Project Title:	A review of peat usage and alternatives for commercial plant production in the UK
Project number:	CP 41
Project leader:	Paul Waller, Paul Waller Consulting
Report:	Final report, April 2006
Previous reports:	none
Key staff:	Paul Waller Susie Holmes (ADAS, Senior Consultant data collection and provision)
Location of project:	UK
Project coordinator:	Neil Bragg, Chairman BBPA
Date project commenced:	1 November 2005
Date completion due:	30 April, 2006
Key words:	bark, coir, composted greenwaste, growing media production and market size, own-mix, peat, peat alternatives, substrates, woodfibre

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Grower Summary

Headlines

This report provides details of current and projected peat usage in growing media employed in professional plant production, and reviews the background to this and commercial issues affecting the principal alternatives.

Background and expected deliverables

In the UK Government's Biodiversity Action Plan developed in 1992, it committed itself to:

- review and where necessary amend or develop policies on the consumption of peat
- undertake and promote research and development of sustainable alternatives to peat
- speed up reduction of peat used in both amateur and professional markets
- aim for a minimum of 40% of total market requirements to be peat-free by 2005 and 90% by 2010
- monitor and review take-up and if feasible accelerate the programme of peat reduction

The latest assessment commissioned by Defra is entitled 'Monitoring of peat and alternative products for growing media and soil improvers in the UK 2005' and is in the latter stages of preparation by Enviros Consulting Ltd. and ADAS Consulting Ltd. Its primary purpose is to establish if the 40% replacement target by 2005 has been achieved. It should be noted that this target is generic and covers all uses in all markets and is not applicable to each and every sector. Once published later this year it will be used as a basis for a Defra led discussion with stakeholders to drive and target the process of peat reduction. Further assessments are scheduled for 2007, 2009 and 2010.

HDC has published two general reports on this subject, namely, '*A review of peat reserves and peat usage in horticulture and alternative materials'* (HDC Project CP 1, 1990) and '*Peat Alternatives for Commercial Plant Production in the UK'* (HDC, 2001). This project was commissioned to update this information and to enable HDC and others to have a more complete and independent understanding of the current and prospective position in respect of peat replacement in commercial horticulture.

The overall aim of the project was:
'To collate up-to-date statistics and technical information on the use and performance of materials in professional horticulture growing media in the UK & [continental] Europe, for the purpose of advising policy makers, retailers, growers and growing media suppliers of the performance and availability of peat alternatives and the technical and environmental barriers to peat replacement.'

Soil improvers were excluded from the analysis, but comparisons with the retail sector have been included.

Structure of the project and report

The project was undertaken and reported in four sections:

Part 1: Survey of current and projected peat usage in professional and retail growing media in the UK by growing media manufacturers

- Data has been obtained from 19 leading growing media suppliers (mostly members of the UK Growing Media Association) and from ADAS UK Ltd and others (for own-mix) on the detailed composition of mixes used in seven professional crop sectors and the retail market in 2005, together with their projections for 2007 and 2010.
- The scale of the response and the volumes reported support the view that this survey (including the own-mix estimate) represents 80% to 90% of the entire growing media market and suggests that conclusions drawn about the proportion of peat and alternative usage are likely to be highly robust.
- Glasshouse salads are grown almost exclusively on rockwool and these volumes have not been assessed in the survey.

Part 2: Review of selected published R&D work and other relevant information relating to peat and growing media

- Because growing media manufacturers themselves do not publish their R&D trials data and most peer-reviewed scientific research generally has little commercial significance, a detailed review of the so-called 'grey literature' has been conducted.
- Information has been extracted from a number of known published sources of pertinent information from the UK and abroad. UK data has been sourced from Government peat policy and review documents, Defra (HortLINK), the HDC itself and WRAP (for trials on composted green waste). International data has been sourced from *Acta Horticulturae* (the Technical Communication of International Society for Horticultural Science [ISHS]) where papers given at regular symposia by most of the key European and many other researchers in both the public and private sectors are published), and International Peat Society symposia papers, articles (again with a commercial input) and their book 'Wise Use of Mires and Peatlands', published in conjunction with the International Mires Conservation Group.
- Some other important sources of basic information and data from the UK and Holland are also cited.

Part 3: Key raw materials for growing media manufacture – availability, cost and commercial issues

- This section considers the latest information on the availability, cost and commercial drivers affecting peat and its principle alternatives as advised by the major growing media manufacturers and substrate suppliers.
- It is not intended as a review of the pros and cons of all potential growing media substrates and the myriad of peat alternatives from around the world. This is not necessary as they were considered in the previous HDC report (HDC, 2001) and have been highlighted in Part 2.

Part 4: Grower perspectives on peat replacement in growing media

- This section is a brief review of some grower responses to questions about how they are impacted by the peat issue and the requirement to maximise peat alternative usage.

- In addition to a general review, comments are given for each crop sector.

Conclusions

Part 1: Current and projected peat use

- Growing media used in plant production in the UK are made principally in the UK.
- In 2005, the volume of growing media supplied to professionals by major manufacturers plus that mixed on the nursery was estimated to be over 1.25M cu.m., but for retail use the figure was almost 2.4M cu. m. Peat comprised 86% of professional media and 76% of retail media giving an overall peat usage of 79% across the two markets, down from 92% in 2001 (ODPM, 2002)
- Peat usage in professional horticulture is projected to decline to 80% in 2007 and to 72% by 2010. Bark will remain the predominant diluent followed by wood-derived materials. Coir will be used in some niche applications but Composted Green Waste use will remain minimal. In the vegetable transplant and mushroom casing sectors peat use will remain at around 90%.
- In the retail sector peat usage is expected to fall to 65% in 2007 and to 55% by 2010
- In the professional market, nursery stock was the largest sector in 2005 (32%) followed by bedding and pot plants. These three sectors accounted for 79% of all media and 76% of peat usage by professionals.
- By 2010 less than 40% replacement of peat is likely in the whole growing media market. On this basis, assuming the growing media and soil improver (GM & SI) markets to be the same proportions as in 2001 and that the latter is entirely peat-free; it is possible to estimate that the degree of peat replacement by 2010 in the combined GM & SI markets will (realistically) be in the order of 60%. To achieve the Government aspiration of 90% peat reduction would require the growing media suppliers to reduce the peat content of professional and retail products by 85% overall - more than twice that which is anticipated.

Part 2: Review of published work

- There is a large amount of technical information in the public domain and many non-peat substrates have been and continue to be investigated as growing media constituents throughout the world. These include barks (softwood, hardwood, cork oak), sawdust, industrial woodfibres, charcoal, woodwastes, fibre boards, composted green and other wastes, composted animal and human manures, sludges (including paper, and soy scrap) coir fibre and dust, food wastes (rice hulls, grape marc, palm oil fruit bunches, and fruit and vegetable waste), *Miscanthus* and seagrass, minerals (rock wool, pumice, perlite, vermiculite) and synthetic foams; and most of these have been used successfully as partial peat replacements or, especially in combinations, as peat-free media.
- The exploitation of peat and numerous other substrates in growing media for horticultural production in any one country is essentially governed by cost, performance, and geographical, socio-economic and environmental factors rather than the results of research elsewhere.
- In countries in northern Europe (such as Finland, Sweden and the Baltic States where there are still vast reserves of horticultural grade sphagnum peat) and in other countries in more southerly latitudes that were once self-sufficient in sphagnum peat (such as Holland, Denmark, Germany and the UK) peat remains the substrate of choice amongst professional growers and manufacturers for both technical and commercial reasons. In other countries (such as Belgium and France, where for geographical reasons, indigenous peat has always been of limited quality and availability) the horticultural industries which have developed in

the last 50 years still use imported sphagnum peat or ready-made growing media from those countries where supplies were freely available, although the use of indigenous organic (waste) materials derived from bark and woody materials etc. is increasing.

- Bohlin (2002) undertook a quantitative study of peat and alternative substrate use in growing media produced in European countries on behalf of the International Peat Society. This showed that in 2001, 16M cu. m. was produced in eight countries and that average peat usage was 85%. In both Germany and the UK, which accounted for 31% and 22% of production respectively, peat usage was highest at around 95%.
- The next two biggest producers were The Netherlands (20%) and France (11%) and there, peat usage was 70% and 63% respectively. However, the reasons for lower usage are quite different; in Holland it was due principally to the high proportion of rockwool use [for the production of crops such as salads and cut flowers] whilst in France it was due to the high proportions of organic and composted materials used in the dominant retail sector
- It is widely recognised that to sustain a modern, competitive, European commercial horticultural industry, sphagnum peat is critical because no other material combines as many favourable physical, chemical and biological properties at an economic price. This peat is the most versatile, most reliable, most used and most traded material in the production of growing media and the performance of the horticultural industry is thoroughly dependent on growing media based upon it.
- Whilst it has been reported that many organic materials have been used successfully, there are recurring concerns about consistency, stability, nitrogen lock-up and the need to modify feeding and watering regimes to take account of the nature of the materials used, together with concerns about material variability, hygiene and the carry over of plant diseases.
- The UK is alone in having a Government policy of very significantly reducing the use of peat in horticulture and a programme of monitoring the level of its replacement. However, for the last ten years there has been little publicly funded R&D to support government-endorsed peat replacement targets and to address the technical and horticultural issues through programmes based on scientific <u>and</u> commercial principles. Grower, (100% levy) funded R&D under the auspices of the HDC has been modest to date due to other higher priority R&D issues for various sectors that utilise peat.
- Since 2001 there has been heavy, Government-funded investment in the testing and promotion of composted green waste (CGW) by the Waste and Resources Action Programme; but this has been driven by the need to reduce landfill and has so far not led to any great uptake of this material in professional horticulture by sceptical growers and cautious manufacturers mindful of its variability, technical weaknesses, performance limitations and product liability concerns. This situation is mirrored in Holland, where RHP does not include CGW in any of their recommendations for professional growing media.
- There has been some significant research and development in the Netherlands in recent years to increase peat replacement levels to protect the competitiveness of their pot plant industry in response to UK retailer demand. However, extra cost is involved and it not clear yet if this will become a commercial reality.
- EurepGap and other internationally-based accreditation schemes are not prescriptive over the use of peat, and European retailers are unwilling to pay more for plants, produce or growing media to facilitate peat reduction.
- It is as true today as when Bragg (1990) first made the observations: ‘There is [sic] not, at present, sufficient quantities of consistent materials [available in the

UK], and in many cases insufficient experience/knowledge of necessary long-term management of plants in alternative materials.'

Part 3: Availability and cost of raw materials

- As has been shown in the survey reported here, the key substrates used in commercial growing media now and in the coming five years (as in the Netherlands, Germany and the other EU nations with established horticultural industries) are peat, bark, wood products and coir. Composted green waste will remain principally confined to the retail sector.
- Bulk density and its effect on the cost of transport and distribution is a major factor in the choice of material, not just cost per cubic metre.
- Sphagnum peat from sites without any environmental designation where harvesting is permitted is readily available from within the UK and from Ireland, the Baltic States and Finland. When sourced from UK bogs that the manufacturers' own, it costs less than £5/m^3 but bought-in peat typically costs around £12-15/m^3 delivered. However, for such a readily available, consistent, reliable, versatile and lightweight material this represents the best value for money for the manufacturers and their customers.
- Mixed conifer bark which is used principally as a peat replacement has its price benchmarked against imported bought-in peat but its more limited supply, greater density and potential for nitrogen drawdown count against it. Good quality pine bark used specifically to enhance and maintain aeration in nursery mixes is typically around twice the price of peat.
- Processed wood-based materials and forest co-products are a heterogeneous group of materials which are usually lighter than bark fines and more peat-like. They are potentially attractive to manufacturers but their relatively high price (up to twice that of bought–in peat) and/or limited availability has restricted their utilisation. Some major processors are investigating ways of increasing the supply of such material and reducing their cost.
- Coir pith is a peat-like material with a low bulk density that is widely used in long-term cropping systems in Holland and increasingly as a peat replacement in areas of the world such as Asia where it is produced. Supply is not said to be a long-term issue but delivered prices in the UK can be up to twice that of bought-in peat and thus it has been not become widely used.
- Composted green waste, which is available at below the cost of bought-in peat, has many technical uncertainties and it is considered by most in the industry to be too risky to use in mixes for most commercial glasshouse crops. For technical and bulk density reasons, rates of incorporation will be relatively low and there remain concerns over its variability and propensity for nitrogen lock-up in prepared media, even for retail applications.

Part 4: Grower perspectives on peat alternatives

- Pressure to reduce peat usage is greatest from multiple grocery and DIY retailers and least from garden centres. The general public are generally unconcerned with the components of the growing medium in which their plants or produce is grown.
- With the exception of the salads sector (other than lettuce) which has long abandoned peat-based growing bags in favour of better performing cropping systems based on artificial media and some other low volume, niche applications, peat sustains commercial horticulture. It is the preferred substrate; growers rely on it because it is the most reliable, most flexible and cost-effective medium for crop production.

- Those pressing for peat reduction are unwilling to support or finance any of the costs of research and development or the additional production and distribution costs that arise.
- So far, UK growers in various sectors have accommodated demands for reduced peat usage and have borne the associated extra costs of trialling, materials, distribution, crop failure, pest problems and wastage themselves. However, at this time with ever increasing energy costs, a slowdown in gardening activity and extreme pressures on margins, further reduction are considered uneconomic. Indeed some growers have had to reduce the extent of peat replacement in their media to ensure continuity of supply and to maintain profitability.
- UK growers (who service only their home market) believe that, in comparison with their continental competitors (who supply many export markets, not just the UK), they are disadvantaged by UK government and retailer anti-peat policies as those non-UK growers are better able to resist demands for peat reduction without commensurate payment for the extra costs and risks involved.

Financial benefits

N/A

Action points for growers

N/A

Commonly used Abbreviations

aka	also known as
ASI	Areas of Scientific Interest (in the Republic of Ireland)
ASSI	Areas of Special Scientific Interest (in Northern Ireland)
BAP	Biodiversity Action Plan
BBPA	British Bedding and Potplant Association
BOPP	British Ornamental Plant Producers
BSI PAS100	British Standards Institution Publicly Available Specification 100
Ca	calcium
CBD	Convention on Biological Diversity
CGW	Composted Green Waste (aka Composted Green Material or Green Compost)
CNS	Containerised Nursery Stock
cu. m.	Cubic metre (also written as m^3)
Defra	Department for the Environment Food and Rural Affairs
DIY	Do It Yourself
DTI	Department for Trade and Industry
EC	Electrical Conductivity (a measure of the concentration of soluble salts)
EPAGMA	European Peat and Growing Media Association
EU	European Union
GC	Garden Centre
GMA	(UK) Growing Media Association
GM & SI	Growing Media and Soil Improvers
HDC	Horticulture Development Council
HNS	Hardy Nursery Stock
HONS	Hardy Ornamental Nursery Stock
HRI	Horticulture Research International
IMCG	International Mires Conservation Group
IPS	International Peat Society
ISHS	International Society for Horticultural Science
K	potassium
K cu. m.	Thousands of cubic metres
M	Million
M&S	Marks and Spencer
Mg	magnesium
MPG	Minerals Planning Guidelines
MPS	Milieu Project Sierteelt (a Dutch-based environmental qualification)
MRF	Multi-Roll Filter-cake
MT	Metric Tonnes
N	nitrogen
Na	sodium
NT	National Trust
NW	North-west
ODPM	Office of the Deputy Prime Minister
PPG	Planning Policy Guidelines
PWC	Paul Waller Consulting
R&D	Research and Development
RHP	Regeling Handels Potgronden Foundation (a Dutch quality mark for substrates)
RSPB	Royal Society for the Protection of Birds
SAC	Special Area of Conservation (throughout the EU)
SE	South-east
SPA	Special Protection Area (throughout the EU)

SSSI	Sites of Special Scientific Interest (in England, Scotland and Wales)
TCA	The Composting Association
TMV	Tobacco Mosaic Virus
UK	United Kingdom (of Britain and Northern Ireland)
USA	United States of America
WIRM	Waste Into Rooting Media
WRAP	Waste and Resources Action Programme
WUMP	Wise Use of Mires and Peatlands

Data Section

Part 1: Survey of current and projected peat usage in professional and retail growing media in the UK by growing media manufacturers

Overview and analysis

1. Data has been obtained from 19 leading growing media suppliers and from ADAS UK Ltd and others (for own-mix) on the composition of mixes used in seven professional crop sectors and the retail market in 2005, together with their projections for 2007 and 2010.
2. Growing media used in plant production in the UK is made principally in the UK.
3. In 2005, the volume of growing media supplied to professionals by these manufacturers plus that mixed on the nursery was over 1.25M cu.m. and for retail use the figure was almost 2.4M cu. m. Both the figures and the ratio are very similar to those collected for the ODPM in 2001 but the current professional market the figure is 48% greater than estimates derived from the latest Defra crop statistics by ADAS.
4. The scale of the response and the volumes reported support the view that this survey (including the own-mix estimate) represents 80% to 90% of the market and suggests that conclusions drawn about the proportion of peat and alternative usage are likely to be highly robust.
5. Peat comprised 86% of professional media and 76% of retail media in 2005 giving an overall peat usage of 79% across the two markets.
6. Bark represented 63% of the peat alternatives use in professional media and 49% of those employed in the retail market media.
7. In the professional market, nursery stock was the largest sector in 2005 (32%) followed by bedding and pot plants. These three sectors accounted for 79% of all media and 76% of peat usage by professionals.
8. Peat replacement was over 20% in the nursery stock and bulb and cut flower sectors but, whereas bark accounted for 88% of the former, coir accounted for 79% of the latter.
9. Peat usage in professional horticulture is projected to decline to 80% in 2007 and to 72% by 2010. Bark will remain the predominant diluent followed by wood-derived materials. CGW use will stay minimal and in the vegetable transplant and mushroom casing sectors peat use will remain at around 90%.
10. In the retail sector the reduction in peat usage will be greater, falling to 65% in 2007 and 55% by 2010. Bark will still be the predominant single diluent but by 2010 wood-derived material and CGW combined will be a greater proportion.
11. These data are highly relevant as they are based on commercial assessments of the availability and cost-benefit of growing media components in the UK. They represent the collective, expert view of growing media manufacturers supplying the vast majority of the UK market.
12. By 2010 less than 40% replacement of peat is likely in the whole growing media market. On this basis, assuming the growing media and soil improver (GM & SI) markets to be the same proportions as in 2001 and that the latter is entirely peat-free, it is possible to estimate that the degree of peat replacement by 2010 in the combined GM & SI markets will (realistically) be in the order of 60%. To achieve the Government aspiration of 90% peat reduction would require the growing media suppliers to reduce the peat content of professional and retail products by 85% overall - more than twice that which is anticipated.

