

Third Annual report of the Government Industry Forum on Non-Food Uses of Crops



Third Annual Report of the Government-Industry Forum on Non-Food Uses of Crops



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1. Chairman's review of the Forum

Background and membership

The Government-Industry Forum on Non-Food Uses of Crops is an advisory non-departmental public body, established in May 2001 in responses to the 1999 House of Lords Select Committee report on non-food crops. The Forum's role is to advise Government on the strategic steps needed to encourage the development of non-food uses of crops which can contribute to sustainable development and add to UK economic activity. Members of the Forum are drawn from industry and academia, with input from the DTI and Defra and a government secretariat. A full list of current members and their professional interests is provided in Appendix 3.

Approach

The Forum's approach has developed over time, but is grounded in a number of individual case studies. There are a wide range of potential non-food uses of crops, many of which have been known of for some years but have not yet achieved their potential within the UK. The Forum was keen to understand the barriers to their development, and to identify any common themes between different sectors. Understanding the contribution of crop-derived materials to sustainable development has been a principle aim of the Forum, and all case studies were therefore assessed against the Forum's sustainable development indicators (see Appendix 1). Case studies which performed poorly against these indicators were discontinued, such as the case study on the use of crop-derived dyes in the textiles industry.

Early case studies included biolubricants, biosolvents, packaging, secondary products of wheat, fibres in composite materials and high value speciality products such as essential oils. Where there was no apparent barrier to further development or where no sustainable market for a product existed, the case study was discontinued.

The Forum has commissioned research to support its case studies where necessary. The Forum is pleased that a number of these studies, such as the Sheffield Hallam study *Evaluation of the Comparative Energy, Environmental and Socio-Economic Costs and Benefits of Biodiesel* and the Institute of Innovation Research study *Prospecting Bioscience for the Future of Non-Food Crops*, have made significant contributions to the ongoing debates within their sector in their own right.

The findings of the Forum's case studies are published in its annual reports, of which this is the third and final, and are presented to ministers. The Government's response to the Forum's reports have been published on the Forum's web site, and a record of the progress made in implementing recommendations from the first report is to be found in Appendix 2 to this report. The Forum has been pleased to note that many of its recommendations have resulted in, or are expected to achieve, beneficial

outcomes for the non-food sector. The Forum has also from time to time contributed to wider consultations and enquiries such as the recent Environmental Audit Committee enquiry into sustainable building, and has briefed ministers on individual policy issues such as biofuels.

As anticipated, the individual case studies revealed a number of cross-cutting themes, and the second and third annual reports contain discussions of generic issues affecting progress within the sector as a whole. These issues include waste policy, life cycle assessment (LCA), the impact of legislation and the role of the Common Agricultural Policy (CAP). The Forum has considered the potential role of bioscience in expanding and improving the range of non-food applications of crops, as well as considering the potential implications for land use.

Principal findings

The Forum is pleased to report that the potential for crop-derived products to add value to UK economic activity whilst furthering the aim of sustainable development has been found to be real, with a number of products already at an advanced stage of development, and many others being developed.

Furthermore, there are potentially very large markets for some applications of crops, such as biopackaging using starch-based polymers and biofuels from arable or lignocellulosic materials, and biolubricants and biosolvents. There are also markets for lower volume, high value products such as for extractives from plants including trees, for example as anti-microbials, speciality chemicals and pharmaceuticals.

The Forum has considered the availability of land for non-food uses and the potential impact of non-food crops on biodiversity. The Forum recognises that land use is primarily driven by international commodity markets and that at present demand for crops for non-food uses is relatively modest. However, if several larger non-food applications of crops were to move forward rapidly then land availability and biodiversity issues would increasingly be a factor in developing policy to promote various non-food uses of crops. Biodiversity can best be safeguarded by encouraging a range of feedstocks for a range of products, and whilst for many sectors the UK could derive most economic and environmental benefit from growing feedstocks domestically, for others it may prove more attractive to provide processing capacity or to capture and market associated intellectual property.

The Forum's enquiries have revealed significant potential for bioscience to add value to non-food uses of crops. This might not always be through genetic modification (GM) and the Forum has been at pains to draw a clear distinction between the science of genomics as a whole and GM as one specific means of utilising the knowledge gained from genomics. The Forum believes that the application of genomics to downstream processing of crops (whether GM or otherwise) and the production of high value, high quality products from GM crops under containment agronomy present particularly promising options, but remains aware of the need for appropriate safeguards.

The Forum has become increasingly concerned at the limited timescale for decision making regarding the use of bioscience in the UK and the associated danger of the UK science base being eroded.

The remaining challenges to developing Non-Food Uses of Crops

The Forum has found a range of barriers to the development of non-food uses of crops, which are documented in its annual reports alongside recommendations as to how they might be tackled. Many of these obstacles remain. The potential for the development of these applications is exciting, but building a new industry is a major challenge, especially in the context of the legacy of a dependence upon fossil-derived feedstocks upon which current industrial practices and government policies have been based.

The economies of scale and the efficiencies which come with generations of learning have given conventional techniques and familiar materials a cost advantage over innovative uses of natural materials, even where the whole of life value offered by crop-derived materials may be good. Furthermore, many industries are typically risk averse by nature and natural materials, whilst once the default option, are now considered relatively untested by users who have more experience of, and confidence in, petroleum-based products.

It is generally considered that life cycle assessment favours non-food uses of crops, but whereas there is a wealth of information and data sets available to construct life cycle assessment for fossil—based materials, the information on natural materials is sparse, and consequently it may be harder for policy makers and businesses to evaluate the benefits they offer. Similarly, performance criteria and environmental certification are more widely established and recognised for conventional materials, and such marques are essential if companies, government agencies and individuals are to be able to procure crop-derived products with confidence and a minimum of research and inconvenience.

Finally, the Forum has found that legislation often has a similarly conservative effect, for instance product registration often favours the licensing of familiar chemicals over the development of new applications from crops. The Forum has found that waste strategy is not always well adapted to making a radical break away from non-renewable resources towards agriculturally-derived materials, and the drive towards recycling may not fully reward the value of renewable materials, which are better suited to other means of recovery.

The way forward

The Forum has offered a variety of responses to these challenges during the course of its term. It has recommended further research and development where needed, and has played a role in increasing awareness and discussion of the possibilities offered by crop-derived materials through organising seminars and disseminating targeted studies.

It has identified specific instances where existing legislation and policy works against the development of non-food uses of crops, and has worked with policy makers in the meticulous and often difficult task of devising appropriate and responsible changes. An example is the work with the Health and Safety Executive (HSE) over registration of novel anti-microbial products from crops, which is beginning to bear fruit.

The Forum has been particularly impressed by the need for demonstration activity in this area, and its recommendations helped shape the £1.25m Supply Chain Assessment and Development Scheme, administered by the National Non-Food Crops Centre (NNFCC) and discussed further later in this report. The Forum also strongly believes that government procurement has a valuable role to play in increasing awareness of and confidence in crop-derived materials, and in providing an initial market to facilitate the development of competitive products.

Beyond the Government-Industry Forum on Non-Food Uses of Crops

The collective aim of the measures summarised above is to achieve a radical shift in policy, practice and imagination from an automatic reliance upon conventional materials towards a widespread and early consideration of the sustainable use of renewable materials from crops in those sectors to which they are most appropriate.

The Forum is confident that the structures are now in place to take this process forward. The Forum has been a supporter of the development of a National Non-Food Crops Centre to give the industry a common focus and to form the single national centre for expertise in this area. The NNFCC administers the Supply Chain Assessment and Development Programme, which the Forum considers to be vital to the development of this sector.

The Forum has also contributed to the development of the Government's *Strategy for Non-Food Crops and Uses*, and believes that with these structures in place it is appropriate for it to hand over its task of providing strategic guidance on the development of the sector to the Strategy Group of the NNFCC (see page 7).

The repositioning of non-food uses of crops at the centre of industrial practice cannot happen all at once, nor will crop-derived materials be found to be appropriate in every case, and close attention to the detail of specific sectors will remain important. However it is the Forum's belief that a breakthrough in one sector, perhaps biolubricants, biopackaging or biofuels for transport, will have a powerful effect in changing perceptions, and a clear demonstration of success in one sector may bring a wider change of practice in its train.

I wish to thank my colleagues on the Forum and the staff who have supported us so well for their creativity and commitment and for giving of their time so generously over the last three and half years. I believe that they will be

rewarded with the knowledge that they have made a significant contribution to the development of non food uses of crops in a UK context.

Rob Margetts CBE

2. Taking forward the development of non-food crops in the UK

The Forum has had considerable input into the structures and strategy now in place for the development of non-food crops in the UK.

The Strategy for Non-Food Crops and Uses

The Government's *Strategy for Sustainable Farming and Food (SFFS)*¹ of December 2002 agreed with the Policy Commission on the Future of Farming and Food on the need for a specific long-term strategy for creating and exploiting opportunities for non-food uses of crops.

In the public consultation for the resulting *Strategy for Non-Food Crops and Uses*, the Government said that "The long-term vision of this strategy is that a significant proportion of demand for energy and raw materials should be met through the commercial exploitation of science from crops grown in England, in a way which stimulates innovation and the rural economy, enhances biodiversity, reduces greenhouse gas emissions and waste, particularly biodegradable waste going to landfill, and slows depletion of finite natural resources."

The new strategy will outline a concerted approach to building the necessary links between science, agriculture and industry, to disseminate knowledge and encourage changes both in industrial practice and in society, in order that this potential is realised. The strategy builds on the work of the Forum, which was invited to comment on the draft strategy as it developed. The finalised strategy was published in November 2004.

The Supply Chain Assessment and Development Programme

The Forum has taken a keen interest in the potential for demonstration activities to support and encourage the development of commercial non-food applications of crops, and has commissioned an influential study to support its enquiries².

The work commissioned by the Forum noted that demonstrator projects have traditionally been seen as simply providing a technical demonstration of the benefits and workability of a new product or process, and argued that a new breed of demonstrator project was needed that incorporated wider elements of market introduction activity. In keeping with the Forum's emphasis on bringing new technologies to market, the report recommended that applicants should demonstrate a clear business case for their project, explicitly identifying the barriers to introduction and showing how the work programme would overcome those barriers. The report proposed that future

¹ <http://www.defra.gov.uk/farm/sustain/newstrat.htm>

² *Application of Demonstrator and Other Projects to Support The Market Introduction of Crop-Derived Products*, Miller-Klein Associates, February 2003.

demonstration programmes should be sufficiently well resourced and managed to support them in this market-focussed activity.

The Forum was encouraged that findings of the report were taken into consideration in devising the new £1.25m Defra Supply Chain Assessment and Development Programme, led by the Defra Sustainable Farming and Food Science Division and administered by the National Non-Food Crops Centre, and it remains of the view that such market-oriented activity must be a central plank of a strategy for encouraging the competitive non-food uses of crops in the UK.

The National Non-Food Crops Centre

The National Non-Food Crops Centre was launched by Lord Whitty in November 2003.

The NNFCC's purpose is to provide a single, independent and authoritative source of information on non-food uses of crops, and to disseminate scientific and technical information on these uses to meet the Government's and society's wider objectives of sustainable development. The NNFCC receives funding from Defra, which provides core funding, and from DTI, which sponsors two Technology Translators, as well as industrial sponsorship from members of its Sponsor Group. The Forum has been a strong supporter of the case for developing such a centre.

The NNFCC is now fully operational, with a staff of six drawn from industry and academia. It has quickly developed a high profile within the industry and is developing valuable relationships across the sector. Early successes have included a successful event to raise the profile of non-food uses of crops amongst Regional Development Agencies and the launch of the Supply Chain Development and Assessment Programme, and the Forum is delighted with its early progress.

Strategy Group of the National Non-Food Crops Centre

In September 2003 the Forum agreed to begin the process of a managed transfer of its responsibilities to the National Non-Food Crops Centre.

The NNFCC is in the process of establishing a Strategy Group, drawn from a range of senior industry experts and academics of different backgrounds, to enable it to assume the Forum's role of providing impartial strategic advice on the development of non-food uses of crops. This group will be independent of the commercial interests of the NNFCC's Sponsor Group and its activities will be complimentary to the day to day involvement of staff at the NNFCC in issues surrounding non-food uses of crops. The Forum believes that the NNFCC is the proper organisation to support the new group, and that its staff will have a key role in monitoring and in some cases implementing the Strategy Group's recommendations.

3. Generic Issues

Waste strategy and end of life natural products

Current practice

The Forum has noted before a potential conflict between current practice for disposing of waste and the use of natural materials. The existing waste structure is not helpful to the proper disposal of bio-based materials: in England in 2002/3, 75% of municipal waste was disposed of to landfill, 15.6% was recycled and 9% disposed of through energy from waste technologies. The figures are less certain for non-municipal waste, although a lower proportion is disposed to landfill. Where crop-derived materials are disposed to landfill there is often potential for anaerobic degradation, with resulting emissions of methane gas which contributes towards global warming and hence climate change. Measures for improving these practices have themselves been devised against the background of a heavy reliance upon non-renewable materials such as metals and plastics.

