a possible substitute (see barriers in section 4.4).

Australian producers source Irish peat (this is of a different type to that used in growing media as it is more humified and of a heavier consistency) and transport it on return shipping loads (otherwise empty ships returning to Australia) at a price that is economically viable.

South Africa has shown some interest due to their shortage of peat but, as they do not face competition from mushroom imports from neighbouring countries, there is no market pressure to reduce peat use.

4.4 Barriers to peat replacement in mushroom production

The direct cost of the raw material will always be a major concern but it is the indirect cost of the effects on yield, quality, pinning control (and therefore harvesting costs) and disease introduction that will determine any substitution of peat. Pinning is a fundamental process to mushroom production by which the vegetative growth of the compost or nutrient base converts the life cycle of the organism into the reproductive - mushroom – stage (from vegetative). The major concern at present is that the most promising materials would be classed as waste (i.e. MRF, recycled casing, rockwool, etc) and an unnecessary regulatory burden by mushroom producers. There is pressure from the supermarkets to replace peat in mushroom production but until the economics are favourable this will not lead to change taking place within the production industry.

5.0 Global supply of materials

Raw materials for horticultural growing media are now traded internationally and therefore there may be competition for materials between countries. Despite the bulky nature of such materials transport by ship is relatively cheap (compared to road haulage) and if there is a market for them it can be viable to move materials large distances, for example peat from Ireland is exported to the USA and Australia and peat from Canada is exported globally; coir fibre dust is exported to both Europe and the USA from India. The costs of fuel and currency exchange rates between countries will influence this trade however. For amateur gardening growing media the margins on products tend to be low and most are based on materials that are sourced locally to the manufacturer. For professional growing media importing raw materials from further afield can be justified because of the higher technical specification and value of the end product.

The greatest threat to the supply of raw materials for the horticultural industry is from the renewable energy industry because it competes for some of the same feedstocks (for example timber industry by-products). In the UK there is concern that there is not enough land area available for forestry to produce wood chips for biomass. Growing media manufacturers will not be able to source this material for wood fibre production at an economic price in the longer term because of the incentives for the energy industry to increase the proportion of renewable fuels they use. An alternative feedstock for wood fibre production is the oversize material from composting of green waste. This currently cannot be used in UK biomass boilers which require clean wood chips (although it is actually exported to Europe for this use). There are significant volumes of compost oversize material potentially available however the capital and running costs of systems to clean it prior to making it into fibre are significant and may be a barrier to rapid expansion of this technology.

Defra report SP08019 found that global coir fibre supply is increasing but not at a fast enough rate to meet possible requirements for peat replacement in the UK. Coir fibre dust is more expensive than peat. However, where its use gives benefits for crop production price is not a barrier to its use, for example there has been a large increase in the use of coir in bags for ‘table top’ strawberry production in the UK and The Netherlands because it can give yield increases and it can be re-used more times than peat. The increasing area of fruit and vegetable/salad crops being grown in substrate systems rather than soil, particularly in southern Europe (in order to maximise yields per hectare and per litre of water) is likely to increase the global demand for coir.
Composted waste materials will be useful to supply a proportion of the raw materials for growing media, particularly for amateur products, and the supply of these is increasing. However, low nutrient materials such as wood fibre, bark fines or coir will still be needed to blend with composted organic materials. The professional growing media sector has more stringent quality requirements and only composted materials of consistent quality, produced from restricted feedstocks are suitable for this market. Agricultural crop wastes could be available in large quantities but cereal straws do not contain enough lignin to produce a peat replacement. Straw from crops such as oilseed rape, flax and hemp have more potential (Dresboll, 2008) but there could be competition for these from the bioenergy market.

6.0 Conclusions

This study has found that the pressure for peat reduction in other countries is less than in the UK. However the issue is becoming more important globally as part of the drive for more sustainable use of resources. Those countries that have local peat reserves are generally still exploiting them for horticultural growing media (and in some cases also for fuel), however those countries remote from peat sources have developed good quality growing media based on locally available resources because peat is too expensive to use. Economics are a key factor; where peat is more expensive there has been investment in alternative growing media ingredients. Where peat is cheap there is less incentive to use other materials because it is a very good growing medium, well researched and relatively consistent in quality.

Countries that do not have locally available peat, such as Australia and southern parts of the USA, generally use high carbon, local industry by-products as the main component of growing media, often in conjunction with composted organic materials. Crops are successfully grown in these substrates (Hummel et al., 2010). The composted materials used in other countries such as the USA and Italy sometimes include biosolids, which would not be permissible in the UK because sewage compost is not an accepted feedstock for composts to comply with the British Standards Publicly Available Specification 100 (PAS100). In the USA wood based materials are now being used in addition to solely the bark from trees, for example whole pine tree chips (Jackson & Wright, 2009). Pine bark is a major alternative to peat where it is available, for example in Australia and France, and there is less competition for this from the energy industry as biomass boilers can typically only take up to 15% bark with the biomass feedstock. Bark supply is however dependent on a sufficient area of forestry, the activity in the construction industry and processing methods (for example more trees are now debarked in the forest). Crop by-products such as rice husks and nut processing wastes are common components of growing media in tropical/sub-tropical zones, in addition to coir fibre dust. In southern Europe there is more use of inorganic materials in growing media than in the UK, for example clays, sand, perlite and pumice. These are not all readily available in the UK and heavy mineral materials are not suitable for the UK retail growing media market because of the associated high transport costs. Countries in southern Europe which do not have ready access to peat are also using composted locally available organic materials in growing media. For example, olive mill wastes in Greece have been used successfully at up to 25% of the substrate for poinsettia (Papaflotiou et al., 2004). There appears to be potential for the waste from agricultural fibre crops to be used in growing media mixes but there has been limited research on this to date.

The German growing media market has the greatest similarity to that in the UK, having a mature retail market and large demand for growing media in this sector, however there is less focus on peat reduction in Germany and growing media are currently 94% peat. Germany has had the technology for wood fibre production and a plentiful supply of wood chip since the 1990s but production has reduced and plants decommissioned due to lack of demand and the lower price of peat.

In addition to economic factors the evidence from research in other countries indicates that growers and gardeners tend to prefer the types of growing media that they are accustomed to and know how to manage, hence inertia is also a barrier to change. Uptake of new growing media is more rapid where there has been good quality research and development (by research stations as well as manufacturing companies) followed by good knowledge transfer to growers and gardeners. The experiences in the UK in the 1970s when the growing media industry converted from loam-based growing media to peat-based media and that in recent years in the USA are confirmation of this. Quality standards for growing media are also beneficial to reduce the incidence of poorly formulated
reduced peat/peat-free products being released on to the market and having an adverse effect on the image of peat reduction. The Australian model for standards for growing media and RHP (Dutch accreditation body) standards for growing media ingredients are examples of this.
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