Introduction

Growing media (including mushroom casing) used by professional growers in the UK are almost exclusively supplied ready-made by growing media manufacturers based principally in England and Northern Ireland but also by others in the Republic of Ireland and Germany. The proportion made from component parts on the nursery (own-mix) has been reducing steadily. Waller and Temple-Heald (WRAP, 2003) estimated that (excluding mushroom casing) it could be as much as 30% but it is now widely accepted to be much lower and possibly as low as 10 -15%.

As up to 90% of professional media and 100% of retail growing media are currently supplied by manufacturing companies, it was sensible to ask them what mixes they supply to each sector now and what changes they expect to make by 2010 – the time by which the Government aspires to have 90% of the combined volume of growing media and soil improvers sold in the UK to be non-peat. These projections necessarily take account of their views on the availability, suitability and cost of peat alternatives, their development programmes, and a commercial appreciation of the market.

On this basis a survey has been conducted in which 17 members of the UK Growing Media Association (GMA) and seven other key suppliers were asked to supply, in strict confidence, sales data for 2005 and the volumes of the proportions of the components used. This data was sought for all seven HDC crop panel sectors, plus retail. In addition, suppliers were asked how the percentages of each component were likely to change in 2007 and in 2010.

Growers' own-mix is believed to account for a relatively small and declining percentage of the overall growing media market but no statistics exist for this. However, a 'rough estimate' has been derived by PWC with the assistance of ADAS and GMA substrate suppliers. As with the manufacturers' data, estimates have been made of volumes and percentages of components for such mixes for 2005-2010 and these data have been incorporated into the consolidation of the whole professional grower market.

ADAS has also kindly provided an independent estimate for the total volume of media and peat usage for each sector of the professional market for 2005, based on the latest available crop statistics.

Many suppliers gave sales volume projections for future years and these were invariably higher than for 2005. Since it is not known if the whole market would expand or the extent to which brand weightings would alter, all volumes were rebased to 2005 levels and the volumes of components and their proportions recalculated accordingly.

It will be seen that the results for Glasshouse Salads show a minimal volume usage. There are five reasons for this:

i. Specific data from only one pot herb grower known to own-mix has been recorded in this sector
ii. No proprietary media sold for pot herbs has been placed in this category and this is probably included in the pot plant or bedding sectors
iii. Volumes of growing bags (other than for soft fruit) are now insignificant and have not been reported separately by the manufacturers
iv. For simplicity, suppliers of blocking compost were asked to allocate all sales to Vegetable Transplants since the ratio of protected to outdoor grown block-raised crops and the volume used for cut flowers is very low
v. No suppliers of rockwool or any other inorganic substrate system were surveyed and no attempt has been made to assess the volume of these

materials used (use of alternative slab materials e.g. coir have also not been included).

It should also be noted that in the Mushroom sector one supplier has included sugar beet lime as a bulky constituent contributing to the volume whilst others have not. I have taken the view that it should not be considered as a peat diluent but as a liming agent only and I have recalculated the proportions of peat and other ingredients on this basis.

Results

1. General

A summary of the organisations and persons contacted and the replies received is given in Table 1.

Of the 25 organisations approached 23 responded positively; one non-manufacturing GMA member failed to reply and one non-GMA member declined to take part.

Market data was obtained from 19 proprietary growing media suppliers and these were combined together with the estimate of own mix volumes for 2005 and 2007. For 2010, two manufacturers were unable to provide estimates and only 18 estimates were consolidated.

Growing media used in plant production in the UK is made principally in the UK. Three of the companies manufacture media in the Republic of Ireland but these mostly supply the UK retail market. Only three of the UK companies sell any imported professional growing media. These products come from Ireland (Shamrock), Finland (Vapo) or Germany (Klasmann). No information has been obtained concerning the volume of growing media supplied by TrefEGO b.v., but it is unlikely to be more than about 1% of the total.

In only two instances did a supplier decline to identify all the ingredients being used in their mixes and these only related to 2010 where there is obviously a large degree of uncertainty.

The results of the survey on current usage, comparisons with other data and projections for 2007 and 2010 are shown in Tables 2 and 3.

2. Absolute and relative market sizes in 2005

A summary of this data is shown in Table 2 and it can be seen that in this survey the volume of growing media used in the Grower and Retail markets in 2005 was 1.25M cu. m. and 2.38M cu. m. respectively. It is interesting to note that these volumes are very similar to those reported by the ODPM for 2001 and the 1:1.9 ratio between the two is identical.
It had been assumed that this survey of the major suppliers would sample 80% to 90% of the market. The scale of the response and the volumes reported support this and suggest that the conclusions drawn about the proportion of peat and alternative usage are likely to be robust.

Table 2 also includes a comparison between the results of the current survey and an estimate for the professional market for 2005 by ADAS based on Government crop statistics and market information available to them. The ADAS estimate of growing media usage is only 68% of that derived from supplier sales data plus the own-mix estimate. Also, whilst the nursery stock and mushroom casing sector estimates are similar, the pot plant, bedding and vegetable transplant sector estimates are markedly lower. ADAS suggest that some of this may be due to a failure by the crop returns to capture wastage and unsold plants, but the differences are far too large for this to be the full explanation.

3. Comparison of peat usage in the professional and retail sectors in 2005

According to the current survey (Table 2) peat usage by the professional sector was just over 1M cu. m. representing 86% of media volume and similar to the 89% estimated by ADAS. The comparable figure for peat usage in retail media was 1.8M cu. m. or 76% and the figure for the combined markets was 79%. These compare with 92% reported by the ODPM for 2001 in both sectors and equate to the replacement of some 0.5M cu. m. more peat *per annum* by alternatives than in 2001.

4. Professional market sector sizes and peat usage in 2005

The data from this survey in Table 2 show that that nursery stock is still the dominant sector (31%), followed by bedding (27%) and pot plants (18%). Given the contraction of the (indoor) pot plant industry in the UK over the last decade, the proportion for this sector seems to be over-stated and it is likely that media destined for pot-bedding or patio plants use etc. may have been categorised under pot plant media by the suppliers. However, perennials etc. grown in lower pH mixes will have been classed as nursery stock.
According to the ADAS estimate this declining sector represents only 8% of the total.

Overall these three sectors account for 79% of growing media volume and 76% of peat usage by professionals. The corresponding ADAS estimates are 70% and 68%

5. Peat alternative usage in 2005

Comprehensive data showing the components of the growing media used in each sector are given in Table 3.
In 2005 bark was the predominant peat-alternative in both professional and retail growing media, accounting for nearly 9% and 12% respectively and giving an overall mean of 11%. Wood-derived material was the second biggest peat-alternative in both markets, accounting for 2.5% in professional and 4% in retail mixes. CGW also accounted for 4% of retail mixes but was virtually absent from professional market.

Within the crop sectors, the largest degree of peat replacement was in the nursery stock (21%) and bulb and cut flower sectors (22%). In nursery stock media, bark accounted for 19% and in bulbs and cut flowers, coir accounted for 18% of the mix.

6. Projected peat and peat alternative use in 2007 and 2010

In the professional sectors, peat usage overall is projected to reduce to 80% in 2007 and to 72% by 2010. In nursery stock and in bulbs and cut flowers, peat usage is expected to fall to 61% and 69% respectively by 2010. However, for mushroom casing and vegetable transplants the percentage of peat in the media is likely to remain around 90%.

The alternatives used in professional media will still be predominantly bark but with increasing use of wood-derived materials. Coir use will increase to 2% but CGW will not be used at more than 0.3% overall.

In the retail sector peat usage will fall to 66% in 2007 and to 55% by 2010. Once again bark will be the predominant peat alternative but wood–derived material and CGW combined will exceed bark from 2007 onwards.

Unspecified 'others' become significant in retail mixes from 2007 and in professional mixes by 2010.

7. Own-mix (2005 and projections for 2007 and 2010)

ADAS *et al* consider that growing media production mixed by nurserymen from materials sourced independently is in decline and only of major significance in the nursery stock and bedding plant sectors.

Based on pooled knowledge, it is estimated that the volumes of growing media used for nursery stock and for bedding plant production in 2005 were 100,000 cu. m. and 70,000 cu. m. respectively. For nursery stock the average mix was considered to contain 80% peat with bark being the predominant alternative. For bedding mixes the peat content was lower (73%) with woodfibre being the main diluent. The sector contains the largest single own-mixer (Roundstone Nurseries) who produce 50,000 cu. m. of growing media annually. Their mix contains 70% peat and 30% woodfibre at the present time (Chris Need, pers. comm.) and so this has a major impact on the figures.

There is also a known 3,000 cu. m. volume of all-peat own-mix for pot herb production.

It should be recognised that our overall estimate of 173,000 cu. m. for 2005 (<14% of the total) represents a 'best guess' as it has not been built 'bottom up'. Estimates of this market vary and one GMA member suggested a total of 270,000 cu. m., but he acknowledged that his estimate was possibly inflated due to his particular customer base. This is an area requiring further quantitative investigation.

ADAS also point out that some nurserymen move from proprietary to own-mix and back again and the effect due to one large grower can have a major influence overall. The total volume of own-mix is expected to continue to decline in 2007 and 2010, but, as with the proprietary mixes, ADAS believes that the extent of peat replacement will depend on the future availability and price of bark and wood-based materials.

It can be seen that only 'rough estimates' of the own-mix market have been presented as no concrete data are available. This is an important gap in our knowledge of the market and it is recommended that further work is commissioned to obtain better quantification of this significant sector.

All of these data have been consolidated with that from the growing media manufacturers.

Table 1: Summary of organisations and persons contacted and data supplied

Supplier	GMA member ?	Contact	Data Supplied		
			2005 YE	2007	2010
ASB Greenworld Ltd.	Yes	Ian Field; 01406 350167 ianfield@asbgreenworld.co.uk	31-Aug	Yes	No
Bulrush Horticulture Ltd.	Yes	Pat Walls; 02879 386555 pat.walls@dial.pipex.com	30-Sep	Yes	Yes
Erin Horticulture	Yes	John Molloy; 01462 744500 sales@erinhorticulture.com	31-Dec	Yes	Yes
Gem Horticulture Ltd.	Yes	Julian Metcalf; 01254 356635 julianmetcalf@gemweb.co.uk	31-Dec	Yes	Yes
EJ Godwin (Peat Industries) Ltd	Yes	Andrew Roland; 01458 860644 ejgodwin@btinternet.com	30-Nov	Yes	No
Harte Peat Ltd.	Yes	John Ward; 00353 47 51557 harteprofessional@btinternet.com	31-Dec 2004	Yes	Yes
Horticultural Coir Ltd.	Yes	Tom de Vesci; 020 7731 2013 tom@coirtrade.com	N/a, not GM supplier in 2005		
Humax L&P Peat Ltd. (now Humax Horticulture Ltd.)	Yes	Jonathon Cox; 01461 339260 jonathon@humax.co.uk	30-Sep	Yes	Yes
Melcourt Industries Ltd.	Yes	Catherine Dawson; 07850 612976 catherine.dawson@melcourt.fsnet.c	N/a, not GM supplier in 2005		
Midland Irish Peat Moss Ltd.	Yes	John Neenan; 00353 43 76086 john@mipm.ie	Klasmann brand; UK data included under William Sinclair		
The Scotts Company (UK) Ltd.	Yes	Elaine Gotts; 01473 201252 elaine.gotts@scottsco.com	30-Sep	Yes	Yes
Terra Eco Systems	Yes	Mark Lewington; 07747 640465 mark.lewington@thameswater.co.u	30-Sep	Yes	Yes
Toresa UK Ltd.	Yes	Bill Brogden; 07775 678231 billbrogden@btinternet.com	N/a, not GM supplier in 2005		
Vapogro Ltd.	Yes	Neil Gray; 07715478111 neil.gray@vapogro.ltd.uk	30-Sep	Yes	Yes
Westland Horticulture	Yes	Jamie Robinson; 01233 860148 jrobinson@westlandhorticulture.co	31-Dec	Yes	Yes
Whitemoss Horticulture Ltd.	Yes	Graeme Eardley; 0151 547 2979 graeme@whitemoss.co.uk	30-Sep	Yes	Yes
Wilson's Natural Growing Media Ltd.	Yes	Christopher Wilson; 01666 838534 c.wilson@thewilsongroup.co.uk	Not GM supplier no response		
Bord na Mona	No	Davis Keating; 00353 45 439000 david.keating@bnm.ie	31-Dec	Yes	Yes
AW Jenkinson	No	David Hodgeson; 07767 242252 davidh@awjenkinson.co.uk	31-Dec 2004	Yes	Yes
Petersfield Growing Mediums	No	Neil Williams; 0116 286 7029 www.petersfieldgrowing.co.uk	GM supplier, but declined to participate		
Roffey Ltd.	No	John Short; 01202 537777 johns@roffeyltd.idps.co.uk	30-Nov	Yes	Yes
Violet Farm Horticultural Products	No	Alvin Neale, 01458 860314 violetfarm@netbreeze.co.uk	31-Dec	Yes	Yes
William Sinclair Horticulture Ltd. (includes all Klasmann UK sales)	No	Chris Turner, 01522 537561 chris.turner@william-sinclair.co.uk	30-Sep	Yes	Yes
Tunnel Tech Ltd.	No	Martyn Dewhurst; 07831 654758 MJDREW27@aol.com	31-Dec	Yes	Yes
Own-Mix (ADAS UK Ltd. estimate)	N/a	Susie Holmes; 01243 555592 susie.holmes@adas.co.uk	31-Dec	Yes	Yes

Table 2: Current survey data for market size and peat usage by sector for 2005 and comparisons with ODPM data for 2001 and ADAS estimate for 2005

Sector	2005 HDC Survey				2001 ODPM Data [a]			2005 ADAS Estimates [b]			
	Market size K cu.m.	% Prof. market	Peat Volume K cu. m.	% Peat	Market size K cu.m.	Peat Volume K cu. m.	% Peat	Market size K cu.m.	% Prof. market	Peat Volume K cu. m.	% Peat
Nursery stock (including propagation)	399.4	32	314.2	79	-	-	-	337.3	40	286.7	85
Pot Plants (including transplants)	221.3	18	189.5	86	-	-	-	69.0	8	62.1	90
Bedding Plants (including transplants)	358.4	29	311.6	87	-	-	-	186.0	22	158.1	85
Mushrooms (casing)	95.8	8	88.4	92	-	-	-	89.0	11	89.0	100
Vegetable transplants	140.4	11	138.4	99	-	-	-	59.0	7	59.0	100
Glasshouse salads (pot herb own-mix only)	3.0	0.2	3.0	100	-	-	-	15.0	2	15.0	100
Bulbs and cut flowers	18.1	1	14.1	78	-	-	-	56.0	7	53.2	95
Soft fruit (in containers)	11.0	1	10.6	97	-	-	-	32.0	4	24.0	75
PROFESSIONAL GROWER SECTORS	**1247**	**100**	**1070**	**86**	**1217**	**1116**	**92**	**843**	**100**	**747**	**89**
RETAIL	**2383**	**-**	**1805**	**76**	**2320**	**2131**	**92**	**-**	**-**	**-**	**-**
TOTAL	**3630**	**-**	**2875**	**79**	**3537**	**3247**	**92**	**-**	**-**	**-**	**-**