The Waste Hierarchy

Government policy on municipal waste is driven by the EU Landfill Directive 99/31/EC to reduce biodegradable municipal waste landfilled to 75% of that produced in 1995, by 2010; to 50% by 2013; and to 35% by 2020. The current paradigm often cited for the proper disposal of waste favours re-use ahead of recycling, and recycling over incineration (with or without energy recovery), an order of acceptability formalised in the Waste Hierarchy. This hierarchy may itself be problematic for renewable raw materials: the Forum has noted that many crop-derived materials cannot be economically recycled, and that recycling the carbon content of a material through incineration with energy recovery is often the best policy. Where waste regulations and practices discourage energy recovery, crop-derived materials are also disadvantaged: to take a parallel from another sector, the Forum's studies on the End-of-Life Vehicles Directive are an example of how strict adherence to such an order of preference might lead companies to consider reverting to non-renewable materials such as plastics and metals.

In effect, measures based on the best means of treating non-renewable materials can have the effect of locking industry into the use of just such materials, and discouraging a more radical move away from them to an economy based on renewable raw materials from crops.

The Forum believes that the Government should use the forthcoming review of the Waste Strategy to develop a flexible strategy which is more sensitive to the challenges and opportunities presented by different materials, including crop-derived materials. Life cycle assessment appears to show that for some sectors the benefits of renewable raw materials are real and significant if waste issues are properly managed. The Forum therefore believes that a new approach is needed, in which renewable energy policy, waste policy, and policy towards renewable materials are integrated and made mutually

complementary in order to promote economic development at minimum environmental cost.

Composting

The Forum recognises that the Government has made efforts to accommodate biodegradable materials within existing waste policy by emphasising and expanding the role of composting, which is considered a form of recycling. The Forum warmly welcomes the Government's efforts to increase composting capacity, although it is also mindful of the finite market for compost, especially in view of the potential volumes of biodegradable materials to be disposed. It is also mindful of the difficulties of separation of compostable and non-compostable material, although new technology may have a role to play here (see below).

Having considered existing LCA data the Forum sees no reason to narrow the waste treatment options available by focussing upon composting to the exclusion of energy recovery: a significant role for composting is an essential part of a new strategy for treating waste, but will not be sufficient in itself to remedy the difficulties natural materials face under the existing Waste Hierarchy.

Further issues: new technology and waste legislation

The integration of policy for waste, renewable energy, and renewable materials raises a variety of other issues, which can only be considered in outline here.

(i) New technology

The Forum is aware of a number of ongoing technical developments in the sorting and treatment of waste, which are of relevance to crop-derived materials. Mechanical sorting of waste can be calibrated to identify and remove crop-derived materials, and new methods of municipal waste treatment may alleviate some of the concerns identified above. These issues are discussed in the context of biopolymers on pages 29-30. There is some limit to the ability of central government to predict and influence the development of these new methods, as machinery manufacturers are typically large multinational organisations and excessive intervention in the methods local authorities use to meet their obligations would run counter to the increasing emphasis on regional responsibility within government. However, the Government should use its existing means of communication with local authorities and industry to ensure that the impact of new technology on the prospects for correctly handling crop-derived raw materials is fully considered when investing in and developing new plant and machinery.

(ii) The European Waste Incineration Directive

The European Waste Incineration Directive (WID) requires facilities burning waste to meet more stringent standards for emissions than plants burning fossil fuels. Provided the facilities in question burn *only* crop-derived waste from agriculture or forestry, or from the food processing industry where the heat is to be recovered, the WID does not apply to them. Products such as biolubricants which may not conform with these WID exclusions can be used

as a fuel in fossil-based generating stations, but many of these are not otherwise required to undergo the expense of becoming WID compliant, and could not justify such expense simply in order to co-fire spent biolubricants.

The requirements of the Waste Incineration Directive arise out of the sensitivity of the European public to waste incineration, which is an issue that extends beyond the remit of the Forum. It is possible that a wider move to tighten the emissions standards which fall on non-WID plant might erode the distinction between the two, with consequent benefits for spent bio-based materials. However, at present there remains (i) a need to understand and apply the existing WID exclusions correctly, and (ii) a nevertheless apparently strong case for considering further exclusions of spent crop-derived materials from the provisions of the WID. Whilst the Commission is understood to be resistant to granting further exclusions at this stage, Defra should monitor this situation for the possibility of a change of position and should actively prepare the ground for a proposal to amend the legislation at its review in 2008.

Life cycle assessment

The Forum has previously recommended that life cycle assessment be conducted for two of the products it has considered: biopackaging and biosolvents in the printing industry.

The Forum considers the value of life cycle assessment to be two-fold. Firstly, although crop-derived materials are generally more sustainable than conventional alternatives, the Forum has always acknowledged that this is not bound to be the case for every application³. It is important both for sustainable development and the credibility of this emerging industry that sound information is available to policy makers and consumers on the actual environmental contribution of crop-derived products. Secondly, LCA can diagnose points in the manufacture or subsequent handling of natural materials where their environmental performance can be modified with a view to maximising the benefits they can provide. This has been discussed further in the case study on biopolymers, a sector in which LCA has in the past underwritten significant improvements in the production of material, and still has a large role to play in guiding policy on their disposal as discussed above.

The Forum would encourage consideration of how life cycle information can be made more easily available, and how life cycle assessment can be made easier to conduct and easier to interpret and understand. The Association of Plastic Manufacturers in Europe (APME) has made available a compendious chart of life cycle data, which manufacturers can use as the basis of a life cycle assessment of products based on (fossil-derived) plastics, and this enables the plastics industry to give a statement of its environmental performance without the need to repeat expensive and time consuming primary research. The Strategy Group of the NNFCC might helpfully consider

³ See *Biodegradable Polymers and Sustainability: Insights from Life Cycle Assessment*. Richard Murphy, Imperial College London, and Ian Bartle, on behalf of the National Non-Food Crops Centre, April 2004. Available on the NNFCC web site.

the feasibility of establishing such a database for biopolymers and other renewable raw materials, or of integrating information on renewable materials into existing databases.

Secondly, life cycle assessment is often technical and involves sensitive judgments as to the original parameters of the work, and this can impede understanding of and trust in the results. Whilst there are existing international standards for full life cycle assessment, there is also a need for simpler protocols which are within the resources of smaller companies to carry out and interpret. The Forum suggests that the staff of the NNFCC have an important role in assisting the Strategy Group and wider industry in locating and interpreting the correct forms of life cycle assessment for different products and different applications.

Government procurement

The Forum has become increasingly convinced of the importance of ensuring that government procurement strategy is drafted in the awareness of the range of environmentally benign crop-derived materials. The Forum's investigations appear to identify a number of products which have potential to meet the aims of a sustainable procurement strategy. In turn, the buying power which government can provide through its own procurement should be capable of providing the market pull needed to bring a wider range of innovative crop-derived products to market.

The Forum has asked officials to ensure that developments in government procurement strategy reflect the possible contribution from non-food uses of crops wherever practically possible and where environmental benefit is properly documented. For instance the procurement section of the Strategy for Sustainable Development on the Government Estate is currently being revised and this presents an opportunity to highlight to government buyers the ways in which crop-derived materials can help meet targets for sustainable procurement.

Whilst not all products are yet available in sufficiently large and reliable quantities to be mandatory across the government estate, other materials, notably biolubricants, appear to be potential 'quick wins' and an insistence upon high environmental standards for many lubricants is becoming more common across the government estate. The Forum believes that these criteria should be developed to keep pace with improvements in products themselves, possibly through the Defra-led Market Transformation Programme.

4. Bioscience

Background

The Forum has taken a deep interest in the opportunities for bioscience to expand and enhance the range of non-food products available from crops, and in doing so to enhance UK competitiveness and further the aim of sustainable development.

An outline of some of the potential applications of bioscience to non-food uses of crops was included as an appendix to the first annual report. The Forum announced in its second annual report that it wished to further explore the contribution that the application of bioscience to non-food crops can make to UK competitiveness and sustainable development, and outlined some of the key issues that would guide its study. The Forum emphasised the distinction between bioscience as a whole and GM technology as one particular means of applying the discoveries of genomics; it expressed concern at the limited timescale for decisions effecting the competitiveness of the UK science base; and it noted the need to explore the risks and benefits of novel non-food crops which use GM technology.

The Forum study and the IOIR report

In order to assist it in exploring the contribution that bioscience could make to the development of crop-derived products and processes and to assess the opportunities in the UK, the Forum commissioned a major study from the Institute of Innovation Research (IOIR) at the University of Manchester entitled *Prospecting Bioscience for the Future of Non-Food Crops*. The full study, including a number of wide-ranging recommendations, was made available on the Forum website. In reviewing the study, the Forum particularly noted:

- The limited timescale for decision making regarding the use of bioscience in the UK
- The emergence of a major UK opportunity for high value, low volume non-food crops under containment agronomies
- The importance of applications of bioscience in downstream processing and bio-refining.

There is only a limited time-frame for the UK to gain competitive advantage
The IOIR confirmed the Forum's belief that the UK is beginning to lose competitiveness in agricultural bioscience. Whilst the UK science base is widely respected, the report describes the UK as being already in a 'catch-up' situation in comparison to the US and elsewhere in commercialising the technology. There is an increasing danger that the science-base essential to underpin a knowledge-based economy of the future is being eroded as a result.

Early action to continue to develop bioscience is particularly important in non-food applications of crops, as long lead times are required to restructure supply chains and industries. A clear example of this is the potential for crop-derived products to replace fossil fuel feedstocks for industry. Entirely new supply chains and processing technologies must be established before any benefits can be fully realised, and the research and development taking place now provides the foundation for applications that will not reach the market for some 10-20 years.

A major opportunity for the UK: high value, low volume non-food crops in closed containment

The report highlights a major opportunity for the UK to lead in the production of high value-added products from crops (both GM and non-GM) grown in protected environments. The UK already has considerable strength in the highly efficient cultivation of crops under glass, giving rise to higher yields and better quality products. This presents an opportunity for the contained cultivation of new GM crops designed for the production of high value products such as those for the pharmaceutical and health-care sectors.

The Forum considers that this strategy will help address issues of public concern over open-field GM applications, whilst playing to the UK's strengths in further developing an already established agronomic practice. However, it should be noted that for GM varieties which do not have release consents more stringent levels of containment are required than those offered by conventional greenhouses, and the Forum has noted that the expense of obtaining a consent, including considerable evidence gathering, might be an obstacle for some smaller companies.

The applications of bioscience to downstream processing and biorefining

Plants produce a variety of metabolites with potential industrial uses. However, processing is necessary once a crop has been harvested, in order to extract the wide variety of metabolites with potential industrial uses and provide them in a commercially useful form. The Forum is impressed by the contribution bioscience can make to downstream processing, and increased knowledge of biological materials will inform new, efficient processing technologies. It is also apparent that biocatalysis has major potential, and clean technologies have become available through the use of enzymes. A good example is the post-harvest processing of biomass by enzyme hydrolysis to yield bioethanol.

White (industrial) and green (plant) biotechnology will form major technology platforms under the Framework 7 programme. The Forum believes that these technologies can be integrated in a useful way so that new enzyme technologies could be used for complex processing of crop products as an alternative to putting new genes into plants.

Forward view

The Forum remains confident that bioscience research can continue to improve our understanding of how non-food uses of crops can contribute to

sustainable development and developing a UK skills-based economy, and recommends that the Strategy Group of the National Non-Food Crops Centre maintains a strategic interest in the opportunities discussed above.

5. Review of Forum Case Studies

Use of crops within the construction industry

Background

The Forum's first two annual reports

In its first annual report, the Forum initiated a study on secondary uses of wheat. Of the uses considered, the potential uses of crop-derived materials within the UK construction industry, including wheat by-products, appeared the most exciting, and this was pursued in the second annual report.

The Forum noted that a wide range of materials, including natural fibre insulation products, wall and floor coverings, geotextiles, composite board materials, straw bales and other products all represented opportunities for UK producers. However, in the main the UK industry has failed to exploit these opportunities. The Forum considered that government procurement was likely to be a key tool in securing change within the conservative construction industry, and looked ahead to the work being commissioned from the Construction Industry Research and Information Association (CIRIA) and the Building Research Establishment (BRE) to identify barriers to wider use and to address issues of confidence and information within the industry. Since then, the Sustainable Buildings Task Group (SBTG) has also reported to Government on a wider strategy to improve the environmental performance of the construction industry.

CIRIA, BRE and the Sustainable Buildings Task Group report

The Forum is pleased that a number of helpful studies have followed from their early investigations. The Forum has served on the steering group and assisted in the development of the CIRIA *Crops in Construction Handbook*, which received funding from both Defra and the DTI. The purpose of the handbook is to encourage the use of crop-based construction materials by explaining the benefits of crop-derived materials and providing case studies of the successful use of such materials. The heart of the report is a survey of the crop-derived materials which are currently, or are soon to be, available to architects and builders in the UK. The Forum firmly supports the CIRIA handbook and hopes to see it widely deployed in order to address the issues of information and confidence explored further below.