[a] Excluding 92 K cu. m. for 'LA and Landscaping'

[b] Based on latest available crop statistics

Table 3: Current and projected percentages of growing media components by sector 2005-2010

Sector - 2005	Peat	Bark	Wood - derived	CGW	Coir	Loam/ Soil	Other
Nursery stock (including propagation)	78.7	18.8	1.4	0.1	0.7	0.1	0.2
Pot Plants (including transplants)	85.7	9.1	2.1	0.1	1.5	0.3	1.3
Bedding Plants (including transplants)	86.9	4.3	5.8	0.3	0.7	0.5	1.4
Mushrooms (casing)	92.3	0.0	0.0	0.0	3.2	0.0	4.5
Vegetable transplants	98.6	0.0	0.0	0.0	0.6	0.0	0.8
Glasshouse salads (pot herb own-mix only)	100.0	0.0	0.0	0.0	0.0	0.0	0.0
Bulbs and cut flowers	77.6	3.5	0.0	0.9	17.8	0.0	0.2
Soft fruit (in containers)	96.6	2.8	0.3	0.0	0.3	0.0	0.0
PROFESSIONAL GROWER SECTORS	85.8	9.0	2.5	0.2	1.3	0.3	1.1
RETAIL	75.7	11.9	4.1	3.7	0.5	2.6	1.5
OVERALL PERCENTAGE	79.2	10.9	3.5	2.5	0.8	1.8	1.4

Sector - 2007	Peat	Bark	Wood - derived	CGW	Coir	Loam/ Soil	Other
Nursery stock (including propagation)	74.8	20.2	2.8	0.3	0.8	0.1	0.9
Pot Plants (including transplants)	78.3	10.7	2.8	0.1	1.8	0.4	5.9
Bedding Plants (including transplants)	77.2	11.8	6.0	0.6	0.8	0.7	3.0
Mushrooms (casing)	90.3	0.0	0.0	0.0	5.2	0.0	4.5
Vegetable transplants	92.8	5.6	0.0	0.0	0.8	0.0	0.8
Glasshouse salads (pot herb own-mix only)	100.0	0.0	0.0	0.0	0.0	0.0	0.0
Bulbs and cut flowers	74.0	4.5	0.0	0.9	20.6	0.0	0.0
Soft fruit (in containers)	89.6	5.7	0.5	0.0	4.2	0.0	0.0
PROFESSIONAL GROWER SECTORS	79.5	12.5	3.1	0.3	1.6	0.3	2.6
RETAIL	65.1	12.9	6.1	8.3	0.5	2.1	5.0
OVERALL PERCENTAGE	70.0	12.8	5.1	5.5	0.9	1.5	4.2

Sector - 2010	Peat	Bark	Wood - derived	CGW	Coir	Loam/ Soil	Other
Nursery stock (including propagation)	60.8	26.3	9.1	1.4	1.0	0.2	1.1
Pot Plants (including transplants)	71.9	10.8	5.7	0.1	2.9	0.4	8.1
Bedding Plants (including transplants)	71.2	12.4	9.4	0.1	1.5	0.7	4.7
Mushrooms (casing)	89.0	0.0	0.0	0.0	6.5	0.0	4.5
Vegetable transplants	91.4	5.6	0.0	0.0	1.0	0.0	2.1
Glasshouse salads (pot herb own-mix only)	100.0	0.0	0.0	0.0	0.0	0.0	0.0
Bulbs and cut flowers	68.8	6.0	0.0	1.9	23.4	0.0	0.0
Soft fruit (in containers)	75.3	11.2	5.5	0.0	8.0	0.0	0.0
PROFESSIONAL GROWER SECTORS	71.7	14.8	6.7	0.5	2.3	0.3	3.7
RETAIL	55.1	15.5	9.9	8.1	2.2	2.0	7.1
OVERALL PERCENTAGE	61.1	15.2	8.7	5.3	2.3	1.4	5.9

Note the ‘Other’ category includes two groups of materials:

1. those that are only used to a limited degree - spent mushroom compost, composted biosolids, spent grains, sand and grit, perlite, vermiculite, and composted stable manure and
2. those which have been or are projected to be used to a greater degree, but by only a few suppliers, namely
    a. MRF (‘multi-roll filter-cake’, a by-product of the coal mining industry consisting principally of fine clay particles) which is used exclusively in mushroom casing and

b. generic 'non-peats' and 'agricultural residues' which have been used as collective descriptions of various unspecified organic materials.

Part 2: Review of selected published R&D work and other relevant information relating to peat and growing media

Overview and analysis

1. It is known that extensive work has been undertaken by growing media manufacturers to find commercially viable and effective alternatives to peat since the 1970s in the UK and across Europe - but these data are confidential and unpublished. Nevertheless, there is a large amount of technical information in the public domain and many non-peat substrates have been, and continue to be, investigated as growing media constituents throughout the world. These include barks (softwood, hardwood, cork oak), sawdust, industrial woodfibres, charcoal, woodwastes, fibre boards, composted green and other wastes, composted animal and human manures, sludges (including paper, and soy scrap) coir fibre and dust, food wastes (rice hulls, grape marc, palm oil fruit bunches, and fruit and vegetable waste), *Miscanthus* and seagrass, minerals (rock wool, pumice, perlite, vermiculite) and synthetic foams; and most of these have been used successfully as partial peat replacements or, especially in combinations, as peat-free media.
2. The exploitation of peat and numerous other substrates in growing media for horticultural production is essentially governed by cost, performance, and geographical, socio-economic and environmental factors rather than the results of research elsewhere.
3. In northern latitudes (in countries most affected by the last great ice age and which have low population densities) there are still vast reserves of horticultural grade sphagnum peat which, because of its technical features, consistency, ready availability and low cost made this the substrate of choice for horticultural production and hobby gardening. In countries such as Finland and Sweden (but also in Norway, Canada, Russia, the Baltic States and Ireland) extensive peatlands remain and the use of peat for horticulture is often considered sustainable or environmentally friendly. The same is also true for its use as an energy source.
4. In other countries of higher population density which were once self-sufficient in sphagnum peat, such as Holland, Denmark, Germany and the UK, peat remains the substrate of choice amongst professional growers and manufacturers for economic and technical reasons. However, the raised peat bogs in these countries are either worked out or are now relatively small in scale and/or subject to conservation pressure. This is leading these countries to import peat from others with good peat reserves – especially Scandinavia and the Baltic States. It is only in the UK that there is a political impetus to very significantly reduce peat usage in horticulture. In the other three countries, and notably Holland, peat is replaced to improve the performance and value of the media used or in response to the opportunity to supply media to niche markets such organic growers or finished plants to the peat-conscious UK. Recently, the Dutch have invested heavily to evaluate and develop low-peat substrates and management strategies for pot plant production to be able to meet UK retailer requirements and maintain their competitiveness.

5. In many other countries in more southerly latitudes, indigenous peat has always been of limited quality and availability, and the horticultural industries which have developed in the last 50 years often used imported sphagnum peat or ready-made growing media from those countries where supplies were freely available. Some have long recognised the need and benefit of exploiting plentiful sources of indigenous alternative materials for reasons of economy, self sufficiency, waste

recycling and environmental protection. For example in France, Belgium, the USA and Australia the use of media based on forest co-products (barks and/or sawdust) are commonplace.

6. For historical and practical reasons, France also employs a wide range of organic and manure-based amendments, composted greenwaste and wood-derived components in its hobby market media. In more recent times a paucity of sphagnum peat has also spurred the development of designer woodfibre products derived from indigenous or reclaimed wood in France (and Germany too), and these both mimic and enhance peat to some degree.
7. The only quantitative study of peat and alternative substrate use in growing media produced in European countries was undertaken by Bohlin (2002) on behalf of the International Peat Society. This showed that in 2001, 16M cu. m. was produced in eight countries and that average peat usage was 85%. In both Germany and the UK, which accounted for 31% and 22% of production respectively, peat usage was highest at around 95%.

   The next two biggest producers were The Netherlands (20%) and France (11%) and there, peat usage was 70% and 63% respectively. However, the reasons for lower usage are quite different; in Holland it was due principally to the high proportion of rockwool use [for the production of crops such as salads and cut flowers] whilst in France it was due to the high proportions of organic and composted materials used in the dominant retail sector
8. No other material combines as many favourable physical, chemical and biological properties as sphagnum peat. It is the most suitable, most reliable, most used and most traded material in the production of growing media and the performance of the European horticultural industry is thoroughly dependent on it.
9. In the Middle East and many tropical and sub-tropical countries once reliant on imported peat and ready-made growing media for intensive horticulture, the exploitation of local materials such as composted manures, coir dust and other crop wastes has been developing steadily.
10. Whilst it has been reported that many organic materials have been used successfully, there are recurring concerns about consistency, stability, nitrogen lock-up and the need to modify feeding and watering regimes to take account of the nature of the materials used, plus concerns about material variability and hygiene. It is also apparent that optimising fertigation and media composition for different crops and situations requires commitment and experience. Furthermore, it is interesting to note that some peat alternatives themselves (like rockwool) which were once considered 'environmentally friendly' and/or better than peat (for cropping systems) are coming under the environmental spotlight because of the waste disposal issue.
11. In an international attempt to resolve conflicts between commercial use of peat for horticulture etc. and the demands for the cessation or reduction of this exploitation because of the environmental, ecological, aesthetic and scientific values of peatland the International Mire Conservation Group and the International Peat Society has published '*Wise Use of Mires and Peatlands* [WUMP] – *Background and Principles including a Framework for Decision-making'* (Joosten and Clarke, 2002). 'Wise Use' is defined as *those uses of mires and peatlands for which reasonable people now and in the future will not attribute blame*. It concludes that '*there is not at present any alternative material available in large enough quantities and equally risk-free which could replace peat in horticultural crop production*' and furthermore that '*alternative growing media [such as composted green waste] work best when they contain an element of peat*'. However, although endorsed by The UK Growing Media Association and the corresponding trade associations in other producer countries, these 'Wise Use Guidelines' have not gained wide recognition and their impact has been muted.

12. The UK is alone in having a Government policy of very significantly reducing the use of peat in horticulture and a programme of monitoring the level of its replacement. But, for the last ten years there has been little publicly funded R&D to support government-endorsed peat replacement targets and to address the technical and horticultural issues through programmes based on scientific and commercial principles. Grower, (100% levy) funded R&D under the auspices of the HDC has been modest to-date due to other higher priority R&D issues for sector Panels. Furthermore, unlike their continental counterparts, the potential for improving growing media performance and crop returns using non-peat components has been largely ignored in recent times. On the other hand, since 2001 there has been heavy investment in the testing and promotion of composted green waste (CGW) by the Government funded Waste and Resources Action Programme; but this has been driven by the need to reduce landfill and has so far not led to any great uptake of this material in professional horticulture by growers and cautious manufacturers mindful of its variability, technical weaknesses, performance limitations and product liability concerns. This situation is mirrored in Holland, where RHP does not include CGW in any of their recommendations for professional growing media.
13. ADAS believes that whilst the UK multiple retailers have established challenging peat replacement targets for 2005 - 2010 they are generally behind schedule and the degree of peat replacement in the growing media used to produce the plants and cut flowers they sell probably did not exceed 40% on average in 2005. It is relevant to note in this context that EurepGap and other accreditation schemes are internationally based and are not prescriptive over the use of peat, and that retailers are unwilling to pay more for plants, produce or growing media to facilitate peat reduction.
14. Two other projects begun in 2005, the so-called 'WIRM' (HNS 127) project supported principally by Landfill Tax Credit Scheme money and the 'growing media from composted food waste' (CP 23) project sponsored by Defra both have a degree of HDC financial backing. These are seeking novel waste materials to use in growing media in the future, but it is not yet clear if these will yield commercially attractive options for growing media manufacturers.
15. Sixteen years ago Bragg concluded that 'There is [sic] not, at present, sufficient quantities of consistent materials, and in many cases insufficient experience/knowledge of necessary long-term management of plants in alternative materials.' and regrettably, because of a combination of economic and supply issues together with a lack of targeted research, this report now also concludes that it is still largely true of the UK today.

Introduction

Although the key development work for the UK market is undertaken by the GM manufacturers themselves, they do not publish their R&D trials data and the question is 'what other trials work is relevant?'

It is not worthwhile carrying out an appraisal of all peer-reviewed scientific literature as this generally has little commercial significance. However, a detailed review of the so-called 'grey literature' has been conducted.

Information has been extracted from a number of known published sources of pertinent information from within and without the UK. UK data has been sourced from Government peat policy and review documents, projects supported by Defra (HortLINK), by the HDC itself and WRAP trials on composted green waste. International data has been sourced from *Acta Horticulturae* (the Technical Communication of International Society for Horticultural Science [ISHS]) where papers given at regular symposia by most of the key European and many other researchers in both the public and private sectors are published), and the International Peat Society symposia papers, articles (again with a commercial input) and their book 'Wise Use of Mires and Peatlands', published in conjunction with the International Mires Conservation Group.

These are considered separately and, within each section, essentially in chronological order to enable the changing emphasis of R&D to be seen.

Some other important sources of basic information and data from the UK and Holland are also cited.

UK Sources

1. UK Government policy and reports

The UK Government, in response to the Convention on Biological Diversity (CBD) signed in 1992 by developing the UK Biodiversity Action Plan (BAP, see http://www.ukbap.org.uk/).

Within this BAP it established a Habitat Action Plan for Lowland Raised Bog – the source of horticultural sphagnum peat.

A Peat Working Group considered the position on peat extraction and the uses of alternatives. A key outcome was the publication of revised Planning Policy (PPG9 and PPG16) and Mineral Planning (MPG13) Guidance notes. These advocate careful consideration for the protection of lowland raised peat bog habitat and the palaeoecological archive, and the conservation after-use of peat extraction sites. They also set targets for increased usage of peat alternatives.

In the BAP the Government committed itself to:

- review and where necessary amend or develop policies on the consumption of peat
- undertake and promote research and development of sustainable alternatives to peat
- speed up reduction of peat used in both amateur and professional markets
- aim for a minimum of 40% of total market requirements to be peat-free by 2005 and 90% by 2010
- monitor and review take-up and if feasible accelerate the programme of reduction

As part of the monitoring and review process a number of reports have been commissioned by the Government on peat use in the UK including ODPM (2002) and Defra (2004). These have assessed the availability and characteristics of alternatives and charted the progressive replacement of peat in the various sectors of commercial and retail horticulture in response to environmental pressure and the aforementioned Government targets.

The data published by the ODPM (2002) showed that peat use in retail growing media was 91% in 1993, rose to 96% in 1997 and fell to 92% by 2001. Data for professional grower media is limited; peat use was 95% in 1999 when first monitored but down to 92% in 2001.

The most recent report from Defra (2004) was prepared by Susie Holmes of ADAS and considered the situation in England and Wales in 2003. The principle conclusions were:

- Trends in peat use by commercial horticulture -
  - peat use has increased where production has increased but declined overall
  - professional growers use a larger proportion of imported peat than amateurs
  - imports of peat from the Baltic States is growing
- Customer peat policies in respect of cut flowers, pot plants, nursery stock and bedding plant supplies -
  - retailers and Local Authorities have corporate and social responsibility policies that include limitations on peat usage
  - multiple retailers (e.g. M&S and B&Q) were typically requiring 20-25% of the medium used to grow container plants to be non-peat in 2003, 50% in 2005 and for the proportion to be progressively reduced
- Peat and alternatives use in other European countries -
  - peat usage reflects national availability of peat or the extent of material imports
  - only in the UK and Switzerland are suppliers of plant material to multiple retailers being asked to commit to peat reduction
  - for different reasons, substrate manufacturers in Holland and France are less reliant on peat than in the UK and Germany
  - to meet the demands of the UK market the Dutch horticultural industry is investing in alternative growing media
- Peat and accreditation scheme requirements -
  - BOPP members are required to demonstrate use of peat from non-SSSI sites only and to demonstrate the assessment of alternatives to facilitate peat reduction
  - EurepGap is an international scheme and peat policy is excluded, although all substrates must be traceable and must not originate from designated conservation areas
  - MPS (Milieu Project Sierteelt) is a Dutch-based environmental qualification and because of its international scope has no specific reference to peat, although M&S are pressing for a UK version to include monitoring of peat reduction
- Peat use by sector -
  - the use of alternatives is well established for the production of CNS, especially the use of bark

- peat usage in pot plants is difficult to assess as much is imported and sold without repotting. For the limited range of pot crops grown here, sophisticated scheduling is critical and there is a lack of confidence in the use of peat alternatives. Except in cyclamen, where 20-25% bark is often incorporated, little peat substitution is practiced. However, many growers are experimenting with up to 50% replacement under pressure from multiple retailers and moves towards such media are expected in the next year or so

- in bedding plants, peat consumption has increased since 2000 due to increased production. Substitution levels generally vary from 5-25%. The sector is very cost-conscious and economic factors including transport costs have restricted uptake of materials of high bulk density whilst the low density of woodfibre has led to its use by some large bedding plant operations

- peat is ideal for mushroom casing and because alternatives are often higher in cost, the level of substitution is only about 10% on average, but the market continues to decline sharply

- the volume of production of vegetable transplants has decreased since the early 1990s; there are technical and economic constraints in using alternatives and uptake is very low except for ‘organic’ crops

- the majority of glasshouse salad production is in rockwool, but for the expanding pot herb market peat is mostly used

- substitution of peat for pot bulb production is easy to achieve but economics has favoured the use of peat, although continued retailer pressure will force a reduction in usage. Cut flowers are only propagated in peat blocks before being soil-grown

- Peat is used for the propagation of strawberries and increasing volumes are used in grow-bags for extended season production. Coir is used widely in The Netherlands but only about 12% of production in the UK is in coir

Susie Holmes (pers. comm.) believes that little has changed since 2003 and advises that retailers have not reached their 2005 targets for peat replacement. She suggests that for flowers and plants only (i.e. excluding food crops) the level of peat replacement is currently only at around 40%.

2. Defra HortLINK Projects

Defra have advised that only three HortLINK projects ‘address peat replacement’ and these are listed in Table 4:

Project Hort 215/HL0135 is summarised in Fact Sheet LINK (Hort 215) and had as one of its objectives ‘The development of the optimum soilless medium [for strawberry production] to enable the move away from peat substrates’ but only 10% of the funding was directed towards this (Raffle, pers. comm.). Nevertheless, two peat free substrates (bark/loam and bark/green compost) were identified as having potential - but there is no evidence of these being commercialised at the present time.

Table 4: HortLINK Projects 'addressing peat replacement 1999 - Present

PROJECT NO.	**TITLE**	**TIMING**	**CONTACT**
Hort 215/ HL0135	Overcoming the loss of methyl bromide with a competitive and sustainable soil-less strawberry production system	Start Date: 1/10/99 End Date: 31/3/04	Contact: Scott Raffle ADAS, Oast Building, East Malling, West Malling, Kent, ME19 6BJ Tel: 01732 876662 Email: scott.raffle@adas.co.uk
HL0171	Development of the entomogenous fungus *Metarhizium anisopliae*, for control of vine weevil and thrips in horticultural growing media	Start Date: 1/4/05 End Date: 31/3/08	Contact: Tariq Butt University of Wales, Singleton Park, Swansea, SA2 8PP Tel: 01792 295374 Email: t.butt@swansea.ac.uk
HL0172	Producing high quality horticultural growing media through the retention of plant structure in composted food-processing waste	Start Date: 1/10/04 End Date: 31/3/06	Contact: Keith Waldron Institute of Food Research, Norwich Research Park, Colney, Norwich, NR4 7UA Tel: 01603 255000 Email: keith.waldron@bbsrc.ac.uk

Project HL0171 investigates the efficacy of *Metarhizium anisopliae* in peat, peat alternatives (coir, bark) and reduced peat blends (incorporating 10% or 20% green compost waste) media. Protocols are being developed to monitor the physical-chemical and microbial properties of these media and to establish how these influence pest establishment and the efficacy of *Metarhizium*, and plant growth (Butt, pers. comm.). However, this project does not deal with the agronomic and technical aspects of peat replacement *per se*.

Project HL0172 is summarised in Fact Sheet LINK (HL0172) and has been reviewed by Waldron (2005). It is based on the premise that there is a lack of fundamental understanding of the quality characteristics which peat provides and whether or not those characteristics could actually be emulated by composted plant material. It seeks to identify the microbial, physico-chemical and structural changes that take place during composting of selected food processing 'co-products' with special reference to the characteristics required in peat-based products.

The collaborators in the project (who include the growing media producer Bulrush Horticulture Ltd.), have successfully demonstrated that if the nature and extent of plant structure degradation can be better controlled during the composting process then sufficient functional structure will remain in the resulting product to provide the basis of high quality growing media (Waldron, pers. comm.). This feasibility project is expected to cost £290K and the HDC is providing £20K of this. It has been given the

HDC number CP 23. Recently, (Anon 2006) Waldron reported to a Horticulture LINK seminar in London that sustainable production could be achieved at £20/m^3 at 5000 tonnes per annum. Realistically, the price could be even higher and, together with the very small volume, this is unlikely to be a commercially attractive prospect.

3. Horticulture Development Council

Details of the HDC projects of potential relevance and a summary of the key conclusions are given in Table 5. The most relevant projects are shown in bold type. Sorted according to Crop Panel, the findings may be summarised as follows

Cross Panel:

Bragg (1990) produced the first comprehensive review of peat and its alternatives, listing over 30 potential alternatives, which concluded that: 'No one material can immediately replace the peat which is used in professional and/or amateur markets. There is [sic] not, at present, sufficient quantities of consistent materials, and in many cases insufficient experience/knowledge of necessary long-term management of plants in alternative materials'

Bulbs and Flowers:

In 1991/92, a report concluded that forced narcissi (but not tulips) could be grown in mixes in which a portion of the peat was replaced by locally available substrates even with high AFP values and that there were good prospects of using non-peat substrates based on coir for pot lilies. More recent work on lilies reported in 2003 showed that they could be successfully produced in mixes based on wood-, bark-, and green-compost derived materials and that these might improve flower quality.

Bedding and Pot Plants:

In 1995, reports showed that peat-free media available at the time could be used successfully for commercial bedding production with appropriate amendments to watering and feeding and that poinsettia could be produced successfully in a proprietary mix with only 70% peat in admixture with coir fibre and clay.

Hardy Nursery Stock:

In 1997, a review of three year's screening work concluded that coir and processed woodfibre appeared useful bulking agents with various bark, wood products and inorganic materials as amendments. However, it was concluded that no one mix was suitable for all and that variability between batches of alternative materials was a problem. In 2003, it was recommended mixing 50%v perlite with peat for rooting of leafy cuttings.

Mushrooms:

Reports in 2000 and 2002 showed respectively, that replacing 25%v peat with composted bark fines could probably reduce cost and increase yield and that replacement of 30%v peat with sugarbeet lime reduced bruising and discolouration of mushrooms.

Herbs and Salad Crops:

Reports in 2005 showed that composted materials were not yet a suitable substitute for peat in pot herb production but fine composted conifer bark was a promising alternative to rockwool for glasshouse tomato production which was sustainable and had lower disposal costs.

In addition to the numbered HDC projects listed in Table 5, another (HNS 127) is funded principally by GrantScape (using Landfill Tax Credit Scheme funds) with the HDC providing 10% of the cost (£12,894). This is known as the Waste Into Rooting

Media ("WIRM") project and was initiated by Warwick HRI, Wellesborne. This project started in April 2005 and aims to identify waste materials (excluding CGW) that are economically and technically suitable for use in growing media, for the production of woody and herbaceous ornamental plants, by the nursery stock industry.

The focus is on industrial wastes, with the aim of identifying sustainable sources of materials that are technically and commercially fit for purpose. The types of wastes envisaged so far include:

(a) organic materials (e.g. paper and textile wastes, plastic and carbon waste powders)

(b) inorganic/mineral materials (e.g. fine particle de-watered tailings)

There is also one feasibility HortLINK project that has received £20,000 funding from HDC and has been given the number CP 23. This project seeks to control the composting of food waste to preserve a peat-like structure and produce a growing medium. It was discussed in the previous section (see HL0172).

Table 5: Summary of HDC projects dealing with peat, peat alternatives and compost: 1987- Present

PROJECT	TITLE	SUMMARY
HNS 2: Report 1987	Composts for container plant production	No investigation of peat alternatives
CP 1: Final report 1990 (Publication: "Peat and it's alternatives")	**A review of peat reserves and peat usage in horticulture and alternative materials**	**The original, comprehensive review of peat reserves, peat usage and over 30 potential alternatives for the partial or complete replacement of peat in horticulture by Neil Bragg**
BOF 26: Final report 1991/92	**'Bulb forcing: the use of peat substitutes or extenders'**	**Concluded that forced narcissus grew robustly in a wide range of substrates and demonstrated that a wide range of materials, even those with very high AFP values, could be used when mixed with peat and suggested that a variety of locally available substrates could be exploited. Tulips showed a poor tolerance to low pH, low AFP and high conductivity and that further work was needed to understand the relationship between crop stress and substrate properties. Trials with lilies showed that there were good prospects of using non-peat substrates and that coir or coir mixes were a ready alternative to peat.**
M 20: Final report 1993, Fact Sheet 15/04	A survey of mushroom casing materials and practices	No peat alternatives mentioned - essentially a review of practice and of black vs. brown peats
PC 71b: Final report 1995	**Poinsettia: evaluation of the effect of pinching technique and compost type on the growth, development and shelf life of poinsettia cultivars**	**Three proprietary poinsettia composts based on 70% or 90% peat mixed respectively with 20% coconut fibre and 10% clay or with 10% perlite were used successfully at Efford in the production of poinsettia. However, it was concluded that each requires separate cultural/management practice to optimise its performance**
PC 113: Final report 1995	**Bedding plants: evaluation of reduced peat or alternative peat-free substrates for use in bedding plant production**	**Nine peat-free media based on rockwool, coir, woodfibre, bark or composted green material supplied by growing media manufacturers were compared with Levington M2 peat standard for the production of six popular bedding plant species at Efford. It was concluded that: (1) peat-free media are now available which can be successfully used in commercial production (2) each media would require changes to watering frequency and/or supplementary liquid**

		feeding to optimise their performance (3) coir appeared to facilitate earlier rooting and bark based media better buffering between wet and dry waterings and (4) media type can influence shelf-life and subsequent quality.
HNS 28 & 28b: Fact Sheet 41/97	**Alternatives to peat for container HNS production**	**A review of three years screening by Margaret Scott at Efford showed that: (1) no peat alternative presently available can be used as a direct substitute for peat (2) coir and processed woodfibre appeared useful bulking agents with various barks, wood products and inorganic materials as amendments (3) base fertiliser and irrigation regimes needed to be matched to the mix (4) species response was variable and no one peat-free mix was suitable for all (5) variability between batches of the alternative materials was a problem (6) animal waste, spent mushroom compost and paper waste in their present form were unsuitable for container production but that domestic waste could have potential in combination with other materials.**
M 20a: Final report 1998, Fact Sheet 15/04	The effects of casing materials and casing management techniques on the yield and quality of mushrooms	Not relevant - peat only see M20
M 20b: Final report 1998 Fact Sheet 40/97	Properties of peat sources used in mushroom casing	Not relevant - peat only
HNS 43e: Final report 1999, Fact Sheet 05/05	Investigation of the benefits of incorporating base fertiliser with CRF in growing media of HNS	Not relevant - fertilizer only

Table 5 continued

PROJECT	TITLE	SUMMARY
M 38: Final report 2000	**Peat substitution in mushroom casing**	**This investigation concluded that the most promising peat substitute was composted bark fines which could be added at 25%v/v resulting in a small increase in yield and a probable reduction in material cost without affecting mushroom dry matter or cleanliness. Bark fines, coir or mineral fibre waste could also be used to replace up to 50%v/v peat without significantly affecting mushroom yield or quality. Paper sludge wastes were not suitable peat substitutes.**
FV 219: Final report 2001	Composting of onion and other vegetable wastes, with particular reference to control of allium white rot	Not directly relevant as use is a field application. However, the use of composted material to suppress disease in container grown plants is under review by the same team for WRAP (Project ORG 0034).
M 40a: Final report 2002, Fact Sheet 15/04	**Mushroom quality: (i) Use of bruisometer to determine which agronomic and environmental factors affect bruisability; (ii) Effects of humidity, water potential of casing and casing type**	**The replacement of 30%v/v peat by sugar beet lime resulted in less discolouration of mushrooms grown on dry casing than only 9%v/v replacement.**
HNS 98: Final report 2003	**Hardy nursery stock: optimising rooting media for leafy cuttings**	**This study advised growers that increasing the air content of the rooting medium generally increases rooting and reduces rotting. Apart from enhancing capillary drainage, the replacement of peat by at least 50% v/v of a coarse material such as perlite is recommended and suggests that pure vermiculite is worth testing.**
BOF/PC 140: Final report 2003	**Lilies: nutrition of forced bulbs in peat-free and recycled peat substrates**	**The headline conclusions of this review were that trials have shown that high quality lilies (cut-flowers and pot-plants) may be produced successfully in proprietary non-peat composts, such as mixtures based on wood-, bark- and green compost-derived material and in some cases the flowers were judged superior to lilies raised in conventional peat substrates. Furthermore, these (and peat) substrates can be re-used without compromising the quality of lilies grown for cut flowers.**

FV 219a: New project – awaiting first report	Integrated Allium white rot control using composts and *Trichoderma viride* (LINK)	Not directly relevant, but see also FV 219 (above)
PC 182: Current	**Composting of organic wastes to produce a peat replacement substrate for herb production**	**Evaluation of a number of composted materials produced under different regimes and of different maturities in mixtures for the production of pot herbs under commercial conditions showed that germination and vegetative growth were poorer than in the peat-only control. At maturity, foliage weight was around 20% less than control. The report implies that the quality of composts is not sufficiently high to encourage its use by commercial growers and that the composting industry needs to take note of this.**
PC 209: Year 1 Annual Report 2005	**Tomatoes: reducing waste disposal costs through use of sustainable wood-based growth media**	**The headline conclusions from the preliminary results of short-term trials comparing four wood-based media with a rockwool control for the production of tomatoes were encouraging. No significant consistent differences in yield or any other measured parameter were found. No phytotoxicity and little structural breakdown were observed. Fine composted conifer bark was chosen as the material to be taken forward to full season trials.**

4. Waste & Resources Action Programme (WRAP) Projects

WRAP was established in 2001 in response to the UK Government's Waste Strategy 2000 to promote sustainable waste management and is set up as a not-for-profit company limited by guarantee by Defra, the DTI, and the devolved administrations of Scotland, Wales and Northern Ireland. WRAP's current programmes of work concentrate on creating stable and efficient markets for recycled materials and included specific work in six material streams: aggregates, glass, organics, paper, plastics, and wood, supported by work in three generic areas: financial mechanisms, procurement, and standards. WRAP Organics Section has been extremely active in developing and promoting the use of composted green waste (green compost or composted green material) in horticulture, agriculture and landscaping and has published numerous research reports and fact sheets which it has commissioned.

A full list of these 124 publications and the 44 research reports may be found respectively at:
http://www.wrap.org.uk/applications/publications/index.rm?programme=materials%7croot.organics
and
http://www.wrap.org.uk/templates/temp_org_reports_category.rm?id=4162&&page=1

The ten most relevant are reviewed below:

Of principle concern has been the issue of safety and presence of human, animal and plant pathogens. Jones and Martin of the Institute of Animal Health (WRAP, 2003b) dealt with animal pathogens and the safe use of composted green material. They concluded that a large number of pathogenic viruses, bacteria, protozoa and parasites may gain access to waste materials including those destined for composting. The most important agents for humans are those which cause food-borne infections including *Salmonella, E. coli* O157:H7 and *Campylobacter*, but there was no information on the survival of the latter in composting systems. Nevertheless, most pathogens are efficiently removed during the composting of green waste as long as a temperature of 55°C for 3 days is achieved (as per PAS 100). The authors also observed that animal and human wastes have been used in agriculture as fertilisers and as a method of disposal for thousands of years and that infection in humans and animals because of this practice have only seldom been recorded. However, although there is an extensive literature on the survival of human and animal pathogens in farm animal and human sewage wastes, less information is available on the survival of pathogens (and especially viruses) during green waste composting. It has been suggested that compost may be responsible for an increase in cases of poisoning by the toxins of *Clostridium botulinum*.

Noble and Roberts of HRI, Wellesbourne (WRAP 2003c), found that for all of the bacterial plant pathogens and nematodes, the majority of fungal plant pathogens, and a number of plant viruses, a compost temperature of 55°C for 21 days was sufficient for ensuring eradication. The fungal plant pathogens *Plasmodiophora brassicae*, the causal agent of clubroot disease of Brassicas and *Fusarium oxysporum* f.sp. *lycopersici*, the causal agent of tomato wilt, were more temperature tolerant and a compost temperature of at least 65°C for up to 21 days was required for eradication. [A more thorough investigation of the eradication conditions for *P. brassicae* is underway.] Several plant viruses were temperature tolerant and for example Tobacco Mosaic Virus (TMV) requires compost temperatures in excess of 68°C for longer than 20 days for eradication. Temperature x time eradication conditions during composting were lacking for a number of important soil-borne plant pathogens. These included the causal agents of damping-off (*Pythium ultimum*), Fusarium patch disease of turf (*Microdochium nivale*), foot rots and wilts caused by *Fusarium oxysporum* sub-species (e.g. *radicis-lycopesici* and *lycopersici*), root rot (*Phytophthora nicotianae*), black root rot (*Thielaviopsis basicola*), and black rot of Brassicas (*Xanthomonas campesis* pv*. campestris*). The authors also reported that it was not clear from the literature whether sufficiently high temperatures can be achieved using predominantly plant-based feedstocks such as green wastes, in different composting systems, to achieve sanitisation.