The Forum has also encouraged and supported the review of obstacles to the development of non-food crops commissioned from BRE by the National Non-Food Crops Centre. This work was conducted as a direct result of Forum recommendations, along with fire safety tests on straw bales and an assessment of the prospects for eco-profiling for crop-derived materials. The report concluded that the potential for crop-derived materials in construction was large, and identified unfamiliarity as the basis of most obstacles, including the cost of providing sufficient technical data, difficulties in demonstrating performance to the satisfaction of building control officers, and a lack of skilled labour.

The Sustainable Buildings Task Group reported to the Government in May 2004 on options for improving the environmental performance of the sector. Disappointingly, the report contained no specific discussion of crop-derived materials other than timber, and this may serve to illustrate the apparent lack of information and awareness of the opportunities presented by crop-derived materials and the challenge which remains in moving this issue to the forefront of the sustainable construction agenda. Nevertheless, the Group made a number of very worthwhile recommendations, including recommendations on the role of planning and building regulations in sustainable construction, and importantly the development of a Code for Sustainable Buildings, and these might be expanded to include consideration of the contribution of natural materials.

The Forum's comments and recommendations below draw on the activities of all of these groups.

Findings of the Forum study

The wider use of crop-derived construction materials: benefits and barriers
As with virtually all the other areas looked at by the Forum there is significant potential for crop-derived materials within the construction industry. These renewable raw materials offer significant economic and environmental advantages, principally:

- Superior technical performance to current mainstream solutions – especially for insulation
- Lower energy costs for construction and lower embedded energy
- Lower life-time energy costs
- Delayed carbon release during the lifetime of the building
- Better waste management profile - the construction industry currently generates around 100 million tonnes of waste per annum in the UK with 20-25 million tonnes going to landfill

Inhibiting factors limiting the development of crop-based materials include issues familiar from other Forum studies: a lack of awareness within the industry, lack of confidence in the technical performance of the materials and their availability, and cost concerns. In addition there are shortages of the skilled labour needed to handle some natural materials, and difficulties in getting planning permission and building regulations clearance are also often cited as a burden.

Lack of awareness in the construction industry and the lack of robust performance data

There is a lack of awareness and information concerning various aspects of the potential application of crop-derived materials in construction. In the first instance, crop-derived materials are typically not evaluated when alternative construction materials are being considered, and there is a need to place

crop-derived materials alongside other novel and alternative materials in the mind of the industry.

Secondly, where an architect, builder or planner *does* consider crop-derived materials, there is typically a lack of robust performance and fitness-for-purpose data to support their use. This is an especially significant issue given the conservative nature of the construction industry, its many players, and the significant financial risks and extended life spans involved in construction projects. In some cases information on longevity and durability is not available because the crop is relatively new, in others evidence is plentiful in other countries, but has not been available to UK builders and planning officials from a source they know to be authoritative. There is a need to build confidence and demonstrate viability to potential users.

Thirdly, unfamiliar crop—derived materials suffer from a lack of information on the best way to use them and there is a shortage of the skills needed to exploit them. There is also a need to provide greater quantitative data on the environmental impact of crop-derived construction materials throughout the lifecycle.

To address these problems, and building on the CIRIA project, there should be a concerted effort to provide information on the materials available and their performance to builders and architects throughout the industry, as well as planners, insurers and other participants. This initiative should be led by a body fully embedded in the industry and in liaison with the NNFCC. Government might also provide assistance by gathering together innovative sections of the industry to form a major presence at high-profile industry trade fairs, such as *Interbuild 2006*.

The Forum also recommends that NNFCC should be invited to commission work from the construction industry to review existing knowledge from research programmes in other countries and to augment the information collated under the CIRIA report. This task should include work to identify and adapt for UK consumption knowledge that is applicable to UK conditions and practice, and to identify those gaps where new research is needed. The NNFCC should then be asked to research commission further work to fill gaps in both performance specification and life cycle assessment for key products.

Planning policy, building regulations a code for sustainable buildings

(i) Building regulations

The Sustainable and Secure Buildings Act received Royal Assent on 16 September 2004 amending the Building Act 1984, to allow regulations to be made in the future with the objective of promoting sustainability. The Forum believes that such an act is timely and welcome, and that it is important that the permissive powers it contains are taken up and used sensitively.

In view of this the Forum notes the SBTG's recommendation that future regulations require buildings to include 10% recycled, reused or reclaimed materials. The Forum welcomes the suggestion of specific measures to improve the environmental performance of buildings, but the Forum believes

that there is potential for this particular proposal to force the industry to address sustainability considerations by one particular method, to the disadvantage other ways of achieving the same end, such as renewable raw materials. The Forum has noted examples of this in other sectors, such as in the case study on fibres in the automotive industry. The Forum would therefore suggest that the Government should adopt a method-neutral approach instead.

The Forum recommends that Government should put in place a requirement to reduce the life cycle energy requirements of construction, using the building regulations as and where appropriate but also using wider measures as required. Such an approach might involve setting a series of targets for reducing embodied carbon across the construction industry, accompanied by information as to how this might be achieved including use of crop-derived materials. The approach should not be prescriptive to the level of specifying which of these methods and materials the industry must adopt to meet its targets. The Government's approach might also include a trading scheme for embodied carbon in building materials, working in concert with scaled targets, to reward companies which 'overperform' and so enable greater progress across the sector as a whole.

(ii) Planning

The Forum welcomes the new duty in the Planning and Compulsory Purchase Act 2004 for Local Authorities to pursue their plan making functions with the objective of contributing to sustainable development.

The Forum re-iterates the need for Local Authorities and planners to be aware of the contribution crop-derived materials can make to sustainable development. This might be achieved by incorporation of the information on crop-derived products into best practice guidelines to accompany PPS (1), in concert with the measures suggested in recommendation no. 31 below.

(iii) Code for Sustainable Buildings

The Forum is encouraged by the Government's positive response to the recommendation of the SBTG that a Code for Sustainable Buildings be developed, to set out a code of best practice which goes further than regulatory requirements. The Forum was pleased that the Government committed itself to ensuring that the Code considered materials across their life cycle, and considers it essential that the Code sets out the ways in which crop-derived materials can benefit the life cycle performance of buildings.

The choice of UK grown materials supporting the construction industry.

The UK imports the majority of its wood and wood products, importing 18.1 million cubic metres of roundwood and sawntimber (excluding paper). This compares with a total UK wood production, for all purposes, of 7.6 million m³. With this level of imports opportunities are apparently being missed, as some forests within the UK have little to no market for their forestry products.

Consideration should be given to alternative processing methods to enable current UK timber to be more widely used. In addition, and although

modifying the trees species harvested in the UK will take considerable time, the Forestry Commission should consider whether more appropriate species compatible with the UK climate would better meet the needs of the construction market.

The role of government procurement in the construction sector

The Government is a major initiator of construction projects and it is appropriate for the Government to require a certain level of environmental performance in commissioned building: buildings which do not take account of their environmental impact, even where their initial cost is low, cannot be considered as providing the Government with value for money given its strategic commitment to sustainable development.

As in other sectors, government procurement also has the potential to focus research and development onto more sustainable materials, and to increase awareness of such materials, so changing the industry standard in the private sector as well as the public sector.

Forward view

The Forum's primary concern is that the UK positions crop-derived construction materials at the centre of the debate over how construction must evolve, and the above recommendations aim to outline ways in which this might be achieved.

The Forum's studies have noted that there is considerable conservatism within the construction industry, but practices may be forced to change significantly over coming years as the industry faces a number of pressures including the need for a significant increase in housing stock, the challenges of building and adapting houses to *manage the effects* of climate change, and mounting pressure to improve the industry's environmental impact. Building design may change to incorporate design features such as insulation to ensure constant temperature without energy-demanding air conditioning, and the industry may need to move towards new techniques such as system-build. It is critical that the ability of crop-derived materials to facilitate a benign and much needed change in practice are not overlooked, and the Forum believes that the Government and the NNFC have a major role to play in ensuring that these opportunities are not overlooked.

Recommendations⁴

Forum recommendation no. 31

Building on the CIRIA project there should be a concerted effort to provide information on the materials available and their performance to builders and architects and other participants throughout the industry. This initiative should be led by a body fully embedded in the industry and in liaison with the NNFC. Particular effort should be made to raise awareness amongst

⁴ The Forum's practice is to maintain a continuous numbering of recommendations through successive annual reports, to avoid confusion with previous recommendations.

planners and local authorities, which might be achieved by incorporation of the information on crop-derived products into best practice guidelines to accompany PPS (1), in concert with the measures suggested above.

Forum recommendation no. 32

The NNFCC should be invited to commission work from the construction industry to review existing knowledge from research programmes in other countries, to augment the information collated under the CIRIA report. This task should include work to identify and adapt for UK consumption knowledge that is applicable to UK conditions and practice, and to identify those gaps where new research is needed.

The NNFCC should then be asked to research commission further work to fill gaps in both performance specification and life cycle assessment for key products.

Forum recommendation no. 33

The Government should put in place a requirement to reduce the life-cycle energy requirements of construction, using the Building Regulations as and where appropriate but using wider measures if required.

Forum recommendation no. 34

Consideration should be given to alternative processing methods to enable current UK timber to be more widely used. In addition the Forestry Commission should consider whether more appropriate species compatible with the UK climate would better meet the needs of the construction market.

Forum recommendation no. 35

The development of procurement strategy across the Government estate must consider the environmental impact of materials on a whole-life basis, and should outline the contribution which crop-derived materials can make.

Extractives from forestry materials

Background

In its first annual report the Forum signalled its intention to work with the Forestry Commission to investigate the potential to add value to trees.

Interest in new markets for wood and forestry products has increased over recent years against a background of falling timber prices and reduced profitability within the forestry industry. There has been considerable interest in developing existing uses such as biomass heat and power from forestry material and using wood in biocomposites. There has been less progress in identifying new products from trees, including extracting chemical products from low grade timber and foliage which is not suitable for existing markets such as construction. To this end the Forum and the Forestry Commission jointly commissioned a major study from the Central Science Laboratory (CSL) to review the potential chemical products available from forestry materials, together with a survey of extraction techniques and markets.

The findings of the Forum study and the CSL database

The key output of this project is a very extensive database of UK tree species and their chemical composition, available on the CSL web site along with the full report. The report also identified broad potential markets for classes of products from trees, such as adhesives, flavours and fragrances and detergents. Finally, the report surveyed extraction techniques, and found that limited effectiveness together with the environmental and health hazards involved in existing extraction methods such as steam hydrolysis and the use of organic solvents were key obstacles to progress in this sector.

The report was reviewed at the Forum's 10th meeting, and at a specially convened workshop on Friday 4 June 2004 at Heriot-Watt University, Edinburgh, in partnership with the Forestry Commission, CSL and the Forestry Industries Cluster. Both meetings identified a number of obstacles to the progress of an extractives industry, and suggested some ways forward.

Communication across the supply chain

It was widely commented that, in keeping with many non-food uses of crops, the extractive industry suffered from a lack of communication across the supply chain. The chemicals and pharmaceuticals industries have a generally low awareness of the potential from forestry products, compounded by a reluctance to divulge information about prospective commercial developments. There is a corresponding need for the forestry industry to be more proactive in seeking out manufacturing industry's needs and exploring means of meeting them.

It was commented that the CSL study and the searchable website derived from it were useful bridges between the sectors, providing a compendious catalogue of potential products from trees in an easily comprehensible form.

The seminar was also an excellent means of bringing the sectors together and a follow up meeting is planned. Finally, the National Non-Food Crops Centre was represented at the meeting, and is well placed to assist communication across the supply chain as part of its core role.

Registration

The difficulties of registering new chemical products emerged as a major inhibitory factor in this sector, as it has for high value chemicals from botanicals. The full process of registering a new chemical product is lengthy and costly. It is very much more cost effective to focus on registered products currently derived from other sources which could be marketed as coming from renewable and natural materials when extracted from trees. Issues surrounding the registration of chemical products are discussed further on pages 49-50.

The economics and logistics of extraction: alternative options

It is apparent that different approaches are needed to different sectors within the extractives markets: policies and business approaches which are suitable to low volume, high value chemicals are significantly different to those required by high volume but relatively low value markets.

i) High volume, low value

For large-scale processing in which the economics of extraction and transport are critical, the future economic viability of many low value products such as cellulose may rest upon locating plants which derive chemical extractives along side large-scale processing facilities producing timber, bark, and woodchip.

ii) High value, low volume

For high value chemicals, where the quality of extractives is paramount, the additional cost of more advanced extraction techniques is likely to be justified. Conventional chemical extraction and steam-based hydrolysis has been found to be relatively non-selective, may damage labile tree metabolites, and can be environmentally damaging or dangerous to operators. New methods such as supercritical fluid extraction (SFE), although more costly, have proven more satisfactory. SFE, which uses carbon dioxide as an extraction solvent, is already used in the decaffeination of coffee amongst other applications. It is significantly more selective than conventional techniques and by varying temperature and pressure the density of the fluid can be controlled in order to extract specific chemicals.

Where low volumes of material are to be processed there is some interest in the possibility of developing mobile processing units. High value chemicals, which can be extracted on site, can then be sold on, thus retaining the added value within the forestry industry, rather than selling a bulk commodity and the value being captured outside the forested areas.