A further study by Noble and his collaborators (WRAP, 2004c) re-examined the issues surrounding the fate of plant pathogens during the composting of green materials. The plant pathogens of greatest concern were: *Phytophthora* spp., *Pythium* spp., *Plasmodiophora brassicae*, *Rhizoctonia solani*, *Fusarium oxysporum* f.spp. and *Thielaviopsis basicola*. They found that propagules of *F. oxysporum f.spp. lycopersici* and *radicis-lycopersici, Pythium ultimum,* and *Thielaviopsis basicola,* and *Rhizoctonia solani, F. oxysporum* f.sp. *lycopersici, Verticillium dahliae* and *Xanthomonas campestris* pv. *campestris* in affected plant material were eradicated in laboratory tests by a compost temperature of 52°C or less, held for 7 days. *Fusarium oxysporum* f.spp. *lycopersici* in affected tomato plant material was eradicated from compost that exceeded 50°C for 4 days and peaked at 70°C in a large-scale tunnel. However, a minimum composting temperature of 65°C for 7 days, with a minimum compost moisture content of 51% w/w at the start, is required to eradicate all the pathogens examined (including *Plasmodiophora brassicae)*, but with the exception of TMV. They concluded that a temperature of 65°C for only 1 day may be adequate if this can be shown to eradicate *M. nivale* [although this is not relevant to commercial plant production]

A major series of growing trials was undertaken by Peatering Out Ltd. and Enviros Ltd. in 2003 (WRAP, 2004b). Twenty trials were conducted at nurseries and research establishment across the UK on a wide range of crops together with two retail application trials. In the situations tested, CGW, at rates of at least 25% v/v, was able to provide all the major and minor base nutrients that the plants required other than water-soluble nitrogen. It was found that CGW (to PAS 100 standard) diluted 2:1 with alternative materials such as composted bark provided peat free media that grew plants to a 'marketable standard', although they were slower to root and sometimes to flower and finished plant quality was often lower than in peat-based treatments (with or without CGW at 33% v/v). In the peat free mixes where CGW was mixed with bark or brash a reduction in the incidence of disease, snails and red spider mite was seen in a few crops whilst a reduction in the growth of algae, moss and liverwort was frequently observed in HONS. [see also WRAP, 2006] A dwarfing effect was seen in many species when CGW was used in the growing medium – especially in peat-free - and might facilitate reduced use of plant growth regulators. The CGW used had a relatively high electrical conductivity (EC) resulting in mixes with a high EC by peat standards although they did not appear to have as adverse an effect as might have been expected by growers familiar with the EC of peat proprietary peat-based media. It was also concluded that water management practices on commercial nurseries will need to take into account the different properties of growing media containing CGW and be watered more frequently but with a lower volume of water. The issue of bulk density and the effects of the use of CGW on material and pot weights and on labour and distribution costs were not resolved. Based on these trials WRAP published Factsheet 10 – 'Use and benefits of composted green material in growing media' in February 2005 which can be accessed at http://www.wrap.org.uk/document.rm?id=1048

A preliminary study of the storage stability of the mixes used in the above growing trials was also undertaken by Peatering Out (WRAP, 2005b). It was found that despite good performance by mixes based on 33% v/v CGW in germination tests (used to assess maturity and suitability for use), significant reductions in available nitrogen in most mixes showed that, for practical purposes, they were not storage stable (due to microbial activity). Best storage stability was obtained in mixes containing 33% v/v green compost and 67% v/v sphagnum peat. Peat-free mixes exhibited the greatest water-soluble N loss. The authors concluded that CGW and its diluents must all be thoroughly matured before they are used as growing media constituents.
WRAP initiated another project (ORG0019) to assess this problem more thoroughly (WRAP, 2005c) which showed that inclusion of green compost at over 20% in growing media can lead to a rapid loss of available nitrogen in storage, especially in peat free mixes. After 12 months storage, only three of the eleven mixes evaluated were adjudged fit-for-purpose, namely, 100% Irish peat, Irish peat plus 20% CGW and 100% bark fines. Mixes of Finnish peat and CGW showed rapid and marked N lock-up. These data showed that extreme caution should be exercised even in the use of a low proportion of CGW in retail media which are often stored for long periods before sale.

Waller and Temple-Heald (WRAP, 2003a) assessed the supply and demand position for CGW in the UK with specific respect to growing media production by established manufacturers. It was found that only 68,000m^3 of green compost was used for proprietary growing media manufacture in 2002 and the barriers to large-scale uptake of composted materials were not only technical, but logistical. The latter are related to the location of growing media manufacturing sites in mainly rural, former and current peat producing areas that are away from centres of population and hence waste sources, and the density of composted materials compared to peat. Nevertheless, the authors concluded that, there were opportunities to increase the uptake if commercial manufacturing facilities were to be located close to the sources of CGW - especially in SE England - thereby reducing distribution costs. However, the future viability of composted materials will still be influenced by the availability and price of low density peat imported from Scandinavia and the Baltic States.

The quality of CGW is of critical importance to growing media manufacturers and 'Guidelines for the specification of composted green materials used as a growing media component' were drawn up by Waller (WRAP, 2004a). The guideline specification outlined in the document supplements the BSI PAS 100 requirements by recommending limits for criteria that need to be met for CGW to be used as a growing media constituent at up to 33 % by volume in the final product. These guidelines are designed to (1) assist producers of composted green materials to better understand and meet the specific requirements of growing media manufacturers and own-mix growers; (2) help to provide these customers with a framework for the establishment of an appropriate purchasing specification as part of a supply contract. They were developed in partnership with the Growing Media Association, with input from the Composting Association, growers and other stakeholders and pay particular attention to those technical and practical factors that affect CGW's fitness for purpose for a demanding horticultural application and to limit potential liabilities from its use.

One of the continuing doubts about CGW is its variability and this was investigated by Ward, Litterick and Stephen (WRAP, 2005a). They reported that there are some pronounced seasonal variations in the characteristics of the feedstocks tested during this project - for example nitrogen and potassium levels were higher during spring/early summer - but there were no great differences between different green waste feedstocks (i.e. kerbside v bring site). Seasonal variations in feedstocks did not necessarily translate into variations in compost quality although potassium [and EC] levels did show a degree of variation. Many compost parameters showed no significant geographic or seasonal variation across all sites but site-specific factors, such as screen size, maturation period and storage arrangements had most impact on compost variability. Compost producers who maintained a consistent composting process regime produced more consistent composts. Process management factors which had a positive effect on product consistency included increasing the length of time that composting is actively managed and for subsequent maturation and they concluded that at least three months following active composting or longer may be required for compost to be used in growing media preparations. Storing finished product under cover, using appropriate tests to assure completeness of composting and ensuring composting process parameters (turning regimes, active composting periods etc.) are consistent over the whole year are all recommended. The authors concluded that, in general, the composts performed well against the growing media specifications (WRAP 2004a), particularly those composts aimed at the horticultural sector. However, this author considers these conclusions to be optimistic and observed that manufacturers and growers who attended a WRAP seminar at which these results were presented were not reassured by the data shown and local suppliers' track records need to be very carefully vetted before purchases are made.

Noble et al (WRAP 2006) have conducted a 'Scoping study of research conducted on the disease suppression capability of composted materials in horticulture, agriculture and turf grass applications'. They reported that there is overwhelming evidence that amendment of soil or peat with green waste or food waste composts can suppress soil-borne diseases. However, composts that are suppressive to one disease may be ineffective against another, and the reliability of the suppressive effect differs between diseases. Compost inclusion rates of at least 20% v/v were normally required to obtain a disease suppressive effect in peat-based media, but there was little or no advantage of increasing the inclusion rate above 50% v/v. However, whilst there were no clear differences in disease suppressiveness between composts in terms of age, production methods (windrow or in-vessel) or feedstocks used, they found that composts which are intermediate in age (about 12 – 15 months after composting of feedstocks started) appear to be more reliably suppressive than 'immature' (less than 6 months old) or 'very mature' (more than 2 years old) composts. [For practical and economic reasons most compost supplied for use in growing media will be around three to four months old only] They also concluded that there has been little attempt to standardise a compost test for disease suppressiveness, or to examine the repeatability of a suppressive effect, either within or between related pathosystems.

WRAP has also recently initiated a project (ORG0042) to provide financial support to growing media manufacturers for research to develop reduced peat and peat-free products containing increased volumes of green compost. Four manufacturers, three of whom are members of the growing Media Association have been selected by competitive tendering and this represents a further investment by WRAP to encourage the uptake of CGW.

International Sources

1. International Society for Horticultural Science (ISHS)

The ISHS originated in 1864 and was formally established in 1959. It has members in 128 countries, and is the leading, independent organization of horticultural scientists in the world, although for substrates the predominant representation has been from Europe. Proceedings of these symposia are published in *Acta Horticulturae*® which are a valuable source of information on horticultural research and development from academic, governmental and, importantly, commercial interests.

A list of symposia directly relevant to this project is as follows:

- 648 South Pacific Soilless Culture Conference - SPSCC (Feb 2004)
- 644 International Symposium on Growing Media and Hydroponics (Feb 2004)
- 608 International Symposium on The Horizons of Using Organic Matter and Substrates in Horticulture (Jun 2003)
- 554 World Congress on Soilless Culture: Agriculture in the Coming Millennium (Jun 2001)
- 549 International Symposium on Composting of Organic Matter (Mar 2001)
- 548 International Symposium on Growing Media and Hydroponics (Mar 2001)
- 481 International Symposium on Growing Media and Hydroponics (Jan 1999)
- 469 International Symposium on Composting & Use of Composted Material in Horticulture (Jul 1998)
- 450 International Symposium Growing Media and Plant Nutrition in Horticulture (Jul 1997)

- 342 International Symposium on Horticultural Substrates other than Soil in situ (Jun 1993)
- 302 International Symposium on Compost Recycling of Wastes (Mar 1992)
- 294 II Symposium on Horticultural Substrates and their Analysis, XXIII IHC (Dec 1991)
- 238 Symposium on Substrates in Horticulture other than Soils in situ (Sep 1989)
- 221 Symposium on Horticultural Substrates and their Analysis (Apr 1988)
- 178 Symposium on Nutrition, Growing Techniques and Plant Substrates (Mar 1986)
- 172 Composts as Horticultural Substrates (Jun 1985)
- 150 International Symposium on Substrates in Horticulture other than Soils In Situ (Jun 1984)
- 133 Nutrient Film Technique and Substrates, XXI IHC (Apr 1983)
- 126 Symposium on Substrates in Horticulture other than Soils In Situ (May 1982)
- 99 Symposium on Substrates in Horticulture other than Soils In Situ (Jun 1980)
- 50 Symposium on Peat in Horticulture (May 1975)
- 37 I Symposium on Artificial Media in Horticulture (Sep 1974)
- 26 III Symposium on Peat in Horticulture (Dec 1972)
- 18 Symposium on Peat in Horticulture (Jun 1971)
- 8 Symposium on Peat Culture (Sep 1968)

As can be seen, the ISHS Commission on Plant Substrates has held 25 relevant symposia from 1968-2004 and it is interesting to note that trends in horticulture and growing interest in non-peat research is reflected in the titles. Until 1975 all symposia contained ‘Peat’ or ‘Artificial Media’ in their titles, but these terms have not been used since. During the 1980s ‘Substrate’ appeared in all and ‘Compost’ (as in composted material) appeared for the first time in 1985. Since 1991 the titles have included ‘Substrate’ (3 times), ‘Growing Media’ (4 times), ‘Soilless Culture’ (twice), ‘Compost’ or ‘Waste’ (4 times) and there are also three references to ‘Hydroponics’.

The most relevant of the papers published in *Acta Horticulturae*® since 1985 are summarised below and are reviewed in chronological order and grouped by decade:

1985-1989:
Calvet *et al* (1985) described the benefit of composting of grape marc for 120 days - when used in media - to improve the germination of cucumber and lettuce, whilst Pivot (1985) showed that the poor growth of gerbera in softwood barks was mainly due to their poor physical characteristics.
Hoitink and Kuter (1985) discussed some of the specific effects of organic components in container media that affect the fate of soilborne plant diseases and Verdonck and Penninck (1985) described how soy scrap sludge could be used as a nitrogen source to optimise composting of bark in order to obtain compost which can

be used as good horticultural substrate. Starck and Oswiecimski (1985) demonstrated that composted pine bark was equal to sphagnum peat for greenhouse tomatoes in ring culture and Wilson (1985) described a 'New perlite system for tomatoes and cucumbers'. Inbar *et al* (1985) described how composting the fibrous waste resulting from the anaerobic digestion of cow slurry ('cabutz') resulted in it appearing to be as good as or superior to peat for the growth of pepper, cucumber and tomato seedlings. Pudeleski (1985) discussed industrially produced pine and common beech bark composts used in different methods of growing vegetables under protection in Poland. Pennink *et al* (1985) described preliminary studies indicating which materials may be composted and stressed that before any of the wastes could be used [as substrates] a complete study of the characteristics and the possibilities of the material must be made. Lemaire et al (1985) reviewed the possibilities of mixing spent mushroom compost with other materials like sphagnum peat, French brown peat and pine barks which had been studied during 15 month-long experiments in containers without plants.

Wilson (1986) reviewed the search for an ideal growing medium for the production of quality tomatoes in Scotland and included work on artificial substrates including peat, bark, vermiculite, rockwool, plastics, nutrient film technique and perlite. Solbraa (1986) showed that spruce bark (*Pinus. abies*) has different qualities from other growth media such as peat, soil, or rockwool and discussed the consequences with special reference to potentially growth reducing compounds and elements, to the nutrient balance, and to physical conditions. Alt and Höfer (1986) stated that town waste compost may be used successfully as a component of substrates for growing woody or other ornamental plants in containers but recommended it to be diluted 1:1 with peat or bark because of its high salt content. Inbar *et al* (1986) described how composted separated manure and composted grape marc were successfully tested as peat substitutes or peat complementary media for vegetable, pepper, cucumber and tomato seedling production. Carlile and Turner (1986) described experiments using combinations of sphagnum peat, sedge peat, composted pine bark and perlite and demonstrated that little difference occurred in rate of growth, leaf and flower development, spike height and flower quality of hyacinths raised in the media in bowls.

Pivot (1988) demonstrated that whilst the physical characteristics (air and water capacity) and fertility levels of sludge and softwood bark compost as a raw material are not well adapted to plant growth, they can be improved by the addition of different rates of peat or absorbent rockwool. Best results were obtained with both materials in mixtures containing 40% (by volume) of peat or 20% of rockwool, or with the control (mixture of 80% peat and 20% perlite). D'Angelo and Titone (1988) discussed experiments with 25 different substrates on *Dieffenbachia amoena* cv. "Tropic Snow" and *Euphorbia pulcherrima* cv. "Diamond" '…. looking for possible alternatives to traditional ones (peat, leaf mould, sand)'. These substrates were based on various mixtures of sphagnum peat moss, uncomposted bark, composted bark, argex, perlite, polystyrene, leaf mould, sand and hydrogel. Observations of the plants have revealed that a ratio of 30 % peat is sufficient to assure good water retention and that whilst uncomposted bark resulted in stunting and yellowing, composted bark gave excellent results, in particular on *Dieffenbachia*.

Hansen (1988) reported on trials that aimed to demonstrate that artificial media (water absorbent rockwool) could be a valid replacement for peat based composts used in pot plant production. Szmidt *et al* (1988) described the perlite culture system developed at the West of Scotland Agricultural College.

Lemaire *et al* (1989) reviewed the physical and chemical characteristics of a ligno-cellulosic material, commercially called "Hortifibre", which is made with wood fibres of

Pinus pinaster and had been marketed in France since 1985. The possibilities of mixing Hortifibre with other materials like sphagnum and French brown peats were evaluated and the best mixtures have been tested as growing media in ornamental pot and container experiments. Santiago and Santiago (1989) reported 'highly meaningful results' from experiments in the use of fertilized crushed, sieved, graded and washed charcoal chips used as pure substrates for growing various kinds of foliage, flowering and fruiting plants in containers in the open, in rain soaked and humid conditions. Kelly (1989) reported that macerated tree bark from both deciduous and evergreen species was widely used as an additive to moss peat in the preparation of growing media to improve drainage and openness and to reduce shrinkage. However, he warned that Sitka spruce (*Picea sitchensis*) can contain high levels of manganese, and leguminous plant species which are cultivated in composts containing bark from this species can display severe chlorosis.