Forward view

There remains some distance to go to add value to forestry by exploiting new products from trees. The key issues identified in the extractives workshops were:

Increasing knowledge and identifying markets with the greatest potential

There is a pressing need to focus attention from the wide variety of species and metabolites documented in the CSL study to a limited number of species that are best able to add value to UK industry, and to identify those products available within this reduced list which offer the best market opportunities.

The Forum considers that Sitka Spruce is a prime candidate for further study, as it is common in the UK but relatively uncommon in global terms. It is currently poorly documented and greater understanding of the practicalities of extracting valuable products from it would be particularly helpful in strengthening UK competitiveness.

The workshop also identified a need to better understand the volumes of extractives within different species and the grouping of extractives within species, as well as a need to further understand the effect of different means of storage on the volume of chemicals extracted, in order to identify commercially viable products. The Forestry Commission Research Agency plans to relate wood properties to site factors offering a potential opportunity to incorporate a study of extractive volumes and groupings into this process. The Forestry Commission will consider the best way to take this forward.

Finally, Quantitative Structure Activity Relationship techniques can use computer modelling to give an early indication of the likely practical uses compounds might be put to, and is to be encouraged as a means of advancing wider understanding of the potential available within UK forestry stocks.

Demonstration and dissemination of information

There is a continuing need to raise awareness across the forestry and the chemicals industries of the possible products available from forestry and of new ways of working to extract maximum value from forestry products.

Demonstration activity remains an important means of illustrating these possibilities, and demonstration activity on supercritical extraction is particularly recommended.

Building bridges and connecting the supply chain.

All the parties involved in organising the extractives seminar remain committed to taking this work forward. However, a clear direction for the industry will not emerge until the issues of secrecy and poor communication across the supply chain have been addressed, and a clear path forward based on the needs of manufacturing industry can be devised.

The Forum recommends that a second seminar is convened to take forward the issues raised in June, and to capitalise on the co-operation and interest which it generated. The Forum also considers this an area which the Strategy Group of the NNFCC should keep under surveillance.

Recommendations

Forum recommendation no. 36

The Forestry Commission should consider how best to take forward a study of extractive volumes and groupings and their susceptibility to handling and storage.

Forum recommendation no. 37

Demonstration activity on supercritical extraction should be eligible for demonstration scheme calls, and interest should be solicited from the forestry and extractives industries.

Forum recommendation no. 38

A second seminar should be convened to take forward the issues raised in June, and to capitalise on the co-operation and interest which it generated. The seminar should consider the output from recommendation no. 36 above if available.

Essential oils

Background

In 2001-2 the Government Industry Forum on Non-Food Uses of Crops examined the case for expanding the production of essential oils that are suitable for the UK climate and it concluded that there is an opportunity to develop a sustainable industry that can compete on a global basis, as well as supporting a number of specialised applications. Since the last report in 2002 the area of essential oil crops in the UK has not changed significantly, however the market has become more competitive partly as a result of the enlargement of the EU and partly as a result of greater global diversification into these crops.

Findings of the Forum study

The Forum originally made three recommendations to address the fundamental barriers identified in the economic study, proposing both industry and government initiatives.

A British Essential Oils Producers Association

The Forum recommended the formation of integrated producer/processor organisations to facilitate a significant increase in planting areas, together with the formation of a British essential oils producers association.

Following consultation with the UK producers, the British Herb Trade Association and the British Essential Oils Association, no common ground emerged and producers remain organised into small co-operatives or single producers. The proposed UK conference was never held due to a lack of support amongst producers and end users of essential oils, and it would appear that producers, traders and end users are content to defend their own niche markets and are reluctant to share information in an effort to expand and support the greater UK market.

Research and development

The Forum noted a need for research into breeding optimised varieties and improving agronomy and processing. The development of a research and development centre of excellence jointly funded by government and industry was recommended to facilitate this.

In its reply to the Forum's recommendations the Government noted that plant breeding is not usually within the Defra remit, and such work is currently only being carried out by one commercial essential oils producer in an attempt to produce higher yielding varieties suitable for UK climatic conditions. The establishment of the NNFCC will enable the evaluation and dissemination of more fundamental research aimed at improving essential oil yield and quality, and communication between BBSRC, Defra and the NNFCC will be essential to ensure that research is well directed and well used.

Branding and diversification

The Forum recommended that producers should develop associated income from other activities such as tourism, preferably with an educational aspect, and should establish a UK brand with associated traceability and quality standards, and perhaps aligned to organic standards.

With the help of rural development and diversification schemes this has been successfully applied to a number of essential oils producers. They have established profitable businesses based on a combination of tourist income, the development of retail products based on their own essential oils and marketing the balance of their essential oil production through a co-operative.

The establishment of a UK brand has not been possible through lack of co-operation between UK producers and the production of organic oils has not been seen as a profitable route to increase production area.

Forward view

The Forum recommends that the NNFCC Strategy Group keeps a watching brief on this area, and monitors potential new opportunities.

Biopolymers and packaging

Background

The potential for crops and their derivatives to form polymers has been a central study for the Forum since its inception, with particular attention to the potential for bio-based polymers in the packaging industry.

Many packaging materials currently in use are based on non-renewable materials developed as synthetic petroleum derived polymers. These are highly developed, sophisticated materials. However the need to preserve precious non-renewable materials has now been recognised and major efforts continue to be made worldwide to identify agricultural crop products that could be used as the base materials for the synthesis of polymers to be used in the production of packaging materials.

The bioplastics currently on the market are mainly derived from starch and in Europe include Novamont producing the Mater-Bi range and National Starch and Chemical producing a range of products through a number of licensees. In the USA Dow-Cargill employ polylactic acid obtained from maize starch under the *Nature Works* banner. Other companies in the field include Earthshell, Potatopak and Avebe.

The market for bio-based, compostable packaging, whilst still relatively small, has expanded during the period of the Forum's studies. The International BioPolymers Association (IBAW) estimates that the total use of bioplastics across the EU increased from around 20,000 tonnes in 2001 to between 35,000 and 40,000 tonnes in 2003. However, the bio-polymer industry clearly has not yet achieved the substantial breakthrough it seeks, and has made a relatively modest impact upon the 40 million tonnes EU 15 packaging market.

Findings of the Forum study

The Forum's initial investigations noted significant challenges to the development of a sizeable biopackaging industry in the UK. These issues remain broadly the same, but there have still been significant developments to consider when reviewing the current position of biopolymers. The Forum's concerns have fallen into three broad categories: (i) the technical and commercial developments required to facilitate domestic production and processing of biopolymers to ensure that value remains within the UK; (ii) the need for adequate life cycle assessment to make the case for biopolymers and to diagnose where improvements in the manufacture and use of such materials can be made; (iii) issues surrounding the effective separation and proper disposal of biopolymers at end of life.

(i) Domestic production of biopolymers: technical and commercial considerations.

Although there is an increasing amount of biopackaging available within the UK, only a small proportion of this is met from UK production from domestic

crops. In 2004 the Forum asked the National Non-Food Crops Centre to commission a review of the industrial markets for starch with a view to increasing understanding of the UK's capacity to meet them⁵.

At present, the technologies used in the biopolymers industry do not play to the UK's agronomic strengths. The first industrial processes using starch were based upon maize starch, and although newer plant for conventional industrial processes other than packaging is usually based upon wheat much existing UK plant continues to use imported maize as a feedstock. The only commercial source of PLA is from the Cargill Dow plant in the USA and is based upon maize starch. In addition, the physiochemical properties of potato starch make it a superior starch for many packaging applications, and the UK, whilst being a significant potato producer, has little historical production of high yielding starch potatoes. As a result it has had no quota or production refunds for the production of starch potato under the CAP, impeding the development of a new industry.

The starch review commissioned for the Forum gives some grounds for optimism on both fronts. Wheat starch can be interchanged for maize starch in the production of biopolymers. The cost competitiveness of wheat ensures that the production of starch from wheat is cheaper than from maize, despite maize's higher technical yield. Furthermore although the market for the major co-product of wheat starch production, gluten, is limited, it is still more valuable than for the co-products from maize, further strengthening the price advantage of wheat starch over maize starch. As a result, wheat starch is now the preferred feedstock for new UK starch processing plant. Whilst this advantage is based upon economics and not the technical potential of the starch, and so may not be permanent, the review suggests that the conversion of maize-based starch processing plant in the UK might now be financially worthwhile.

The review also tentatively suggests that a potato starch processing plant in the UK may be viable, despite UK production of starch potatoes being disadvantaged under the CAP. The potato starch regime was not radically changed in the 2003 reform of the CAP, however the partial decoupling of payments to starch potato growers suggests a move towards a more market-oriented arrangement in which movement in and out of the sector is significantly easier. Furthermore the review suggests that the profitability of potato starch production is such that German starch potato growers are prepared to pass on much of the crop-specific payment in the form of payment for 'delivery rights', and that investment in potato starch processing is continuing in Europe on the basis of the profitability of the sector and with little concern for the uncertain long-term future of the current regime. The report notes that the UK market for potato starch is sufficient to utilise the entire output of a specific potato starch processing plant, and that 10,000-18,000 tonnes of potato arisings are available from the food processing industry to counterbalance the cost of dedicated starch potatoes. The review

⁵ *Industrial Markets for Starch*, Radek Messias de Bragança and Paul Fowler, The BioComposites Centre, University of Wales, Bangor, June 2004.

therefore cautiously suggests that a dedicated UK potato starch processing plant may be economically feasible.

(ii) Life cycle assessment

The Forum's first report suggested that life cycle assessment was needed to evaluate and compare the environmental performance of various forms of biopolymer. A review of the existing literature has since been undertaken by Dr Richard Murphy at Imperial College and disseminated at an NNFCC event in London⁶. Further work will now be undertaken by the Environment Agency, comparing the environmental performance of packaging and bags made from biobased polymers with that of conventional plastics, and fossil-based so-called oxodegradable plastics.

The Imperial College review confirmed that bio-based, biodegradable polymers usually show advantages over petrochemical based polymers in several impact categories, typically including fossil energy consumption and global warming potential, on account of low energy inputs in manufacture, agriculture- or forestry-based carbon content, and end-of-life value through composting or energy recovery. However the study suggested that the life cycle benefits of biodegradable polymers were very sensitive to the range of disposal options at end of life. The review also recommended that further research and development was needed to fill in gaps in the existing data for LCA on biodegradable polymers with a view to producing an appropriate LCA database on bio-polymers comparable with the Association of Plastics Manufacturers in Europe (APME) database for petrochemical-based plastics.

(iii) Identification and disposal of biopolymers

The life cycle assessment discussed above confirms that, in general, biopolymers have an impressive life cycle benefit when they are incinerated or properly composted, but that there is a risk of anaerobic degradation and the production of climate changing methane emissions when they are disposed to landfill.

To ensure that biopolymers are properly treated it is firstly essential that such materials are identified prior to final disposal and separated from other materials in the waste stream. The Forum recommended in its first report that a system was devised to ensure the easy identification of compostable packaging such as supermarket bags, perhaps involving colour identification or a logo, and with provision for mechanical separation in addition to separation at source by the householder. Such a logo has now been developed by the German accreditation company Din Certco, and use of the logo in the UK is overseen by the Composting Association. However, market research commissioned by the Forum⁷ suggests that consumers' awareness of and attitudes towards the responsible handling of waste are not yet at a

⁶ *Biodegradable Polymers and Sustainability: Insights from Life Cycle Assessment*. Richard Murphy, Imperial College London, and Ian Bartle, on behalf of the National Non-Food Crops Centre, April 2004.

⁷ Identifying non-food products that are practical for supermarkets, and understanding how to stimulate consumer/retailer demand for those products, Warwick Manufacturing Group, March 2004.

point where source separation by householders can be considered a sufficiently reliable method on its own, and the Kassel project, whilst encouraging, confirms that so-called misthrows remain an issue even in the presence of a concerted education campaign⁸.

Some form of mechanical separation or treatment therefore seems likely to remain necessary in addition to segregation by the user. Near infra-red technology (NIR), of the sort already used by many waste companies to segregate different forms of recyclable plastics, appears a promising option. A leading manufacturer of NIR machinery has tested the technology on PLA, and found that the material was easily identifiable, and indeed that the properties of the material made it easier to separate than various forms of recyclable fossil plastic. There appears to be potential to recalibrate existing NIR separation equipment to identify PLA and other forms of biopolymer, and in many systems this can be done remotely by modem. The Forum recommends that the NNFCC collate available information of demonstration work done to date, supplementing this with a UK demonstration project if necessary.

Forward view

The Forum remains confident that proper labelling, education, and mechanical identification and separation, along with other measures such as the co-operation of supermarkets, can ensure that biopolymers are correctly identified and managed in the waste stream. However, identification and separation are only one element of ensuring proper disposal, and appropriate methods of treatment must be in place with sufficient capacity to accept such materials once collected.

Life cycle assessment suggests that incineration with energy recovery and composting remain the most suitable existing practices for management of used biopolymers. The Forum is also aware that other options are being developed to deal with biodegradable waste, such as Mechanical Biological Treatment, which partially composts and dries biodegradable waste, enabling separation and diversion of the biodegradable fraction to energy recovery, as well as Anaerobic Digestion and increased home and municipal composting. Given the reliance of biopolymers on available means of disposal, the development of waste policy and infrastructure is of the first importance to the possibility of developing a more sustainable packaging industry using natural materials, and the Forum recommends that policy on biopolymers, waste and renewable energy are increasingly co-ordinated. These issues were discussed above on pages 8-10.

Further development of the materials themselves should not be overlooked, and there is the potential for the development of a new generation of materials with unique barrier properties from wheat. There is also potential for the UK

⁸ http://www.modellprojekt-kassel.de/eng/seiten/news_frameset.html. Recovery and proper disposal of used packaging may be more practical in some commercial settings where the material remains under the company's control, and this may provide some early opportunities.

to lead in the conversion of lignocellulosic material to lactic acid, as a precursor to PLA production, which may enhance the potential for later development of a PLA facility in the UK.

Recommendation

Forum recommendation no. 39

The NNFCC should be asked to collate and publicise available information of demonstration work on mechanical separation of crop-derived packaging done to date, supplementing this with a UK demonstration project if necessary.

Appendix: other uses of starch

The starch review commissioned by the Forum also considered other potential industrial markets for UK starch aside from biopolymers. The report noted that there was a particularly low industrial use of starch in the UK, where 88% of starch is used for food, in contrast to the EU15 where 55% is used for food and the remainder for industrial uses. Potentially viable markets for starch derivatives include use as a water co-flocculant, conversion into a bio-alcohol derived octane booster in road fuels, and as an oil drilling fluid.

The report also found that the UK was importing large quantities of chemicals which could be manufactured from domestic starch. Given the cost competitiveness of UK wheat starch and the high level of chemical processing knowledge available locally it is suggested that there is potential for developing technology to manufacture intermediates for the pharmaceutical industry such as β -lactams and statins which could be further processed by local companies to manufacture a range of high-value products. There is also potential to develop the ability to locally manufacture amino acids, vitamins and colourants that are currently imported into the UK, and to develop a technological platform that can use small molecules derived from starch fermentation, such as lactic acid, as building blocks for organic chemistry.

Recommendation

Forum recommendation no. 40

The Forum recommends that the NNFCC consider the wide variety of products highlighted above, with a view to prioritising them according to the value of the potential markets, and exploring the measures needed to encourage their further development.

Natural fibres in the automotive industry and the End of Life Vehicle Directive

Background

Natural fibres are currently employed in compression moulded thermoset plastic materials used for vehicle interior parts such as door liners, parcel shelves and sound deadening materials, sometimes in place of glass fibres. The use of natural fibres in place of existing materials has a number of environmental advantages: natural fibre composite materials are typically significantly lighter than conventional alternatives, thus reducing fuel consumption across the life of the vehicle, and are also a renewable resource with the potential to recycle carbon and displace fossil fuels if incinerated with energy recovery at end of life. Natural fibre composites also typically require lower energy during manufacturing.

The market pull for such materials has until recently been increasing rapidly, and the Forum has examined the ways in which supply chain, and especially legislative issues, may help or hinder the development of this sector.

Findings of the Forum study

The aims and measures of the Directive

The Forum has expressed concern that the use of natural fibres is discouraged by the End-of-Life Vehicles Directive (ELV). The aim of the ELV is the prevention of waste from vehicles and improvement in the environmental performance of all the economic operators involved in the life cycle of vehicles.⁹ To this end the Directive gives member states binding targets for the proportion of vehicles, or components of vehicles, which can be recycled, re-used, recovered and disposed of to landfill at end of life, and in keeping with the Waste Hierarchy the legislation strongly favours recycling and re-use over incineration with energy recovery and disposal to landfill.

In its consultation on the transposition of the Directive into UK law, the UK Government proposed that responsibility for ensuring proper disposal of vehicles should lie with manufacturers, thus encouraging them to design vehicles which suit the prescribed disposal options at end of life.

The ELV and natural fibres

The ELV is not drafted with natural fibres in mind, and does not consider the disposal and recovery methods which best suit different materials. The heavy emphasis on recycling over incineration with energy recovery in the ELV disadvantages crop-derived raw materials, for which recycling is not a practicable option. For this reason, natural fibres are reportedly losing ground to recyclable products from non-renewable sources such as metal and plastic, and future growth of this sector is inhibited.

⁹ Directive 2000/53/EC Article 1: Objectives

The ELV also appears to some degree to penalise the weight advantages of natural fibres: materials such as metals, which are recyclable and heavy, are well placed to help manufacturers to meet their ELV requirements, which are for a certain percentage of the vehicle *by weight* to be recycled. Even where a lighter component satisfies the requirement to be recyclable it will make up a lower proportion of the vehicle by weight and so, ironically, do *less* to satisfy the overall requirement to make a percentage of the vehicle by weight recyclable.

The ELV therefore effectively undervalues the advantages of renewable raw materials, does nothing positive to encourage their use, and therefore inhibits one means of achieving the very environmental aims it was designed to promote.

Forward view

Legislation

The issues surrounding the ELV remain to be resolved, and the Forum acknowledges that the UK does not have a free hand in transposing the Directive into UK law. However, the Forum reiterates its recommendation that the potential difficulties of the legislation are communicated to the Commission and that the Directive is revised at the earliest opportunity. The Forum also believes that further measures aimed at the start of a vehicle's life have the potential to replicate the problems of the ELV. The Directive proposed by the Commission in comm. (2004) 162 final seeks to amend rules on vehicle type-approval to ensure that vehicles are manufactured so as to be recyclable or re-usable to a specified degree. Again natural materials which deliver environmental benefits when incinerated with energy recovery appear to be disadvantaged, and the Forum has asked the DTI to be aware of these potential difficulties when negotiating the terms of the Directive.

Strengthening the supply chain

The Forum has also examined issues regarding the supply chain for natural fibre vehicle components, which should be strengthened in concert with legislative change.

The Forum is pleased that the Government has accepted its recommendations for further research into flax and hemp varieties and into alternative methods of retting, as well as commissioning demonstration work on non-retting varieties of hemp. Research is also taking place in the UK to develop crop-derived resins, which may allow for the manufacture of 100% plant-based composite materials, and obviate the need for use of thermoset plastic. This might allow for the possibility of composting parts at end-of-life¹⁰, or increase the calorific value attributable to natural materials if composite panels are sent for incineration.

The motor industry is also considering the significant challenges of mechanically recovering and sorting material from end-of-life vehicles,

¹⁰ Which should in turn enable such materials to count within the recycling allowance of an end-of-life vehicle: the Forum has asked the DTI to verify this interpretation of the legislation.

particularly if the targets within the ELV are further tightened. The practical feasibility of such separation is clearly an essential consideration if the ELV is to deliver the environmental benefits it aims at.

The benefits of natural fibre materials remain impressive, and the Forum remains of the view that effort should be made to maintain the momentum of the sector. This will require communication across the supply chain, ensuring that crop science, legislation, materials engineering and end-of-life disposal are all brought more closely into line. As such this subject appears to fall within the interest of the National Non-Food Crops Centre, and we would suggest that the Strategy Group of the NNFCC take on the role of monitoring the progress of the sector and advising Government in the UK and EU on the implications for crop-derived materials.

Biosolvents in the printing industry

Background

The Forum considered the potential for extending the use of biosolvents in the printing industry in its first annual report.

The Forum was impressed by the potential for plant-based solvents, usually from esterified, non-drying vegetable oils, to replace conventional fossil-based solvents in inks, paints and cleaning fluids. The advantages to health from such a substitution are clear: conventional printing solvents are primarily volatile organic compounds (VOCs), which have been linked to dermatitis, damage to kidneys, livers and lungs upon inhalation, and constitute a significant risk of fire or explosion. Although plant-based solvents can increase the risk of slipping if incorrectly used, these risks can be managed if best practice is followed and a move towards renewable VOC-free plant-based products appears highly desirable.

The potential market for biosolvents is large: the Forum estimated that 100,000 tonnes of solvents are used for cleaning in the European printing industry each year, of which 40,000 tonnes is in the UK alone. The industry is already progressing the use of biosolvents in inks and so the Forum has paid particular attention to the market for biosolvents in cleaning materials.

Findings of the Forum study

The Forum's initial recommendations: price, confidence and health & safety

The Forum held a workshop to investigate and analyse the reasons for the slow take-up of biosolvents as cleaning fluids. The Forum believes that the industry is generally well disposed to the idea of using biosolvents and the environmental and health benefits are recognised, particularly by the unions involved in this area. However, printers usually buy on price and on a confidence in the performance of the product based on experience, and the unfamiliarity and typically increased cost of biosolvents are significant barriers to further uptake.

To tackle the issue of confidence and reliability of performance, the Forum recommended that a critical appraisal of opportunities in the printing industry should be undertaken, including establishing of performance criteria. In order to raise the importance of health and safety issues in purchasing decisions it was recommended that consideration be given to measures that might encourage compliance with the Health and Safety Executive (HSE)'s Approved Codes of Practice for the use of VOCs and encourage the use of bio-renewables. It also was recommended that there should be ongoing discussion with the ink and printing machinery manufacturers on the potential for biosolvents.

The Government noted in its response to the Forum that the UK Printing Solvent Substitution Scheme is already active in encouraging compliance with

the HSE's Code of Practice for VOCs. The scoping study recommended by the Forum has yet to be conducted and whilst the Forum reiterates the need for such a study, this should be adapted to accommodate the activity since the recommendation was made.

Ongoing demonstration work and liaison with industry

In addition to the recommendations outlined above, the Forum strongly recommended that a demonstration and education programme should be developed in conjunction with interested parties in the printing industry. A pilot demonstration project has now been carried out by the Central Science Laboratory, co-ordinated by the National Non-Food Crops Centre. This has incorporated communication with industry through the involvement of the HSE in the project and a well-received presentation by CSL to the Printing Industry Advisory Committee (PIAC), a representative cross-industry committee set up to advise the Health and Safety Commission on the protection of people at work and others from hazards to health and safety arising within the printing industry. The demonstration project highlighted the very significant differences between using biosolvents in a manual wash procedure, as used by many small printers, and using them in automatic cleaning facilities. Whilst there is no reason to suppose that biosolvents cannot perform satisfactorily in both systems, current machine design and the range of solvents available to the project resulted in biosolvents performing much better in manual systems than in automatic cleaning systems.

(i) Manual wash systems

Demonstration of two plant-based solvents, one 76% rape-based and one wholly plant based with a 25-50% rape content, was very successful. Although solvents took longer to remove and were therefore more labour-intensive to varying degrees, they lacked the strong odour commonly associated with printing solvents and print quality actually improved after switching to the vegetable-based products.

Cost appears to be the major remaining barrier to further uptake. However, although costs are currently higher than conventional alternatives this is in part due to the need to import materials and might be expected to fall if increasing demand were to justify significant UK production.

It is encouraging to note that in contrast to earlier trials, the printers involved have continued to use the 76% rape oil solvent for manual applications. This appears to support the Forum's view that wider experience of these materials will encourage uptake, and further demonstration work and dissemination of information through PIAC committee is recommended to stimulate the market for these successful products.

(ii) Automatic wash systems

The same solvents were found to be unsuitable when applied to the current breed of automatic cleaning systems, as their viscosity affected the proper functioning and cleaning of machinery not specifically designed for use with plant-based solvents. The trial reinforced the need to match the correct

cleaning product with the correct machinery, alongside appropriately modified working practices.

It is strongly recommended that a further, larger demonstration project is commissioned. This project will be able to benefit from the lessons of the pilot study, and may consider sourcing different cleaning fluids, with particular attention to issues of viscosity. It is also of the first importance that the implications for machine manufacture are also taken into account to ensure a successful outcome. The report of the pilot study suggests that radical redesign of automatic printing machinery is unlikely to be needed, but simpler modifications of the solvent application system, such as the use of a rubber blade wiper, may be required. It is therefore an essential condition of such work that the machinery manufacturers take a full and active involvement, with a clear view to adopting machinery designs compatible with plant-based solvents where found to be practicable. This would also allow for endorsement of particular cleaning fluids by machinery manufacturers, which would significantly improve confidence in the product.

Forward view

The Forum continues to believe that an appraisal of the opportunities for biosolvents across the industry should be undertaken. Such research should be guided by the needs and interests of industry, and perhaps integrated into the ongoing demonstration work discussed above. The NNFCC has already opened up channels of communication with PIAC through the HSE.

In tandem with this, attention should be given to supply side issues, including consideration of other potential solvents that are derived from crops such as ethanol, n-butanol, ethyl lactate, and exploring the range of products available in other countries, notably Germany and the US, in advance of further trials.

The Forum remains confident that this sector has the potential to develop into a significant market for non-food uses of crops, and progress should be monitored by the Strategy Group of the NNFCC, with a view to making further policy recommendations as appropriate.

Recommendations

Forum recommendation no. 41

The National Non-Food Crops Centre should be invited to consider the development and use of biosolvents in the printing industry in Germany, to ensure that lessons are learned from experience there and to avoid unnecessary duplication.

Forum recommendation no. 42

A further, larger demonstration project should be commissioned under the guidance of the NNFCC, and based upon the interests and commitment of the printing industry and machine manufacturers represented through the PIAC committee.

Forum recommendation no. 43

An appraisal of the opportunities for biosolvents across the industry, as recommended in the Forum's first annual report, should be integrated into the ongoing demonstration work in this area.