1990-1999:
Tattini *et al* (1991) reported that the use of the composted waste materials such as urban and dairy sludges and grape marc in growing media permitted an important fertilizer saving and improved the root/shoot ratio of both peach and olive plants grown in containers. Schmilewski (1991) stated that 'the trend in the production of growing media is definitively not away from peat based media but towards stronger use of other components'. Composted materials (in addition to bark) would 'find stronger use in horticulture' because of 'increasing amount of waste, shortage of landfills and political causes' but, 'their heterogeneous properties restrict their use to certain fields of application'. The German Association for Quality Composts was founded in 1990 to establish guidelines for the physical, chemical and biological properties of these composts. Lamanna *et al* (1991) reported cultivation trials giving evidence that a peat-compost mixture, in most cases, produced plants of ten pot ornamental species of better quality than those cultivated in peat or compost singularly. For most of the employed species the quantity of peat could be reduced to 1/3 of the total. Chen *et al* (1991) found that bottom-ash coal-cinder was a satisfactory substrate for growing ornamentals, provided an organic component (compost) was added. Benoit and Ceustermans (1991) examined the possibilities of three 'ecologically sound' substrates (recycled polyurethane foam, felted poplar fibre boards and loose poplar fibre flocks) for the growing of melon and reported promising results with both the foam and the boards. They also explored the possibilities of using peat pots as 'an ecologically sound alternative' to the rockwool blocks used for propagation. Kämpf and Jung (1991) tested mixtures of carbonized rice hulls with peat in potting media in Brazil as they had been used for several years by some commercial flower growers as a substrate for rooting cuttings of roses and chrysanthemum stocks. Stark *et al* (1991) found that carnation plants grown in peat-sawdust mixtures in most cases had longer stems and greater inflorescence diameter than in peat or sawdust alone. Higher doses of nitrogen increased inflorescence diameter of plants grown in sawdust and in a mixture of 25% peat and 75% sawdust. A higher dose of potassium increased the stem length of plants grown in mixture of 50% peat and 50% sawdust.

Wever and Hertogh-Pon (1993) discussed the effects of self-heating on peat and showed that *Ficus* growth in peat that had reached 67°C in storage displayed nitrogen deficiency, caused by nitrogen absorption as a result of decomposition of the peat. Handreck (1993) described how when coir and bark (*Pinus radiata*) were added to peat mixes additional nitrogen input was required to satisfy the microbial activity and prevent deficiency. Jespersen and Willumsen (1993) showed that with tomato cultivated in growing bags and *Exacum affine* grown as pot plants on ebb-flood benches, it is possible to produce composts of such a uniform and suitable quality that compost could replace 20 – 40% by volume of the peat and most of the fertilizers in peat substrates for horticultural crops. Bragg *et al* (1993) evaluated growing media based on peat, coir (coconut fibre waste) and woodfibre ("Hortifibre", France) to which composted sewage, or the organic fraction of domestic refuse - fresh, partially composted, or fully composted and matured was added. At 30% by volume inclusion only slight depression of growth was experienced with various "bedding" plants although only the composted sewage and the fully mature refuse compost could realistically be used as commercial ingredients. They concluded, however, that public prejudice to such materials currently precludes their immediate use. Martorell *et al* (1993) found that lettuce seedlings grown in commercial forest litter (Ecobosc) had a superior response than those grown in peat based substrates but mixes formulated with cork produced seedlings of lower quality than in all other media. Tomati *et al* (1993) conducted vegetative propagation experiments on several ornamental plants and showed that the use of composts in addition to or as substitutes for organic or inorganic components of potting media, improved rooting, rooting initiation and root biomass development to varying degrees. Hansen *et al* (1993) suggested that competitive substrates (for example those based on rockwool granules, air dried clay and a lignous carbon source) can be designed and produced without the decomposition capacities inherent in organic materials which produce high quality pot plants like peat. Nappi and Barberis (1993) observed that the demand for peat as a substrate for plant pot culture has markedly increased in recent years, thus reducing the availability of the resource, worsening its quality and increasing its cost. Furthermore, waste recycling was now a matter of great interest for its energy saving implications and as a means of preserving environmental resources. Bilderback and Fonteno (1993) reported an experiment in which *Cotoneaster dammeri* Schneid. ‘Skogholm’ were potted into combinations of pine bark (PB), horticultural rockwool (RW), composted municipal yard waste (CYW), composted turkey broiler litter (TBL) and washed builders sand (S). The greatest top dry weight was recorded in the PB:RW:TBL (70:20:10, by volume) substrate, which had the most consistent, favourable physical properties. Aguado *et al* (1993) evaluated cork oak bark as a potting media for growth of seed propagated geraniums. Vegetative growth and dry weight of plants were significantly higher in peat than in cork oak bark, but the addition of perlite to the cork oak bark improved its performance. Cid *et al* (1993) reported their search for an economic standard substrate for the Tenerife foliage plant industry and studied the growth and quality of *Schefflera* "Golden Capella" and *Ficus* "Starlight" in various mixtures. They reported that for *Schefflera*, peat + Aqua-Gro 'G' gave the best results of all treatments, mainly on root development and peat alone proved to be the poorest. For *Ficus*, best results were obtained with peat + Aqua-Gro 'G' and peat : basaltic cinder : expanded polystyrene, 2:1:1 by vol. + Aqua-Gro 'G'. D’Angelo *et al* (1993) investigated cheaper domestic components for substrates, to replace peat - at least partially – in pot plant production. They concluded that substrates with higher water retention capacity, like peat, were the best for vegetative plant growth, while better results for flower number and advanced flowering were obtained with the mixtures containing bark compost + peat + a ‘draining component’ in the proportion of 3:2:1; the only exception was New Guinea impatiens, that requires high water availability in the substrate. Among the draining components, rice husks and pumice, which are much cheaper than perlite, performed as well. For cyclamen and pot chrysanthemum, the best cultural results were achieved by reducing the quantity of peat in the substrate to 1/3 of the total amount. Reinikainen (1993) reminds us that whilst there is a great range of substrates to be considered for increasingly intensive pot plant production, ‘peat with limestone and fertilizers alone or mixed with additional materials is a high-class substrate for modern pot plant nurseries’.

Prasad (1997) reviewed the properties of coir and Awang and Ismail (1997) described experiments on the growth and flowering of four annual ornamentals, namely zinnia (*Zinnia elegans*), celosia (*Celosia plumosa*), marigold (*Tagetes erecta*), and vinca (*Catharanthus roseus*) in growing media containing varying percentages of coconut dust and tropical peat (100:0, 75:25, 50:50, 25:75 and 100%, v/v). Martinez *et al* (1997) studied the physical and physico-chemical properties of peat, coir and peat-coir mixes (3:1, 1:1 and 1:3, v/v) and the effects of clay-material addition on peat-coir mixes. Molitor and Brückner (1997) evaluated the nitrogen status of a waste-paper compost in incubation experiments together with investigations of the chemical and physical properties and plant response. The results indicated that both nitrogen and phosphorus deficiency was a problem but this was addressed to create a potential peat substitute. Cárthaigh *et al* (1997) described experiments carried out using shredded and fibrous *Miscanthus* added in different quantities to a sphagnum peat substrate. They concluded that *Miscanthus* appeared to be 'an interesting biomass product' that can be used to stretch peat reserves and that it may be possible to develop a 100% *Miscanthus* substrate along the lines of woodfibre products. Roeber and Leinfelder (1997) conducted two experiments on African violets (*Saintpaulia* x *ionantha*) and gloxinia (*Sinningia* x *hybrida*) and concluded that the fertilization of plants cultivated in woodfibre substrates should start 8 to 10 days earlier than for standard substrates and to obtain high quality plants a modified supply of water and an early start of the fertilization is of great importance. Weinhold and Scharpf (1997) studied the tolerance of some ornamental crops to increasing Na, Cl and other salt concentrations following addition of composted material to peat substrates. They found that, provided no more than 40 %v compost is used, the mix would be tolerated by all tested plant species if composts used in production of potting substrates contained less than 1000 mg Cl/l and 225 mg Na/l. Fischer and Schmitz (1997) concluded that the residues from the composting of separately collected organic waste can be used in growing media after a short term composting process although 'damage and reduced plant growth cannot be ruled out on sensitive plant species', in particular when using composts from residues of the KOMPOGAS-process. Mixtures of peat and 'BTA'-composts or 'BIOSTAB'-composts did well as a growing media in the experiments. Carmona *et al* (1997) concluded that high rates of ammonium nitrate should be added to maintain a constant level of available N to plants in media containing cork. Noguera *et al* (1997) evaluated two coconut fibre wastes (dust and short fibres) from Mexico and Sri Lanka as growing media components for pot plants. In experiments conducted in pots with *Calendula officinalis* and *Coleus blumei* the best formulations performed as well or better than in the control mix composed of 75% vol. *Sphagnum* peat and 25% vol. vermiculite. Gruda and Schnitzler (1997) found that lettuce seedlings cultivated in a woodfibre substrate impregnated with a slow release N-source performed better than in peat or unimpregnated woodfibre and that impregnation provided enough N for the initial microbial fixation.

Prasad and O'Shea (1999) found that after extended incubation, woodfibre materials from France and Germany lost a greater volume than a variety of peats. Narciso *et al* (1999) showed that hardening by higher water stress in plants grown with coarse pine bark produced plants better adapted to transplanting under dry conditions. Shinohara *et al* (1999) compared the chemical and physical properties of coconut-fibre with those of rockwool, bark and rice husks and concluded that, for tomatoes, an excess supply of nutrient solution is essential when coconut-fibre substrate is used for the first time, and that this may be managed more easily in recirculating systems. Verhagen (1999) explained that the chemical characteristics of coir dust differ greatly from peat and other organic media and in particular coir samples showed high contents of exchangeable K, Na, Ca and Mg on the adsorption complex. Carlile (1999) reviewed the effects of the environmental lobby on the selection and use of growing media and stated that peat is still the preferred medium of professional growers in many countries on grounds of reliability, uniformity and continuity of supply and the effect of these lobbyists has been most pronounced in the amateur or hobby markets.

2000-2005:
Rivière and Caron (2001) stated that in the next 10 years environmental constraints will increase, trying to limit the extent of peat use in growing media or to substitute it by industrial by-products. Environmental constraints will also apply to after-use, eliminating other substrates [that cannot be recycled or reused] and they concluded that research on alternatives products of organic origin for potential use as substrates appears necessary. Carlile (2001) considered the problems associated with visible growths of saprophytic fungi which are common in some types of peat free media, notably those derived from composted materials including wood wastes and bark. He concluded that, although unattractive, the fungal growth may reflect the suitable nutrient status and physical conditions of such a medium and undoubtedly originate in the materials from which the growing medium is formulated, and that their sporadic development may be difficult and/or uneconomic to control.

Kresten Jensen *et al* (2001) experimenting with *Hedera helix* 'Mein Hertz' and *Fatsia japonica* concluded that compost of *Miscanthus* straw plus a N-source is a potential substitute for peat. Gruda and Schnitzler (2001) cultivated lettuce seedlings in the woodfibre substrate Toresa nova ± brown coal and a peat substrate Statohum in 4cm press pots (i.e. blocks) and in Toresa nova only in plug trays (77 pots). They concluded that woodfibre substrates possess high air volume even at higher levels of water tension and a high saturated water conductivity, and that they must therefore be watered frequently. Gruda *et al* (2001) presented results that showed that woodfibre substrates in a mixture of up to 30 % by vol. could replace a portion of peat used for the production of press pot (i.e. blocks) for lettuce production.

Reis *et* al (2001) compared grape marc compost (GMC) with rockwool (RW) as a substrate for greenhouse tomato production in open and closed systems. Their results showed that grape marc compost could be used as a rockwool substitute for greenhouse tomato production in both systems. Reis *et al* (2003) composted grape marc and pine bark in windrows for a period of three months, supplied with 1kg of nitrogen (urea) m^{-3} and compared them with rockwool slabs as plant substrates for growing a greenhouse tomato crop in 30 L bags. The results showed no significant differences in yield and fruit quality between substrates.

Nowak and Strojny (2003) found that when gerbera was grown for 24 months in five growing media cut flower production was highest and of better quality in [lightly humified] white peat 90% + perlite 10% (v.v.), [moderately humified] brown peat 60% + calcined clay 40% (v.v.), and coir dust, and lowest in white peat alone after 6 months of cultivation due to its rapid decomposition. Strojny and Nowak (2004) evaluated growing media made from sphagnum peat blended with different additives in respect of their physical properties and influence on bedding plant growth. The additives included perlite, sand, vermiculite or polyamine foam and the media were used in production of: *Tagetes erecta, Salvia splendens, Bacopa* Sutera Nova, *Scaevola aemula* and *Verbena hybrida* Tapien. The results showed that none of the additives to the peat improved the quality of the medium or plant growth.

Bohne (2004) conducted experiments on container growing plants in the open with peat-reduced and with peat-free substrates for 10 years where the non-peat components were mainly woodfibre and bark compost. Growth of the plants was equal or better in the peat-reduced and in the peat-free substrates compared to peat but these substrates had to be irrigated more frequently with smaller amounts of water per irrigation event, although the total amount of irrigation water was reduced compared to peat. Molitor *et al* (2004) incubated wood chips from recycled chipboard in order to quantify the release of mineral nitrogen liberated from urea formaldehyde resin. Mineral nitrogen release amounted to about 500 mg L^{-1} substrate and varied depending on the chipboard source, the addition of phosphorus and other nutrients, but accumulation of released mineral nitrogen could be prevented by the addition of 50% (v) sawdust. Bohlin and Holmberg (2004) reviewed the use of growing media (soilless culture) in Swedish horticultural production. They found that peat and peat-based growing media were dominating in the production of pot and bedding plants, container-grown nursery stock, small forest plants as well as bulb forcing. For pot and bedding plants the medium is often a mixture of lighter and darker peat with sand and clay as common additives. Other additives used to a minor extent are perlite, expanded clay, compost and bark. In vegetable growing, inert media are used, mostly rockwool, but also pumice and perlite. Peat is a domestic raw material; Sweden is more than self-sufficient and at the present level of production for horticulture it is considered a 'sustainable growing media' substrate. Ismail *et al* (2004) demonstrated that in Malaysia composted 'empty fruit bunches' (the waste from palm oil production) could be used as substitute for peat in the production of vegetables in admixture with coconut dust in a soilless culture system. Inden and Torres (2004) investigated 'environmentally friendly substrates' as alternatives to rockwool and perlite for glasshouse tomato production. They found that potential materials require a specific management to match the high yield and quality of the inorganic substrates. Parks *et al* (2004) demonstrated that a range of growth media can be successfully used for hydroponic cucumber production including coir (*Cocos nucifera*), sawdust (*Pinus radiata*), rockwool, perlite and cucumber mix (a commercial soil conditioner). However, to maximise yields and fruit quality, further work was needed to tailor crop management for each substrate. Prasad and Maher (2004) investigated the physical stability of four possible 'peat replacers or extenders', namely, three woodfibres and composted coconut fibre (coir). The results showed that the woodfibres generally break down rapidly over time in relation to H5 peat but there were differences in the extent of break down between the woodfibres. Composted coir was found to be relatively stable. The addition of H5 peat to all the non-peat materials led to a reduction in the rate of break down, whilst the addition of lime accelerated break down. Breakdown of the materials was strongly negatively related to the initial lignin content.

Carlile (2004a) concluded that environmental concerns have intensified in the UK in recent years citing decisions by the NT and RSPB, and their efforts to reduce or stop peat extraction on lowland raised bogs in the UK that are considered to be rare habitats. He observed that the environment lobby in the UK has stimulated research into alternatives to peat, as well as studies into bog regeneration but paradoxically, manufacturers of growing media have undertaken most of this research. Carlile (2004b) reported that over half of all growing media produced in the UK is now sold in pre-packed form which can remain on point-of-sale premises for up to a year. The principal polymer in peat and coir is lignin, which is resistant to microbial degradation, but materials such as bark, timber waste, woodfibres and paper waste have a high cellulose and hemicellulose content, and micro-organisms readily degrade these polysaccharides, resulting in structural breakdown, lock–up of nitrogen and unattractive microbial growths. Solutions to these problems include careful selection of materials for use in peat-free growing media, use of appropriate composting techniques to allow microbial utilisation of readily available carbon sources and blending of materials to counteract storage problems associated with individual components.