Total and potential loss fluids: the role of plant-based oils

Background

In its previous annual reports the Forum considered the use of biolubricants both as total loss fluids such as chainsaw lubricants and as potential loss fluids such as hydraulic fluids. Large quantities of such material are lost to the environment each year and the Forum found that plant-based lubricants have considerable potential to mitigate the environmental impact of such loss due to their generally high degree of biodegradability and reduced ecotoxicity.

Findings of the Forum study

The Forum discovered a number of obstacles which inhibit the wider uptake of bio-based lubricants in partial and total loss applications. Although the environmental benefits of hydraulic fluids are widely acknowledged, this does not equate to a commitment amongst individual operators to source bio-based fluids: the key drivers for hydraulic fluids are cost and performance, and many operators see little reason to change their current practices.

Biolubricants are typically more expensive than their mineral-based equivalents and whilst performance in low-stress applications such as chainsaws is very satisfactory, in applications such as high-stress hydraulic pumps plant-based oils polymerise more rapidly than conventional materials, reducing performance or requiring regular and expensive oil changes. Modification of the base fluid into a plant-based, synthetic ester improves performance, as does the use of additive, but performance issues remain in the higher-stress applications, and there is a danger that additives will compromise the low ecotoxicity of the final product.

The Forum's recommendations aimed at increasing the performance, awareness of, and confidence in biolubricants. It is expected that the cost competitiveness of these materials will improve as the volume in the market increases.

Research and development

The Government accepted the Forum's recommendation that money is made available to fund increased research and development into non-toxic additives to improve performance of bio-based lubricants without compromising their environmental advantages. The NNFCC may have a role in identifying requirements for further research and making industry aware of the research that is already available.

Nomenclature and labelling

The Forum found that the nomenclature used to describe plant-based lubricants was not standardised throughout the industry and that this impedes wider understanding of, and confidence in, bio-based lubricants, as well as making it more difficult to identify and source such materials. The use of the

term “biolubricant” is particularly confusing, as it generally refers to a lubricant which is (to some degree) biodegradable, but does not necessarily ensure the presence of bio-based material, as it may seem to imply.

The proposed formation of a new EU-wide eco-label for environmentally friendly lubricants, building on national standards such as the Blue Angel (Germany) and the Nordic Swan (Nordic Countries), is expected to help consumers identify environmentally friendly lubricants. Early proposals suggest that materials qualifying for the proposed eco-label will need to meet specified standards for ecotoxicity and biodegradability, and will also have to contain a specified percentage of plant-based material, varying between different applications, but proposed at 50% for hydraulic fluids and 70% for chain saw lubricants. The label is expected to avoid the contentious term “biolubricants”, but to provide a single European standard for environmentally friendly lubricants as such. The Forum has indicated its support for the proposed label, which appears to be well placed to increase the uptake of environmentally friendly lubricants, and with it the uptake of plant-based materials.

Demonstration and government procurement

The Forum has often noted that successful demonstration activity and procurement by government agencies can be effective in increasing knowledge and awareness of crop-based products, and establishing them as a mainstream option. As a result of the Forum’s recommendation that demonstration activity be carried out in this area, Defra has commissioned a significant demonstration project through the National Non-Food Crops Centre. The project is based at the Eden Project in Cornwall and involves replacing mineral oil lubricants with plant-based lubricants in a number of chainsaws, hydraulic pumps, tractors and small tractors in use at the site. The participating machines are then clearly labelled and the benefits explained to visitors to the site as part of the Project’s wider environmental education material. The performance of the machinery is being monitored, and the Forum expects that further work will disseminate the results to stakeholders and potential users, including landowners.

The Forum also welcomes the Government’s positive response to the recommendation that it should encourage procurement of environmentally friendly lubricants where practical, favouring bio-based lubricants where possible.

Forward view

The Forum has been delighted by the growth of this sector over the life of its investigations. As anticipated, public procurement has been a key lever, and the decision by the Environment Agency, Forestry Commission and other bodies to require contractors to use only lubricants meeting standards for biodegradability and toxicity has led to an increase in bio-based chainsaw lubricants to a point where they are believed to account for around 70% of the market, and have also encouraged the use of hydraulic fluids which contain a significant volume of bio-based material. In other cases improvements in

performance, as well as health benefits, have helped increase demand. Ford has replaced over 3.5 million litres of mineral oil based cutting fluids and coolants with crop-based alternatives in nine engine plant operations worldwide. Toxicology risk assessments have showed the plant oil based product posed reduced risk to operators, and Ford plans to extend its use of vegetable oils into other aspects of its manufacturing processes.

The Forum believes that there is potential for a very significant further expansion in the use of bio-based lubricants, and we would recommend that the Strategy Group of the National Non-Food Crops Centre maintain an interest in the sector, including wider applications such as cutting fluids and greases, as well as reviewing progress made in this sector in Germany.

With considerable progress made in expanding the market for biolubricants, we anticipate that widening future study to consider other elements of the life-cycle of biolubricants may well prove profitable. The NNFCC should consider the prospects for developing plant oils which might form better base oils, allowing the development of biolubricants with better performance and fewer additives.

The NNFCC Strategy Group may also wish to consider the continuing need to improve and complete the life cycle assessment available for bio-based lubricants, and we would recommend that it explores ways of ensuring that end-of-life disposal for bio-based lubricants is at least convenient and environmentally benign, and at best a source of additional revenue.

Industrial uses of grasses

Background

The Forum's initial studies into the potential for industrial uses of grasses concentrated on uses of miscanthus, primarily as a fibre in industrial materials and as a feedstock for solid or liquid biofuels. This study developed into a broader consideration of the potential of a wide range of grasses including forage grasses, and considered the prospects for the extraction of chemicals and co-products from grasses. The Forum's conclusions in this area have some parallels with the case study on forestry extractives.

Findings of the Forum study and commissioned reports

In its second annual report the Forum discussed a successful survey of potential extractives from forage grasses and miscanthus commissioned from the University of Bangor, which indicated a large number of potential products. The National Non-Food Crops Centre has now commissioned and received a second study from Agros Associates, building upon this work and focussing upon the commercial potential for extracting high value chemicals from forage and amenity grasses in the UK. The project included research into the possible market demand for products derived from grass and an analysis of the cost and feasibility of setting up a pilot grass biorefinery in the UK.

The report concluded that there was commercial potential to meet a number of existing markets using extractives from grasses. In a parallel with the findings of the review of forestry extractives, the report identified careful and efficient co-processing as a key to meeting this demand at a competitive price. Existing grass driers and hammer mills have limited potential for the recovery of cell contents, whereas new bio-refining techniques can separate out compounds contained within grasses much more effectively. The report recommends a "bio-cascading" process geared to the removal of the most valuable stream first with subsequent extractions of lower value materials from the primary flow in order of their value to the enterprise.

Forward view

The Agros review concluded that grass biorefining could be commercially viable in the UK, and the associates are currently working to bring together a consortium with adequate funding to set up a pilot facility, and the Forum recommends that the Strategy Group review developments.

Whereas the Agros study focussed exclusively upon forage and amenity grasses, any further study should also retain an interest in miscanthus: forage grasses other than miscanthus are more widely available and face significant competition from amenity grasses, which may limit potential to retain value within the rural community.

Further study should also give detailed consideration to market development for the products identified, and must incorporate a sound market approach linked to a well-documented business case.

Liquid biofuels for transport

Background

Of all the potential non-food uses of crops examined by the Forum, biodiesel and bioethanol have perhaps the clearest potential to deliver an industry on a large scale in the near future. The Forum considered biofuels in both previous annual reports, and in October 2002 gave advice to ministers on policy options for liquid biofuels. In support of this advice the Forum commissioned research from Sheffield Hallam University on the economic and environmental strength of the case for biofuels¹¹, and submitted evidence to the EFRA select committee Enquiry into Non-Food Uses of Crops (Biofuels) in April 2003.

Findings of the Forum study

The Forum remains of the view that the case for liquid biofuels rests upon a combination of benefits delivered, including CO₂ reductions, benefits to the rural economy and UK industry, and a modest increase in security of UK energy supply. Although biofuels would require very significant amounts of land to be dedicated to non-food crops, the biodiversity issues appear to be manageable if the Government stimulates both biodiesel and bioethanol, and therefore encourages a mix of feedstocks. The Forum is particularly interested in the potential for converting lignocellulosic materials such as straw and short rotation coppice into bioethanol, which would both dramatically increase the volume of feedstocks available and improve the impact on biodiversity. The Forum's views on the case for biofuels are given in greater length in its second annual report.

Forward view

The debate on biofuels in the UK is now long-running, and the UK Government has appeared slow in giving the industry a clear signal as to the level of its commitment to increasing the volume of biofuels used in the UK.

The Forum's contention that the existing 20 pence per litre duty reduction for biodiesel, and the forthcoming equivalent reduction for bioethanol, would be insufficient to stimulate a large scale biofuels industry have been borne out. However the EU Biofuels Directive has stimulated further debate and increased the confidence of biofuels producers, and has resulted in the Department of Transport consultation: *Towards a UK Strategy for Biofuels*. The consultation is a significant development for two reasons, firstly for suggesting UK targets for biofuels consumption as required by the EU

¹¹ *Evaluation of The Comparative Energy, Environmental and Socio-Economic Costs and Benefits of Biodiesel*, N. D. Mortimer, P. Cormack, M. A. Elsayed and R. E. Horne, June 2002.

Directive, and secondly for suggesting a new approach to achieving higher targets in the future, through a Renewable Transport Obligation.

Renewable Transport Obligation and targets for biofuels

A Renewable Transport Obligation, perhaps modelled upon the Renewables Obligation for electricity, might oblige refiners, blenders and importers to ensure that over a given period of time a certain percentage of their aggregate fuel sales was bio-fuel.

The Forum considers an obligation of this sort to be the most promising of the measures available to Government for accelerating the growth of a biofuels industry. A biofuels obligation would give industry the clear lead it has lacked so far, and would divide the cost of biofuels between Government, the fuel industry and the consumer. It may also help to circumvent the difficulties of setting duty reductions against a background of shifting commodity prices. However, as the consultation accepts, such an obligation would not of itself ensure that production was met from domestic sources. A number of other countries have substantial biofuels programmes which have benefited from targeted support, and the Forum considers that a programme of support in the UK may be required to stimulate local UK processing.

Targets for biofuels

The European Biofuels Directive requires member states to set targets for the sale of biofuels, and has suggested indicative targets of 2% in 2005 rising to 5.75% in 2011. The Government has proposed that the UK biofuels target for 2005 should be based on projections of biofuels sales by the end of 2005, which equates to around 0.3% of UK transport fuels, and that targets for 2010 should be set at 2007.

It is the Forum's belief that a 5% blend in forecourt supplies of petrol and diesel would be a realistic long-term target for sales of biofuels. The Forum is also aware that there is potential to increase the numbers of vehicles equipped to use biofuels in blends of greater than 5%. Such vehicles may be needed if higher long-term targets are envisaged, and may require other, more tailored, policy measures.

New uses of wool

Background

The Forum signalled in its first annual report a wish to extend its analysis of opportunities for adding value to agricultural products into new uses of wool. Wool, like many of the other products the Forum has considered, currently fetches a low price as an agricultural commodity. Returns are particularly poor for low grade wools, which are not suitable for apparel, and the majority of sheep farmers have for many years considered wool to be a by-product rather than a product to be developed for maximum value.

The Forum has been interested in the opportunities for adding value to this low grade wool through the development of innovative products. It has taken particular interest in the possibility of producing natural insulation materials, a market that has also been considered under the case study into sustainable construction materials, and which overlaps with alternative uses for fibre crops.

The Forum is pleased that the profile of wool-based insulation has risen in recent years. Thermafleece, a wool-based insulation material produced by Second Nature UK, was awarded the 2004 Queen's Award for Enterprise in the Sustainable Development category, on account of its significantly lower embodied energy, and benign handling properties.

Findings of the Forum study

Developing the market: structures and funding

The Forum expressed concern that the structure of the wool market might be off-putting to potential entrepreneurs and their backers. The wool market remains regulated by the British Wool Marketing Board, under terms established by the British Wool Marketing Scheme (Approval) Order 1950 ("the Order"). All wool producers with more than four sheep must register with the Board, and are legally bound to sell their wool to the Board unless their breeds are exempted. The board in turn is legally bound to buy that wool, in order to present all forms of UK wool to the open market. The Board returns the market value to producers less its own operating costs.

The Forum workshops found that this arrangement was supported by the majority of producers who acknowledge the value of the Board taking responsibility for moving on what was considered a by-product and leaving some returns. However the Forum was concerned that the situation appeared less clear for entrepreneurial producers who wished to add value to their wool *before* selling it on, rather than being obliged to remain commodity producers.

The Order gives the Board power to exempt classes of producers, and in its response to the Forum the Board was keen to make clear that it has granted such exemptions in the past and has given support to the small number of producers who have taken advantage of this provision. The Forum found at

its workshops, however, that the provision for exemption is not widely known of, nor are the terms and conditions of such an exemption or the process by which cases are decided.

The Forum considers it essential that entrepreneurial producers have certainty and transparency before investing in an entrepreneurial diversification or before approaching financial backers, and therefore recommended that all entrepreneurial producers be granted the right to an exemption, which would continue as long as the producer wished, perhaps as part of an entrepreneurial scheme. The Forum also recommended a wider review of the Board, and open competition funding for research and demonstration projects into new uses of wool.

The Government, in response to the Forum's recommendations, resolved that the Board should make public the criteria upon which producers can be granted exemption from selling to the Board to ensure transparency, but decided that a review of the Board should wait until the effect of publicising the criteria could be assessed. It noted that the Board currently funds some research and outlined open competition sources of funding for which innovative wool-based products and processes were eligible.

Forward view

The Board has stated that it is, and has been, concerned to assist entrepreneurs. The Forum's recommendations should be seen as essential measures to take that assistance forward through a transparent and objective process. Producers should be able to gain exemption to retain their wool for entrepreneurial purposes, in order to diversify as recommended by Government, and to retain added value within the farming industry in keeping with the recommendations of the Curry Report. The producer should have certainty that the exemption will remain in place for as long as he or she wishes.

The Forum notes that the Board is already bound by administrative law constraints of procedural fairness and reasonableness and by the requirements of the Order to apply non-discriminatory treatment in making prescriptions as to exemptions. It is hopeful that this duty, in concert with public criteria published on the BWMB and Defra web sites, should provide the conditions producers require when seeking an exemption for entrepreneurial purposes.

The Forum remains very concerned however that the Board remains the final judge of its own decisions regarding exemptions, and that there is no fully independent process in place.

Recommendation

Forum recommendation no. 44

The Forum strongly recommends that the effect of implementing this revised exemption process, and its success in attracting and encouraging

entrepreneurial activity, is specifically addressed in the next scheduled review of the Board, by an independent, international agency with no links to the BWMB.

Plant-derived anti-microbials

Background

The Forum's second annual report recommended a series of measures to enhance the development and use of plant-based anti-microbials, based upon a thorough survey of the field¹². The Forum has been active in supporting these recommendations and has been involved in consultation with government departments to determine how these might be implemented.

Findings of the Forum study

Research

The Forum recommended that consideration should be given to public funding of research to investigate mode of action and synergism of known plant anti-microbials. It was considered that identification of new molecules would probably remain in the private sector.

In its response to the Forum the Government undertook to commission a study to identify research priorities in this sector, to include an assessment of work on the mode of action and synergism of known anti-microbials. The Forum welcomes this: at present there appears to be no core funding allocated to providing this type of data, which would not only provide an insight into potential alternative mechanisms but also stimulate the identification of new natural antimicrobials. Alternative mechanisms that might offer solutions to antimicrobial resistance should be the primary target as this is an area of great concern in human and animal welfare.

Review of pharmaceutical applications

The Forum also considered that a detailed pharmaceutical applications review of therapeutic and prophylactic anti-microbials for human and animal health could be commissioned at a later stage to identify key areas of opportunity for plant-based antimicrobials in this largely unexploited market. It is possible that this could be combined with the assessment of mode of action and synergism discussed above.

The Government has accepted this recommendation, and meetings held with the Defra Veterinary Medicines Directorate suggest that the issue of anti-microbial resistance is the key area that should be targeted. This would embrace similar concerns in human health particularly the growing concern over MRSA.

Registration under the Biocidal Products Directive

The Forum study focuses extensively on the difficulties of registering new anti-microbials under the Biocidal Products Directive (BPD). The Forum recommended that a "fast track" approval system should be investigated for those molecules that are generally regarded as safe (GRAS) or derived from

¹² *Anti-microbial scoping study*, CNAP, June 2003

foodstuffs where the use rate is equal or less than the acceptable daily intake (ADI). This was seen as particularly important if the BPD is not to completely inhibit commercialisation of new plant-derived anti-microbials and it was further recommended that the Forum should seek a meeting with the Health and Safety Executive to discuss the options that might be available.

Since then Forum members have had regular dialogue with HSE and other relevant bodies to seek proposals that will allow more rapid access for natural materials. The current EU legislation imposes restrictions on a wide range of natural molecules for biocidal uses, and a working group on essential uses and other specific categories of active substances has now been set up to look into this area. This group has recommended that active substances that are food or feeding stuffs should be exempted from BPD and a number of substances, including some natural products such as essential oils, are being considered to determine the data that might be required.

In the related area of plant protection products, draft guidelines for natural products including plants and plant extracts have been submitted and are being considered. The working group has suggested that these guidelines might be suitable also for BPD. The Forum still considers that the application of legislation similar to that adopted for the Traditional Herbal Medicines Directive might be suitable for these plant extracts where the emphasis is on the quality and safety of the preparation but the traditional use of this product qualifies its authorisation.

Communication and discussion

A seminar covering the subjects discussed above was arranged by the NNFCC for late summer 2004 on the recommendation of the Forum, but was postponed until a later date as it was considered that maximum attendance from stakeholders would not be achieved at this time of year. It is now scheduled for January 2005. The seminar will cover the main areas of concern raised from the interviews with experts from industry and academia, including legislation and the Biocidal Products Directive, patent law, anti-microbial resistance, activity/structure relationships and example case studies.

Forward view

This issue should be considered further by the NNFCC Strategy Group in the light of the revised seminar discussed above and below.

Recommendation

Forum recommendation no. 45

The Forum remains supportive of a seminar, now rescheduled for January 2005, to consider the barriers to anti-microbials and to identify actions to overcome them.

6. Summary of recommendations

Construction

Forum recommendation no. 31

Building on the CIRIA project there should be a concerted effort to provide information on the natural materials available and their performance to builders and architects and other participants throughout the industry. This initiative should be led by a body fully embedded in the industry and in liaison with the NNFCC. Particular effort should be made to raise awareness amongst planners and local authorities, which might be achieved by incorporation of the information on crop-derived products into best practice guidelines to accompany PPS (1), in concert with the measures suggested above.

Forum recommendation no. 32

The NNFCC should be invited to commission work from the construction industry to review existing knowledge from research programmes in other countries, to augment the information collated under the CIRIA report. This task should include work to identify and adapt for UK consumption knowledge that is applicable to UK conditions and practice, and to identify those gaps where new research is needed.

The NNFCC should then be asked to commission further work to fill gaps in both performance specification and life cycle assessment for key products.

Forum recommendation no. 33

The Government should put in place a requirement to reduce the life cycle energy requirements of construction, using the Building Regulations as and where appropriate but using wider measures if required.

Forum recommendation no. 34

Consideration should be given to alternative processing methods to enable current UK timber to be more widely used. The Forestry Commission should consider whether more appropriate species compatible with UK climate would better meet the needs of the construction market.

Forum recommendation no. 35

The development of procurement strategy across the Government estate must consider the environmental impact of materials on a whole-life basis, and should outline the contribution which crop-derived materials can make.

Forestry

Forum recommendation no. 36

The Forestry Commission should consider how best to take forward a study of extractive volumes and groupings in forestry materials and their susceptibility to handling and storage.

Forum recommendation no. 37

Demonstration activity on supercritical extraction should be eligible for demonstration scheme calls, and interest should be solicited from the forestry and extractives industries.

Forum recommendation no. 38

A second seminar on extractives from forestry products should be convened to take forward the issues raised in the June seminar, and to capitalise on the co-operation and interest which it generated. The seminar should consider the output from recommendation no. 36 above if available.

Biopolymers & other uses of Starch

Forum recommendation no. 39

The NNFCC should be asked to collate and publicise available information of demonstration work on mechanical separation of crop-derived packaging done to date, supplementing this with a UK demonstration project if necessary.

Forum recommendation no. 40

The Forum recommends that the NNFCC consider the wide variety of products highlighted in the BioComposites Centre study *Industrial Markets for Starch*, with a view to prioritising them according to the value of the potential markets, and exploring the measures needed to encourage their further development.

Biosolvents

Forum recommendation no. 41

The NNFCC should be invited to consider the development and use of biosolvents in the printing industry in Germany, to ensure that lessons are learned from experience there and to avoid unnecessary duplication.

Forum recommendation no. 42

A further, larger demonstration project on the use of biosolvents in printing should be commissioned under the guidance of the NNFCC, and based upon the interests and commitment of the printing industry and machine manufacturers represented through the PIAC committee.

Forum recommendation no. 43

An appraisal of the opportunities for biosolvents across the printing industry, as suggested in recommendation no. 10 in the Forum's first annual report, should be integrated into the ongoing demonstration work in this area.

New uses of wool

Forum recommendation no. 44

The Forum strongly recommends that the effect of implementing a revised exemption process for wool producers, and its success in attracting and

encouraging entrepreneurial activity, is specifically addressed in the next scheduled review of the British Wool Marketing Board, by an independent, international agency with no links to the BWMB.

Anti-microbials

Forum recommendation no. 45

The Forum remains supportive of a seminar, now rescheduled for January 2005, to consider the barriers to anti-microbials and to identify actions to overcome them.

7. Acknowledgments, information and contact points

Acknowledgements

The Forum has been greatly helped by a number of expert presentations from outside organisations, and has been assisted by representatives from Defra other than secretariat members. We should particularly like to thank the following:

- Mark Harvey, Andrew McMeekin, Ian Miles, IOIR
- David Britton and Rob Colmer, Shell
- Peter Lillford, Rad Thomas, Jeremy Tomkinson, NNFCC
- Linda Smith, Benjamin Dent, David Short, Defra
- Richard Murphy, Imperial College

Information

All the Forum's reports, and all the work it commissioned, were published on its web site in accordance with its publication strategy. The National Non-Food Crops Centre is taking over the management of the information acquired by the Forum, as a part of its adoption of the Forum's wider strategic role. The NNFCC intends to publish all the major reports commissioned by the Forum, as well as the Forum's three annual reports, on its web site. The NNFCC will review this arrangement from time to time and amend it as appropriate.

Contact points

The Forum secretariat was based at Defra. The Forum's role of providing strategic advice on the development of non-food uses of crops is now undertaken by the National Non-Food Crops Centre. Contact details are given below:

National Non-Food Crops Centre Innovation Centre York Science Park Innovation Way Heslington York YO10 5DG www.nnfcc.co.uk	Defra Crops for Industry Branch Area 5A, Ergon House Horseferry Road London SW1P 2AL www.defra.gov.uk
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8. Acronyms used in this report

Acceptable daily intake	ADI
Association of Plastic Manufacturers in Europe	APME
Biocidal Products Directive	BPD
Building Research Establishment	BRE
Central Science Laboratory	CSL
Common Agricultural Policy	CAP
Construction Industry Research and Information Association	CIRIA
Department of Environment, Food and Rural Affairs	Defra
Department of Trade and Industry	DTI
End-of-Life Vehicles Directive	ELV
Generally regarded as safe	GRAS
Genetic modification	GM
Health and Safety Executive	HSE
Institute of Innovation Research, University of Manchester	IOIR
Life cycle assessment	LCA
National Non-Food Crops Centre	NNFCC
Near infra-red technology	NIR
Original equipment manufacturer	OEM
Printing Industry Advisory Committee (of the HSE)	PIAC
Strategy for Sustainable Farming and Food	SFFS
Supercritical fluid extraction	SFE
Sustainable Buildings Task Group	SBTG
Waste Incineration Directive	WID
Volatile organic compounds	VOCs

Appendix 1: The Forum's sustainability indicators

In order to address the issue of sustainability, the Forum has evaluated innovative uses of crops against the following economic, environmental and social indicators.

Economic issues

Economic performance

Value creation from non-food uses of crops

Rural income generated

Rural economic development, rural infrastructure/resource development

Diversification of rural enterprises

Investment in non-food uses of crops

Positive balance of trade (inward investment, exports, import substitution)

Security of supply (development of indigenous resources)

Innovation

Development of UK science base

UK registered patents in non-food uses of crops

R&D activity

Human capital formation

Education, training, skills formation

Environmental issues

Air pollution (including greenhouse gases), Water pollution, Land pollution

Waste management

Impacts on renewable resources

Soil

Water

Biodiversity

Resource depletion

Impacts on non-renewable resources

Substitution of fossil fuels

Social issues

Strengthening rural communities

Rural employment generation

Countryside recreation opportunities

Social acceptability issues

Animal welfare

Genetic modification

Appendix 2: Implementation of the recommendations of the first annual report of the Government-Industry Forum on Non-Food Uses of Crops

This appendix, which was presented to the Forum at their final meeting, outlines the progress made to date in implementing the recommendations of the Forum's first annual report.

Biopackaging

1. *Methods should be sought to encourage further development of a UK-based packaging industry for the production of compostable plastics from renewable resources preferably using home-grown feedstocks.*
2. *Develop a series of linked mechanisms to encourage a) the use by industry of compostable packaging materials and b) the provision of facilities for the disposal of compostable waste products following their useful life.*

The Government will use the forthcoming Strategy for Non-Food Crops to address the barriers to the development of biodegradable polymers.

Satisfactory resolution of waste management issues remains a key requirement if the use of biodegradable packaging is to be expanded responsibly. The Government is committed to reducing the volumes of biodegradable material reaching landfill, and the capacity of councils to compost biodegradable material is expanding rapidly. These issues will also be given full consideration in the forthcoming review of the Government's Waste Strategy.