In September 2005, the ISHS held an International Symposium on Growing Media in Angers, France. Rivière *et al* (in press) discussed the 'wise use of peat' in growing media in which France is not self-sufficient. It is recognised that peat is the best basic material, but a proportion can be replaced to improve aeration, reduce cost and to use local and recycled materials. The proportion of replacement is higher in the French hobby market. Verhagen and Boon (in press) described the ‘BasiQ Green’ classification system which is under development in Holland that expresses the environmental quality of RHP-certified growing media. The quantitative criteria are based on LCAs (lifecycle analyses) and in almost all materials transport throughout the production chain contributes considerably to the overall environmental profile. Peat scores considerably above average for the emission of greenhouse gasses and other materials score highly too because of energy inputs or pollution due to long-distance shipping. However, realistic peat-based formulations have been shown to have an environmental profile better than the current market average. Waller *et al* (in press) described a study sponsored by the UK Growing Media Association to validate and exploit the use of a state-of-the-art nucleic acid-based technique to investigate the diversity of fungal species in a range of growing media components commonly used in the UK (peat, composted green waste woodfibre, coir and bark). *Plasmodiophora brassicae* and *Rhizoctonia solani* were absent from all samples and the majority of species detected were benign saprotrophs. The technique is now being offered commercially. Alexander (in press) described on-going evaluations of peat-reduced and peat-free media by the Royal Horticultural Society with *Camellia* at Wisley.

To-date, three wood-based peat-free mixes, a peat-reduced mix and a local peat-free mix have all produced camellias of comparable quality to peat grown plants.

<u>2. International Peat Society (IPS)</u>

The IPS publishes Peatlands International, its members’ magazine, twice a year. The magazine consists of about 50-60 pages and includes reports on peat and related matters, research findings, business reports and internal information on the IPS. The IPS also regularly publishes proceedings of its conferences, symposia and workshops. 19 items of relevance to this project from 1996-2005 are cited below.

Schmilewski (1996) reviewed the horticultural uses of peat and concluded that:
‘In all European countries and in all other countries with a horticultural industry, raised bog peat is the basic constituent of growing media. The reasons for this are obvious. No other material combines as many favourable physical, chemical and biological properties.’ He also demonstrated that ‘peat has unique characteristics which make it the most suitable, reliable, most used and most traded material in the production of growing media worldwide’.
Lennartsson (1997) predicted that as a result of Government White Papers in 1990 and 1995, developments in organic waste recovery and processing in the UK would lead to outputs that were ‘likely to become increasingly used in landscaping, hobby gardening and, with future developments even, in the more technically demanding areas of horticulture’. She opined that ‘no single material is likely to replace peat, but a range of materials needs developing to meet current and future requirements’. Bark, wood-based products and coir are viable alternatives but are likely to remain in short supply; inorganic alternatives were costly to the environment because of the energy input in their manufacture.

Van Schie (1999) concluded that the use of peat in NW Europe would hardly increase but because of political and social discussions more and more alternatives like waste materials will be used, not only in the retail market but also in potting soils for professional purposes. Such developments will force the peat industry to take a more active approach to alternative materials. Van Schie (2001) reiterated this last point.

Schmilewski (2000) reviewed the horticulturally and commercially relevant characteristics of peat and the most commonly used alternatives in Germany and concluded *inter alia* that peat was the 'price-worthiest constituent for growing media and available world-wide'. Nevertheless, he predicts that during the period 2000-2020, there will be a necessity to use other materials with the peat industry as a partner but that 'peat remains a decisive factor in sustainable plant production'. Tonnis (2000) explained that peat is still the main growing medium for young plants and ornamental pot plants (40% each of black and white peat) but that additives such as clay, perlite, coconut fibres and bark are used to optimise the growing media [in Holland].

Schmilewski and Falkenberg (2000) stated that 'no other material combines as many favourable properties as raised bog peat does'.

Reinikainen (2001) stated that the pressure in densely populated countries to use local waste-based and recycled materials in growing media originates from internal socio-economical/environmental reasons but the performance of an advanced horticultural industry is thoroughly dependent on an accurate growing medium – peat. Van Doren (2001) estimated that world-wide the market for coir pith would increase from 0.8M cubic metres in 2000 at 15% p.a. to 4.45M cubic metres in 2015. This represents 13% of the potential coir pith production and most of this increase would be in professional potting soil mixes. Grantzau (2001) discussed quality standards for composted household organic waste. In Germany, the demand for so-called bio-substrates consisting of 20-30% (v/v) of this compost is increasing and that some retail products contain 50%. Gumy (2001) reviewed the properties of Toresa® - which is produced from pure wood waste products from the wood working industry - and showed how impregnation of the material with precise quantities of nutrients during production can provide for microbial action and eliminate nitrogen immobilisation. Such material can be used at 20-40% v/v of a growing medium and can improve the properties of black and white peat.
Verdonck and Dietmeyer (2001) explained that in France and Belgium, where good indigenous peat is not available, it is a must to use bark or bark compost in growing media and described sources, processing, properties and possible applications with particular reference to ericaceous and other ornamental shrubs.

Bohlin (2002) conducted a survey on behalf of the IPS to assess the extent of peat replacement in the professional and amateur markets [together] and obtained growing media production data from eight countries in north and NW Europe. The data are summarised in Table 6.

Table 6: Production of growing media and the proportions of peat and other constituents use in eight European countries in 2000/2001 (after Bohlin, 2002)

Country	G. media vol. K cu. m.	Peat vol. K cu. m.	% Peat	%v 0ther organic materials	%v Composted materials	%v Minerals	%v Pre-shaped materials
Germany	5050	4800	95.0	0.8	1.4	2.6	0.2
UK	**3500**	**3290**	**94.0**	**1.1**	**4.6**	**0.3**	**0**
Netherlands	3290	2300	69.9	9.1	0.6	5.2	15.2
France	1850	1170	63.2	15.1	16.2	5.4	0
Sweden	790	670	84.8	0	8.9	5.1	1.3
Denmark	690	630	91.3	1.4	1.4	2.9	2.9
Finland	580	510	87.9	0	5.2	5.2	1.7
Norway	390	340	87.2	0	5.1	5.1	2.6
TOTAL or MEAN %	**16140**	**13710**	**84.9**	**4.2**	**4.2**	**3.2**	**3.5**

This was the first survey of its kind and showed that, out of a volume of 16M cubic metres, the proportion of peat used was 85% overall, although there were significant national differences.

Proportionally, 10% more peat than average was used in Germany and the UK, whilst 15-20% less than average was used in The Netherlands and France. However, the lower usage in Holland was due to the high proportion of rockwool used [for the production of crops such as salads and cut flowers] whilst in France it was due to the high proportions of organic and composted materials used in the dominant retail sector.

De Kreij and Van der Gaag (2003) demonstrated a model designed for optimising the fertilisation of growing media containing composted greenwastes of widely differing composition using water extraction. However, importantly K levels were underestimated and resulted in excess fertiliser addition. Other problems occurred with excess P, S, Fe, Zn, Mn and B and the model needs to be amended to deal with all these issues although the natural surplus of K was likely to be a problem.

Clarke (2003) showed that, far from ‘threatening to strip Ireland’s environment bare’, British gardeners were responsible for utilising only 5% of Irish peat production; professional growers used only 2%.

Berken (2004) described ‘growing media’ use in France, which ‘is a market of 4.2M cubic metres’ [but this definition in France apparently includes soil improvers]. Although peat is the main raw material, it accounts for only 30% of the hobby market. Apart from imported peat, products in this sector incorporate up to 15% of national black peat, 30% composted bark and 8% of wood fibres and composted green wastes.

Reinikainen (2005) reaffirmed that, although alternatives to peat can be found, ‘no other material combines so many positive characteristics’. Furthermore, ‘in Finland and in Sweden peat is continually accumulating faster than it is being used’ and is considered to be ‘an environmentally friendly product’.

Kaskeala (2005) described the European Peat and Growing Media Association (EPAGMA) which represents the peat and growing media industry at a European level and acts as the interface of peat and growing media companies with regards to the EU institutions (European Commission, European Parliament and Council), and where appropriate, national governments and other stakeholders. It has 16 company members from 11 EU countries, but not the UK. (See also http://www.epagma.org/) EPAGMA aims to contribute to the socio-economic development of regions and communities where peat is sourced and used, and is committed to high environmental practices in peat extraction, to the sustainable use of peat as a local energy source and to promoting the unique properties of peat as a substrate in horticultural plant production. In particular, it seeks to raise the significance of the peat and growing media sector amongst decision-makers of the EU, to press for the acceptance of peat within the Eco-label criteria and to press for harmonised EU regulation on growing media covering market access, product content and labelling.

In collaboration with the International Mire Conservation Group the IPS has published '*Wise Use of Mires and Peatlands* [WUMP] – *Background and Principles including a Framework for Decision-making'* (Joosten and Clarke, 2002). This seeks to provide a framework to resolve conflicts between the commercial use of peat for horticulture etc. and the demands for the cessation or reduction of this exploitation because of environmental, ecological, aesthetic and scientific values of peatland.

In this context 'Wise Use' is defined as *those uses of mires and peatlands for which reasonable people now and in the future will not attribute blame*, and recognises that 'Wise Use' in one situation might not be considered 'Wise Use' in another. Appendix 5 deals with decision-making in respect of the 'Wise Use' of peat in horticulture and recognises the conclusion in WUMP that '*there is not at present any alternative material available in large enough quantities and equally risk-free which could replace peat in horticultural crop production*' and further that '*alternative growing media [such as composted green waste] work best when they contain an element of peat*'.

The criteria on which 'Wise Use' is judged are very detailed and comprise:

- the purpose for which the peat is extracted
- the country from which it comes
- the peatland from which it was extracted
- the conditions under which it was extracted and
- the enterprise which extracts it

The UK Growing Media Association endorses the principles of WUMP and its Codes of Practice are being updated to incorporate 'Wise Use Guidelines' for all peat employed in UK growing media production.

3. Miscellaneous information from the Netherlands

Two influential reference works, 'The International Substrate Manual' (Armstrong and McIntyre eds., 2000) and 'Potting Soil and Substrates' (RHP, 2003) are based entirely on Dutch research and experience and contain the most comprehensive and practical reviews of growing media components - as recommended for Europe's largest commercial horticulture industry. Apart from peat, these works list only four types of organic materials (bark/wood chips, coir dust/fibre, woodfibres and rice hulls), eight mineral materials (including perlite vermiculite. pumice, sand and rockwool) and foams. There is no mention of composted green or other composted botanical wastes.

In the RHP brochure it states that 'peat is still the main raw material for most potting soils' and despite the widespread use of amendments in potting soils and the use of rockwool and coir in cropping systems for glasshouse salads and cut flowers, Bohlin (2002) reported that peat accounted for 70% of the growing media produced in Holland but if the use of 'pre-shaped' materials such as rockwool is removed the proportion of peat used in organic growing media is 85%.

It is also interesting to note that in neither publication is there any reference to constraints on the use of peat associated with environmental or any other issue.

Armstrong (2004) reported on a Dutch project aimed at capitalising on the call by UK pot plant and food retailers to move towards 90% peat replacement by 2010 'even though there are no international directives that ban or even limit the use of peat in horticulture'. This significant growing media producer collaborated with a Dutch government-subsidised project led by Gerrit Wever of the Plant Research Institute with the mission of developing an environmentally-friendly, compost-based substrate. As a result a washed and heat-sterilised composted greenwaste material called 'BioMat' has been produced which has been used to 'successfully' grow cabbages and cucumbers.

The article quotes Erik de Ruiter of Tref EGO [the largest producer of growing media in Holland and a founder member of EPAGMA] extensively:

- 'The results were disseminated to the industry but there has not been a single reaction or request for it.'
- 'If growers want to replace peat with a peat-free substrate it has to be just as good as peat, but at no extra cost'.
- 'If companies like Tesco, Marks and Spencer and B&Q say they want peat-free material then growers have to supply that. The customer is king and we will help growers supply it.'
- 'Nevertheless, in this case it seems to be a marketing ploy which consumers aren't particularly interested in. They tend to chose plants which are grown in peat because it is cheaper than more expensive alternatives.'
- 'I believe it is a marketing concept and after a couple of years it will be over.'
- 'Because the demand for the organic BioMat was zero, even without mentioning the price, the project was scrapped.'

Blok (2006) reported on a significant initiative started in the Netherlands in 2003 called 'New Growing Media' to study the feasibility of growing pot plants in substrates containing less, or no peat at all. The initiative members are Flora Holland, Wageningen University's Applied Research Dept., the RHP Foundation, VPN (Dutch potting soil producers' organisation), Intergreen/Sionsplant and the Dutch pot plant growers. It was part-funded by the Dutch Product Board for Horticulture.

Its aim was to safeguard Dutch competitiveness in foreign markets, especially the UK(and Switzerland) by increasing the practical knowledge concerning pot plant behaviour in peat-reduced or peat-free mixes from breeder to consumer. The project was managed by Wageningen University and involved commercial trials with 16 growers and 17 pot plant species.

So far, it seems feasible to grow a number of species (other than *Begonia*) in mixtures with the peat content reduced from an average 77% to 30%. *Hedera* and *Schefflera* performed better with less peat. Five species (*Anthurium, Chrysanthemum, Gerbera, Spathphyllum* and *Castana*) grew no worse but eight species (*Azalea, Guzmania, Poinsettia, Rose, Saintpaulia, Adiantum, Crassula* and *Ficus*) the substrate mixture required more research.

Coir was the most useful alternative and its proportion was raised from 17% to 40%. Other useful materials with good aeration characteristics and no adverse effects on water absorption that were used at up to 30% in the mixes were bark, rice hulls, wood fibre, stone wool, clay granules, pumice, perlite and vermiculite.

These materials were expensive, but an economical review suggested that the new substrate mixes cost no more than 12% above the original and sometimes less. [However, it must be borne in mind that many imported non-peat materials are widely used in pot plant production in the Netherlands now to improve substrate performance and the incremental cost is therefore lower than it would otherwise be.]

More research is planned to evaluate other organic materials and most importantly for the future ‘flexibility’, by adjusting water, air and feeding quickly and even adding in disease suppression.
Nevertheless, ultimately it will be economics that determines the uptake of such mixes.

Part 3: Key raw materials for growing media manufacture – availability, cost and commercial issues

Overview and analysis

1. This section considers the latest information on the availability, cost and commercial drivers affecting peat and its principle alternatives. As has been shown in the survey reported here, the key materials for commercial media now and in the next four years (as in the Netherlands, Germany and the other EU nations with established horticultural industries) are peat, bark, wood products and coir. Composted green waste is principally confined to the retail sector.
2. A common issue with these bulky materials is the increasing cost of transport and distribution. This is a major factor in the choice of material and distance from the source and the densities of the materials are critical parameters.
3. Sphagnum peat from sites without any environmental designation where harvesting is permitted is readily available from within the UK and from Ireland, the Baltic States and Finland. Peat may cost manufacturers less than £5/m^3 if they source material from their own UK bogs but bought-in peat typically costs around £12-15/m^3 delivered and for such a readily available, consistent, reliable, versatile and lightweight material this represents the best value for money for the manufacturers and their customers.
4. Mixed conifer bark which is used principally as a peat replacement can be sourced in the UK - and may become even more available as UK timber production increases over the next 15 years - although some is imported from the Baltic. Delivered prices are benchmarked against imported bought-in peat but its more limited supply, greater density and potential effect on nitrogen drawdown count against it. Good quality pine bark is more readily available shipped in bulk from continental Europe. When screened, the finest fractions can be sold at prices similar to mixed conifer bark fines, but the coarser fractions (used specifically to enhance and maintain aeration in nursery mixes) command a premium and are typically around twice the price of peat.
5. Processed wood-based materials and forest co-products are a heterogeneous group of materials which are usually lighter than bark fines and more peat-like. They are potentially attractive to manufacturers but their relatively high price (up to twice that of bought-in peat) and/or limited availability has restricted their utilisation. Some major processors are investigating ways of increasing the supply of such material and reducing the cost.
6. Coir pith is a peat-like material with a low bulk density that is widely used in long-term cropping systems in Holland and increasingly as a peat replacement in areas of the world such as Asia where it is produced. Supply is not said to be a long-term issue but delivered prices in the UK can be up to twice that of bought-in peat and thus it has been not become widely used.
7. Composted green waste has many technical uncertainties and it is considered by most in the industry to be too variable and risky to use in mixes for most commercial glasshouse crops. Because it is locally produced, it can be delivered to manufacturers at prices below bought-in peat and is likely to replace a small proportion of the peat volume. However, for technical and bulk density reasons rates of incorporation will be relatively low and there remain concerns over nitrogen lock up in prepared media.

Introduction

This section is not intended as a review of the pros and cons of all potential growing media substrates and the myriad of peat alternatives from around the world. This is neither necessary nor helpful as they were considered in the previous HDC report (HDC, 2001) and have been highlighted in Part 2. Nevertheless, it is worthwhile considering the latest information on the availability, cost and the commercial drivers affecting peat and its principal alternatives. Furthermore, since it is the major growing media manufacturers who supply the vast majority of growing media used by professional growers, it is their perspective on material availability, prices and commercial issues which is fundamental.

As has been seen from the survey, for commercial media the key materials now and in the next four years (as in the Netherlands, Germany and the other EU nations with established horticultural industries) are peat, bark, wood products and coir. Composted green waste is principally confined to the retail sector.

In all cases, quite apart from quality and performance, it is the density of the material and the cost of transport and distribution that critically affects the economics and choice of growing media components. Value for money is what the manufacturer and customer ultimately demand.