3. *Commission life cycle assessment from an independent source to enable informed comparisons between starch-based polymers, destructured starch polymers, polylactic acid polymers, polyhydroxyalkonate polymers and petrochemical polymers.*

Imperial College have undertaken a wide ranging review of existing life cycle analysis under the direction of Dr Richard Murphy, and funded by the DTI. The results were disseminated at a NNFCC event in London in May 2004. Defra sit on the steering group of an Environment Agency project to undertake further life cycle assessment of bio-based packaging, which will include a comparison with fossil-based alternatives.

4. *Examine the feasibility of using a colour-based separation system for plastics to facilitate easy separation of compostable from non-compostable materials in the waste disposal stream.*

Consultation with the industry has suggested that colour coding is considered impractical. The Composting Association currently administers

the European 'Din Certco' symbol for compostable packaging in the UK, which seems better placed to gain industry acceptance.

Defra understands that the Near Infra Red (NIR) waste sorting technology that is currently employed to separate various kinds of recyclable plastic can be recalibrated to separate bio-based polymers.

5. *Suitable programmes of R&D to promote a greater understanding of basic carbohydrate and lipid chemistry will be fundamental to progress in this industry*

There have been a number of calls for which applications from this sector would be eligible. Defra has not noted any special demand for research in this area.

Natural Fibres in the Printing Industry

6. *Undertake a full review and analysis of the hemp and flax varieties grown in the UK to determine whether more suitable types can be grown and whether a change in variety will affect the functional performance of the fibre. Studies should be undertaken to determine whether alternative retting processes could be identified to mitigate the effects of the UK's climate.*

UK Government should be fully involved in the reviews of the EU regulatory framework for fibres in 2003 and 2005 and resist the introduction of any mechanisms that are disadvantageous to further development of the UK industry, and ensure that the best outcome for the UK is achieved.

At the time of writing a call for proposals to undertake the recommended review had been issued.

NNFCC have commissioned demonstration work from Bioregional to explore non-retting breeds of hemp. This is an initial study, and further work is required to understand what additional costs and work are needed to develop the prototype equipment to a point where full trials can be completed.

Consultation on the reform of the fibres regime is on track, with negotiations due to begin in 2005.

7. *The Government is encouraged to consider how the End of Life Vehicles Directive can be reconciled with use of renewable raw materials and include other environmentally sustainable raw materials. An EU review of the ELV recycling targets is scheduled for 2005; this review should consider the promotion of environmentally sustainable raw materials.*

The Government is currently considering responses to consultation on the transposition of the Directive into UK law, and is aware of the Forum's views. The 2005 review of targets applies only to targets from 2015, and

may now be postponed in order to incorporate experience of the effects of the initial targets.

The Government will raise the difficulties the Directive can create for renewable raw materials with the Commission with a view to achieving a better outcome for natural fibres in future more fundamental reforms.

8. *UK Government should consider giving start-up assistance to suppliers of the processed natural fibres and the plastic component makers particularly in relation to the development of injection moulded parts, investigating the compatibility of various natural fibres with the matrix, and evaluating the performance of these materials in under-hood conditions.*

Business support is available from Government to assist start-ups and to support innovation within SMEs. DTI's has a new business support product developed for the automotive industry, Supply Chain Groups. The Government is also supporting research under a LINK project to address complex technical issues on use of natural fibres for reinforcing injection-moulded thermoplastics. No further action will be taken.

Secondary Uses of Wheat: Construction

9. *A seminar should be convened to raise awareness of the potential for use of straw bales in construction, and to test the current analysis of the barriers to wider exploitation and proposed solutions. The seminar should consider the barriers and identify the steps to be taken to reduce them, and should include farmers, builders, architects, planners, finance and insurance providers, and appropriate NGOs and Government representatives.*

The proposal for a seminar received little backing from industry. The Government has instead commissioned a number of other contributions to a wider understanding of the sector:

- A review of the regulatory, commercial and technical barriers to the take up in England of building materials based on crops was commissioned from the Buildings Research Establishment, and is available on the NNFCC web site. An analysis of potential for environmental profiling of non-food crops was also commissioned from BRE, and is available on NNFCC web site along with BRE fire safety tests of straw bales.
- Defra and the DTI are major funders of the forthcoming CIRIA handbook of available construction materials, aimed primarily at architects and builders.
- A comprehensive guide to using straw bales in construction, aimed primarily at the self-build market, is available from Amazon Nails in hard copy or on-line. The guide is a key output of a project sponsored by the DTI under its Partners In Innovation programme.

It is the Government's perception that interest in and awareness of straw bales in construction has risen since the Forum's recommendations were made, with a corresponding increase in interest in the R&D community. BRE were invited to sit on the advisory committee of the recent Supply Chain Assessment and Development Programme for Industrial Crops.

Bio-based solvents in the printing industry

10. *A critical appraisal of the opportunities for further uptake of bio-based solvents in the entire printing process is needed. This must include establishment of performance criteria for bio-based products. These studies are essential if the opportunity for exploiting renewable raw materials in the printing industry is to be maximised whilst also recognising standard practice in the industry.*

The NNFCC has asked the Printing Industry Advisory Committee of the HSE to clarify what future research and demonstration activity the industry would like to see and would be able to actively support. Further appraisal will follow from the PIAC committee's comments.

While it seems likely that biosolvents will be more environmentally sound than VOCs, this needs to be assessed through a life cycle assessment. Defra is discussing the prospects for such work with the NNFCC.

11. *To support increased awareness and gradual uptake of bio-based cleaning materials across the printing industry, especially in smaller businesses, an education and demonstration programme should be developed.*

The demonstration project was conducted in the first half of 2005 by the Central Science Laboratory and overseen by the National Non-Food Crops Centre.

12. *Consideration should be given to measures that will encourage compliance with the Health and Safety Executive's Approved Codes of Practice for use of volatile organic compounds and support the use of biorenewables, including biosolvents.*

The 'UK Printing Solvent Substitution Scheme' already exists. This is a voluntary scheme that aims to reduce the use of low boiling point organic solvents in the printing industry in the UK and to substitute safer alternatives wherever practicable. The initiative does not specifically promote the use of plant-based products, but it is hoped that such products will be developed that compare favourably both environmentally and commercially to existing VOCs.

The Solvents Emissions Directive and Integrated Pollution Control initiatives are also expected to increase pressure on companies to adopt good practice when using solvents. Finally, many companies and local authorities now require assurances on environmental and health and safety issues from suppliers.

13. *Ongoing discussion should take place with ink and printing machinery manufacturers. It is recognised that most are not UK-based and some are fully multinational. Discussions should include appreciation of the industry's wider markets and the application of biosolvents, development of OEM [original equipment manufacturer] approval and active support for their use.*

Liaison has been established through the NNFCC and HSE. This relationship will be a key consideration to the decision to commission future research and demonstration activity.

Essential Oils

14. *To address concerns that the supply of UK-grown and distilled oil is unreliable, and at the same time reduce unit production costs, producers need to increase planting areas significantly. To facilitate this the formation of an industry led initiative integrating producer/process organisation is recommended. The Forum considers a targeted conference of all UK users of essential oils, organised by Defra and the DTI, would be beneficial to promote this objective. The Forum also considers the formation of a British Essential Oils Producers Association would be very beneficial to this sector of the industry.*
15. *Research is required in breeding optimised varieties and improving agronomy and processing. The development of a research and development Centre of Excellence jointly funded by Government and industry is recommended. This is fundamental if the UK industry is to compete economically in the global market place.*
16. *Establish a UK brand with associated traceability and quality standards.*
17. *Producers should not miss the opportunity to broaden their income base and develop associated income such as tourism/educational centres where possible.*

There was little response from industry to the suggestion of a combined approach to developing essential oils, and the Government will not progress this further. Some individual companies have benefited from monies under the England Rural Development Programme.

Biolubricants

18. *Lack of education/awareness/product marketing across the whole supply chain is one of the main barriers to the greater usage of plant oil based lubricants in environmentally sensitive total loss applications. The Forum recommends that resources are made available to fund a demonstration project addressing the issues of enhanced cost-benefit of plant oil based lubricants for use in these applications. This would include promotion of pilot trials and promotion of the wider sustainable development benefits, and would require a substantial element of knowledge transfer and awareness raising to end users and original equipment manufacturers. To*

ensure its effectiveness this project should involve all elements of the supply chain and should link industry and research.

A Defra-funded demonstration project to raise awareness of the use of biolubricants in a number of applications is currently underway at the Eden Project, overseen by the NNFCC.

19. *Government should consider providing support by requiring large landowners and public procurement units such as local authorities and land drainage boards to lead by example in requiring contractors using chainsaws or outboard motors to use plant oil based or biodegradable lubricants wherever possible or practical, in the medium to long term. This measure is intended to help springboard the plant oil based lubricants market.*

The Environment Agency and Forestry Commission now require contractors to use lubricants meeting environmental specifications, and the use of bio-based chainsaw lubricants is now common.

The Government is committed to encouraging the use of bio-based materials where practicable and of proven environmental merit, for instance through the Strategy for Sustainable Development on the Government Estate, and is exploring the possibility of adding biolubricants to the Market Transformation Programme.

Appendix 3: Register of Forum members' professional interests

Chairman: Rob Margetts CBE

Chairman of Legal and General Group Plc; Chairman – Europe of Huntsman Corporation; Chairman of BOC Group Plc

Also, Director of Anglo American Plc; Chairman of Natural Environment Research Council; Governor and Fellow of Imperial College of Science, Technology and Medicine (until September 2004); Member of Council for Science and Technology; Director of Foundation for Science and Technology Council; Member of Advisory Committee on Business and the Environment (until 30 July 2001); Director and Trustee of Council for Industry and Higher Education (from 1 July 2001); Member of Council of Chemical Industries Association; Member of Goodison Group; Fellow of Royal Academy of Engineering; Fellow of Institution of Chemical Engineers.

Professor Dianna Bowles OBE

Director of CNAP, Weston Chair of Biochemistry, Department of Biology, University of York.

Also, Independent member of Defra Central Science Laboratory Ownership Board (until 2001); Member of Foresight Panel Task Force on "Unlocking the potential of industrial crops" (until 2001); Member of National Co-ordination Committee on the protection of biodiversity of the UK farm animal genetic resources (until 2002); Member of DTI "high level strategy group" to design a new agri-business strategy for the UK (2002); Member of European Molecular Biology Organisation; Founder and Editor-in-Chief of The Plant Journal (until 2002); Member of EU DGXII Life Sciences and Technologies External Advisory Group on Cell Factories (until 2003); Member of the Yorkshire Agricultural Society Grants and Education Sub-Committee; Member of the Yorkshire Agricultural Society Council; Member of BBC Rural Affairs Advisory Committee (from 2002); Member of DTI GM Science Review Panel (until 2004); Co-Founder and Director of the National Non-Food Crops Centre (from 2003); Founder of Heritage GeneBank (2001) and Director and Chair of The Sheep Trust (from 2002); Director of the National Non-Food Crops Centre (from 2003); Independent member of Scientific Advisory Board of the Swammerdam Institute for Life Sciences, Amsterdam (2003); Independent adviser to EU-US Taskforce for Biotechnology: Bioproducts from Plants (from 2004); Director of Amaethon Ltd (from 2004).

Dr David Carmichael

Director of Battle and Pears Ltd, Arable farmer in Lincolnshire.

Also, Commissioner, Agriculture and Environment Biotechnology Commission; Member, National Farmers Union.

Pamela Castle

Chairman of Environmental Law Foundation.

Also, co-Chairman of the London Sustainable Development Commission; Chairman of Thames Region Environmental Protection Advisory Committee of Environment Agency; Chairman of Business and Community Safety Forum (ODPM) ; Fellow of Chartered Institution of Wastes Management; Member of National Radiological Protection Board; Member of Port of London Authority Board; Member of Royal Society of Chemistry; Member of Law Society; Former Trustee of World Wide Fund for Nature (UK).

Dr Ray Marriott

Chief Executive of Botanix Ltd.

Also, Director of Elixarome Ltd, Phytech Ltd and H.G Hessleberger Ltd (all companies involved in growing and processing of hops and other non-food crops); Member of Foresight Panel Task Force on "Unlocking the potential of industrial crops", Chairman of the British Herb Trade Association and a Director of the British Essential Oils Association (BEOA).

Dr Richard Miller

Miller-Klein Associates.

Also, Director of Knowledge and Sustainability and employee of Uniqema (a member of the ICI group) which uses industrial crops (until 30 July 2001); ICI Senior Research Fellow and Technology Board member (until 30 July 2001); Member of Foresight Panel Task Force on "Unlocking the potential of industrial crops"; (30 July 2001); founder of Miller-Klein associates (a business strategy consultancy); Chairman of Magic Mathworks Travelling Circus (a charity dealing with mathematics education); Fellow of the Royal Society of Chemistry and Chartered Chemist; founder and Director of Vigorat (a knowledge management consultancy).

Andy Taylor

Director of Corporate Citizenship, Ford Motor Company Ltd.

Also, Board member of Faraday Plastics; business advisor to Baby Lifeline (UK Charity); member of Business in the Community East of England Regional Leadership Team.

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