The following brief comments are based on information and advice from many members of the growing media, substrate supply and material processing industry.

Peat

- Only peat that is harvested from sites without any environmental designation is considered acceptable for use. These designations include:
    - Sites of Special Scientific Interest – SSSI - in England, Scotland and Wales
    - Areas of Special Scientific Interest – ASSI – in Northern Ireland
    - Areas of Scientific Interest –ASI - in the Republic of Ireland
    - Special Protection Area – SPA - throughout the EU
    - Special Area of Conservation – SAC - throughout the EU

  SPAs and SACs together form a network of protected sites across the EU called 'Natura 2000'. There are 571 SACs in the UK, almost all of which carry the SSSI designation.
- Such peat is available from UK (including N. Ireland), Irish and Baltic sources, and although nowadays more than half of that used in growing media production is of non-UK origin, it is readily available.
- The cost of peat varies greatly, dependent on the extent to which the producer is self-sufficient in peat (from bogs which it controls) and the proximity of the factory to this or other source(s).
    - Ex-works prices for unscreened ('off the bog') peat are around £5/m^3. Screened peat fractions may cost twice this. Manufacturers supplying themselves will cost-in the peat they use at below this figure.
    - Delivered prices to manufacturers in the UK range from £9-17/m^3 depending on scale and location. Most peat will be sourced at prices in the middle of this range.
    - High grade block-cut white peat is more expensive and does not feature in growing media supplied to the UK market.
- Peat has the advantage of not only being effective, reliable and affordable, but of a relatively low density and thus having minimal affect on transport costs.
- Some experts claim that on a global scale peat is being laid down at a greater rate than it is being harvested and in Finland it is considered as a virtual biofuel. Peatland farming and bog re-establishment is considered by some to be viable in the future. Nevertheless, at a local level, peat is not (yet?) a renewable resource and since the original habitat is irreversibly altered environmentalists consider peat harvesting to be unsustainable.

Bark

- The UK is not self sufficient in bark but between 2004 and 2020 UK bark output will double to 1.6M m^3. However, this will be principally mixed conifer bark as the availability of UK pine has been in decline. This is due to a combination of factors including a programme of planting more (faster-growing) spruce and larch species which are now in production. Additionally, there was a major loss of many mature pine trees in the devastating storms of 1987 (and the early 1990's) and the pines have not yet reached maturity.
- Potentially more UK bark may become available for GM if Recovered Wood Fibre (i.e. chip) gains market share as an alternative for mulching etc.
- Mixed conifer bark and the fine grades of pine bark are used principally as a peat replacement and delivered prices range from £9/m^3 to £16/m^3. This range reflects both the quality of the material and its transport cost but ultimately this material has to compete with the prevailing price for peat which it is replacing. Typically, such bark sells for around £14/m^3.
- Aged pine bark (*Pinus. maritima*) is imported mainly from France, Spain or Belgium but the quantity used in growing media is relatively low. In large quantities this can be purchased for <£25/m^3 and once screened into various fractions sells for a range of prices determined by the market at prices above and below this figure.
- Graded pine barks are used specifically to increase aeration in peat mixes and sell for a premium with prices up to £42/m^3 according to use.
- Barks usually enhance aeration and reduce the water holding characteristics of peat-based growing media which can be a benefit, especially to winter-grown crops. However, care over nitrogen economy needs to be taken as, unless thoroughly composted with added nitrogen, microbial activity in the bark can result in nitrogen lock-up ('drawdown').
- The density of bark can be 50-100% greater than peat and this has an impact on growing media weight and plant distribution costs.

<u>Woody materials and forest co-products</u>

- This is a broad category of materials which may be derived from virgin, processed or recovered material. Currently, commercial substrates include composted chipboard waste (as used by Bulrush in Sunrise Peat-free and other peat-reduced composts), Silvafibre® (a fine wood fibre derived from composted 'lop and top' by Melcourt Industries) and toresa® (wood fibre derived from a thermo-mechanically treated mixture of live coniferous and recycled wood). The Bulrush material is exclusive to them, but the UK delivered price for Silvafibre is £15-18/m^3 and for toresa (Special N-impregnated grade) £24-28/m^3 - but this is for a product in 5.5 m^3 bales transported in containers from Germany. UK production of toresa has been mooted and would substantially reduce the delivered cost, but such a project has not proved viable.
- Such materials are attractive to manufacturers as peat substitutes as they are close to peat in properties, appearance and density (which helps keep transport costs down), although nitrogen lock-up can be an issue if the material is not processed with the addition of nitrogen. However, limited availability and price have restricted use by GM manufacturers so far, but they have found more ready acceptance amongst own-mixers.
- Virgin wood output will rise from 5.1 to 11.4 M m3 in the UK between 2004 and 2020 and much of this is destined for biomass/fuel or panelboard manufacture. Trials are under way by AW Jenkinson into the conversion of virgin wood waste into useful substrates for GM (in place of peat) but for economic and technical

reasons the quantity of suitable material that may arise cannot be predicted with ease at this time.

- As has been reported recently (Abbott, 2006) a woodfibre material is being developed by Sinclair Horticulture and Freeland Horticulture described as a 'fairly revolutionary' non-peat, greenwaste ingredient for compost with low salt content, no pathogens and low weight which is derived from the woody oversize fraction of composted green waste. This material will be lighter and more peat-like than regular CGW and will have the advantage that it will give savings in distribution cost to both the supplier and the user. The target price for this material is below that of peat, but production volumes and availability are unclear at the present time.
- It has been estimated that 7-10M MT of waste wood is recoverable principally from construction and demolition, and from commercial and industrial streams [Review of wood waste arisings and management in the UK, MEL Research Ltd., 2005]. This material, which sells for below £6/m^3, is described as 'Recycled Wood Fibre' but would be better described as 'chip'. Most potential is for biomass/fuel and for growing media, the issue is one of its contamination with glass (which can be removed), paint and PTEs and other phytotoxic organic residues.

<u>Coir</u>

- Coir ('cocopeat') is an attractive material with peat-like properties and low bulk density which, in many ways, makes it an ideal peat replacement. However, because of the transport distances involved from the primary sources in the tropics, it attracts possibly unfair criticism over the environmental impact of transportation. Indeed, Verhagen and Boon (*in press*) concluded that whilst transportation was a significant factor, because coir (unlike peat) was a waste material, the overall environmental profile of the two materials (when used in NW Europe) was comparable.
- Dutch Plantin, the Dutch coir supply company estimate that the 30-60 million cubic metres of coir pith etc. are potentially available worldwide, which compares with less than one million cubic metres used for horticulture in 2000. The biggest single consumer of coir in W. Europe is the Netherlands where it is used principally in commercial horticulture as an alternative to inert substrates like rockwool for salads and cut flower production and as a component of potting mixes. Use of coir is expanding in Europe in both professional and retail markets. In Asia and other regions where coir is produced, its value as a local horticultural substrate is growing and replacing peat imports.
- As untreated coir is high in K and binds Ca and Mg, RHP requires that coir is washed and buffered for professional us.
- In the UK, buffered coir for professional use and unbuffered coir for retail use are both supplied by UK companies for delivered prices in the range of £18-22/m^3. This can be twice the cost of bought in peat and four times that of in-house peat so it is generally only used for niche applications such as propagation, pot plants and in some specialist retail products.

<u>Composted greenwaste (CGW)</u>

- CGW has been heavily promoted by the government-funded Waste and Resources Action Programme (WRAP) who have been sponsoring R&D and supporting the activities of The Composting Association (TCA).

- The most recent TCA survey (The State of Composting in the UK 2003/4, published in 2005) indicates that about 2M m^3 of composted products were produced. This is 20% greater than in 2001/2 and is likely to continue to rise. Most compost is used as a soil conditioner, mulch or as an ingredient of manufactured topsoil. Nevertheless, 170,000 m^3 is said to have been used in growing media, but this is six times the volume advised by GM manufacturers in the 2005 HDC survey reported here.
- According to WRAP's approved supplier list there are some 60 suppliers accredited to The Composting Association Certification Scheme and producing compost conforming to PAS 100, the minimum quality standard for CGW. Of these 11 claimed to supply a grade suitable for growing media incorporation. (See http://www.wrap.org.uk/downloads/Supplier_list_November_2005_-_final.7d90d8aa.pdf)
- WRAP have also published 'Guidelines for the specification of CGM used as a growing media component' which were drawn up by this author (WRAP, 2004a). This guideline specification supplements the basic requirements of BSI PAS 100 to ensure greater reliability and acceptability of CGW for this application, but there are indications that these are not being followed.
- Despite WRAP's efforts, growing media manufacturers and their professional customers remain sceptical about the consistency, safety and suitability of CGW as a GM ingredient.
- Another weakness of the bulk of CGW (i.e. that in the 0- 10/15mm range generally used in growing media) is its high density and the adverse effect this has on distribution costs for growing media and plants.
- Because of the various issues, the use of CGW in professional applications is, according to the manufacturers, unlikely to exceed 0.5%v by 2007 and to only reach just over 2% by 2010.
- By contrast, the proportion of CGW used in the retail sector is expected to rise to over 8%v, although there remain some concerns over the stability of mixes containing more than 20%v CGW and the lock-up of available nitrogen in packed product in storage.
- Ex-works prices for 0-10/12/15mm CGW can be £2-10/m^3. Most material is sourced from relatively close to the point of use but delivery can add up to £7/m^3. However, to achieve high volume sales, Freeland Horticulture believes that a delivered price of under £8/m^3 is required to compete with peat.

It remains to be seen if the April 2006 increase in landfill tax and the £5/MT rise in the gate fees charged by composters will lead to any greater availability or improvement in the quality of CGW which will lead to any greater exploitation of this material.

Part 4: Grower perspectives on peat replacement in growing media

Overview and analysis

1. This is a brief review of grower responses to questions about how they are impacted by the peat issue and the requirement to maximise peat alternative usage.
2. Pressure to reduce peat usage is greatest from multiple grocery and DIY retailers and least from the garden centres. The general public are generally unconcerned with the components of the growing medium in which their plants or produce is grown.
3. UK growers (who service only the home market) believe that in comparison with their continental competitors (who supply many export markets) they are disadvantaged by governmental and retailer anti-peat policies as non-UK growers are better able to resist peat reduction without commensurate payment for the extra costs involved.
4. With the exception of the salads sector (other than lettuce) which has long abandoned peat-based growing bags in favour of better performing cropping systems based on artificial media and some other low volume, niche applications, peat sustains commercial horticulture. It is the preferred substrate; growers rely on it because it is the most reliable, most flexible and cost-effective medium for crop production.
5. Those pressing for peat reduction are unwilling to support or finance any of the cost of research and development or the additional production and distribution costs that arise.
6. So far UK growers in various sectors have accommodated demands for reduced peat usage and have borne the associated extra costs of trialling, materials, distribution, crop failure, pest problems and wastage themselves. However, at this time with ever increasing energy costs, a slowdown in gardening activity and extreme pressures on margins, further reductions are considered uneconomic. Indeed some growers have had to reduce the extent of peat replacement in their media to ensure continuity of supply and to maintain profitability.

General

- Pressure on growers to replace peat in growing media is greatest on those supplying supermarkets and DIY-sheds and least on those supplying independent and multiple GC chains. It is also fair to say, at the same time, that product specifications and the requirement for complete freedom from pests set by the food retailers (including *sciarid* fly which can be associated with the use of less stable organic alternatives) are more demanding.
- The general public are generally unconcerned with the material used to produce the plants they buy and their primary concern is horticultural product quality and price.
- Growers complain that the (anti-) peat policies of the multiples are inconsistent, not uniformly applied and that overseas suppliers are better able to resist and are therefore less compliant. As a result UK producers, who supply only the home market retailers, and who are the only producers in the EU or elsewhere whose government is also pressing for peat reduction, tend to be disadvantaged.
- Furthermore, whilst these customers request and require change, they are unwilling to provide any financial incentives and will pay no more for the crops produced; indeed such retailers often have public policies for driving prices lower still. This has meant that peat-reduction steps taken so far and which have resulted in increased direct and indirect costs have been borne by UK growers.
- The profitability of horticultural enterprises is currently threatened by dramatically increased fuel prices which affect heating and distribution costs which, together

with the Climate Change Levy, a slowdown in gardening activity and other increases in production costs, are causing real difficulties. At the same time, their customers and suppliers are facing similar issues and none of the parties are willing or able to pay premiums for their materials and products.

- Against this background, the use of peat alternatives in plant production, which result in increased costs for the growing media manufacturers and in distribution, and pose some risks to plant production and quality, can be seen as an unnecessary and unwelcome economic burden.
- The pressure for peat replacement from commercial buyers varies from time to time but at present, there seems to be a recognition (at least by some multiples) that peat reduction measures that increase production costs still further, cannot be pursued.

Sector experience

- For technical and performance reasons and not environmental ones the use of peat for long term salad crops has long been replaced by inorganic substrates for both propagation and in growing systems. This is because it was found that the physical characteristics of rockwool in particular facilitated greater control of growth and increased yield. To deal with post harvest rockwool disposal problems, research is now being focussed on organic, non-peat media such as bark or coir.
- To lengthen the growing season, increase yield and find a solution to the loss of the soil sterilant, methyl bromide, soft fruit crops have been moving out of soil and into peat bags or troughs under protection - as did salads in the '70s. This is still being developed and there is no economic case to replace peat at the present time although the situation may evolve as it did with tomatoes and cucumbers.
- For cut flowers and lettuce, which are predominantly soil grown and where peat is now only used in blocking compost for propagation, there is no convenient, cost-effective alternative.
- Vegetable propagators have been under a great deal of pressure to reduce peat as their customers interface directly with all the major food retailers. Continuity and uniformity of cropping are vital, and reliability is key. Extensive testing has been undertaken and some success has been achieved. Propagators would be prepared to change (even to peat-free if the mixes worked reliably) if their customers, the vegetable growers, would fund it; but for now, mixes remain 100% peat-based. Nevertheless, over the last 10 years there has been a 30% reduction in peat usage, although this has been achieved by reductions in some cell sizes and associated crop management techniques rather than peat replacement. Further reductions in peat usage can only be brought about by peat substitution but margins are far too tight to fund such projects. Coir works satisfactorily with some crops (but not brassicas) and vermiculite is useful, but composted green waste has not provided consistency and confidence.
- In the propagation of bedding plants the volumes of peat used in small cells is even lower than in vegetable propagation and, because of the very high demands on the substrate, all-peat media are used exclusively. There is no real pressure to change although research has shown that bark and coir can be used as substitutes at up to 40%. However this will result in growing media cost increases of up to 25% which cannot be justified. Commercial peat–free formulations are not reliable enough for this demanding application. For vegetatively propagated material in larger cells, a general reduction of 25% in peat use can be achieved at low risk but again at some cost. For the production of pack bedding there is pressure for peat substitution from the multiples and based on trials about 20-30% reduction can be achieved, but this is at a cost that

is being borne entirely by the plant producer. Further reduction in peat usage is currently considered uneconomic.

- For pot plant production, much work has been carried out by suppliers to the multiples keen to accommodate their customers' requirements where they can. However, production schedules and specifications are tight and complete peat replacement has not been successful although 30-50% replacement has been achieved with mixed success. One grower has recently had major problems after moving to a 50% proprietary peat reduced mix that included woodfibre which resulted in significant wastage and losses of several thousands of pounds per week. The multiple customer will not compensate him for this and the grower is reverting to a mix containing 15% bark only. The same grower reported that whilst the shelf-life of another crop was enhanced when composted green waste was used in the mix; the resulting *sciarid* fly problem was unacceptable to the (food) retailer. Another grower, encouraged to replace 40% peat for cyclamen and poinsettia production by two retailers, cannot recover even 1p per pot to offset the cost.
- It is often said that nursery stock, grown mainly outdoors and with controlled release fertilizer added to the medium, represents perhaps the easiest sector for peat replacement. In parallel with growers in other sectors who sell plants via the multiple retailers, many trials have been conducted. However, whilst some success has been achieved, notably by substitution with bark and wood fibre, nothing compares favourably across a wide enough range of crops to make it a practical proposition for one leading producer. This grower, who had been at the forefront of bark usage to enhance the physical properties of peat, has now reverted to a 100% peat mix for outdoor crops (since peat quality is now better and augmentation is not necessary) and, for protected crops, to a mix containing only 15% bark to maximise his returns - as his customers are not pressing on peat replacement and will not pay extra for it.
- For mushroom production, peat is the preferred casing material with amendments used only to modify the availability of water.
- For bulb-forcing there has been a great reduction in the use of peat with the employment of alternatives and recycling of the compost.

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Appendices

N/A

Acknowledgements

I would like to thank all those organisations and companies who responded to requests for confidential sales data and to express my appreciation to all the individuals concerned for their considerable efforts in collating figures for 2005 and providing future projections and for the many comments recorded in this document. I would also like to thank the Project Co-ordinator, Neil Bragg for his guidance and support.