

A strategy for non-food crops and uses

Creating value from renewable materials



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Department for Environment
Food and Rural Affairs

Acknowledgements

Thanks to all those involved in the development of this strategy, both within and outside Defra and the DTI, including those who contributed text and images and those who gave feedback on earlier drafts.

Useful Links

For further information about the work of Defra and the DTI, and for an electronic version of this strategy, please use the following websites:
www.defra.gov.uk
www.dti.gov.uk

Cover photography

Top left:	Farming landscape – wheat field (Pictures Crown Copyright courtesy of Defra).
Top middle:	Field of Echium plants at Springdale Crop Synergies. Echium oil contains omega-3 and omega-6 fatty acids, used for cosmetics and health products (Pictures Crown Copyright courtesy of Defra).
Top right:	Close-up of Ecobloc particles, a wheat-based packing material (Pictures Crown Copyright courtesy of CSL).
Bottom left:	Quinoa seeds. This crop has potential uses for textiles and in the paper and cosmetics industries (Pictures Crown Copyright courtesy of Defra).
Bottom middle:	Close-up of oilseed rape crop (Pictures Crown Copyright courtesy of Defra).
Bottom right:	Surf board made from hemp-based cloth and balsa wood, at the Eden project (Crown Copyright courtesy of Eden project).

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Ministerial Foreword

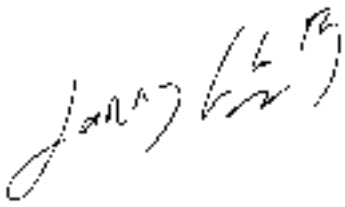
by Parliamentary Under Secretaries of State for the Departments for Environment, Food and Rural Affairs and Trade and Industry

As the Ministers with responsibility for work on non-food uses of crops we are delighted to launch our Non-Food Crops Strategy for England. The Strategy has been drawn up with stakeholders and is published jointly by our two Departments with support from other Government Departments. The Strategy, for the first time, sets out in detail our plans for the future development of non-food crops. It draws from existing work on sustainable food and farming, renewable energy, bioscience and sustainable consumption and production as well as the activities of the Government-Industry Forum on the Non-Food Uses of Crops.

We strongly believe this is an important sector with huge potential. Renewable materials derived from agricultural feedstocks and used for industry and energy can make a positive contribution to the Government's sustainable development agenda, deliver improved industry competitiveness and bring benefits to the rural economy. The UK with its world-class bioscience base is in a strong position to seize the exciting opportunities to utilise the huge diversity of plant metabolism for the manufacture of high value speciality chemicals, including pharmaceuticals, that are impossible or uneconomic to synthesise chemically.

In this Non-Food Crops Strategy we deliberately set out an ambitious programme of work. This means there are challenges ahead. We are committed to ensuring that the Government works with industry, academia, the science community, agricultural producers and consumers to promote awareness of crop-derived products; to identify new commercial opportunities; and, to encourage the development of robust supply chains to meet the needs of the marketplace.

We have made a strong start to this process by establishing the National Non-Food Crops Centre as a nucleus for non-food crops in the UK. We shall continue to build on this base, working closely with all stakeholders to deliver the actions and turn this vision, that a significant proportion of demand for energy and raw materials should be met through the commercial exploitation of science from crops, into a reality.



The Lord Whitty of Camberwell

Nigel Griffiths JP MP

Sustainable development – a better quality of life for everyone, now and for generations to come

Foundations for Our Future, Defra 2002

Our rapid progress in understanding the manufacturing capability of living plants opens up major opportunities for the UK in developing new products of high utility from renewable resources

CNAP – Centre for Novel Agricultural Products, 2004

It is almost certain that the current value of the non-food crop sector does not reflect the economic contribution which these crops could make

House of Lords Select Committee on Science and Technology, 1999

The NFU believe that Non-Food Crops provide a unique opportunity to address wide-ranging issues as diverse as climate change, environmental degradation, rural development and agricultural diversification

National Farmers' Union, 2004

Summary

The Government is committed to sustainable development. Renewable materials, produced by agriculture as feedstocks for industry and energy, will play a vital part.

Plants sustain life and have amazing diversity of form and function. Agriculture, manufacturing industry, end-user businesses and the science base can work together in using this diversity to deliver benefits for the economy, the environment and society.

Crops provide renewable materials which can substitute for fossil and mineral materials and so reduce depletion of the earth's resources. In addition they can

- Benefit the environment by reducing greenhouse gases, cutting waste and pollution, helping biodiversity and prudent use of natural resources
- Improve the economic competitiveness of industry through development of new markets and products
- Produce social benefits by stimulating rural communities through establishment of local industries and providing new markets for farmers.

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, 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.

These potential gains are extremely significant, but to realise them a concerted approach is needed to build the necessary links between science, agriculture and industry, to disseminate knowledge and encourage changes both in industrial practice and in society. Some non-food crop uses such as textiles are widely known. Others may be less familiar such as plastics made from starch-based polymers. There are implications for consumer behaviour – for example in choice of 'green' products, and co-operating with waste disposal strategies to realise the benefits of biodegradable materials. Wider understanding of these issues is an important aim of the strategy. The Strategy will draw on experience gained in the DTI/Defra Framework for Sustainable Consumption and Production.

The strategy for non-food crops needs to be viewed as part of a wider agenda for innovation and diversification in agriculture and industry to enhance the UK's competitive performance, in a way which contributes to environmental objectives. Non-food uses of crops will develop in new directions as science and technology advance and environmental factors and legislation change. Bioscience applications can have an important role in areas such as conversion of crop materials to chemical feedstocks and development of high value products such as pharmaceuticals where the UK has particular strengths.

Realising the potential benefits of non-food crops depends crucially on the development of markets, with products competing effectively on cost as well as environmental grounds, to pull innovation through to commercial application. This is not just about novel crops but also existing mainstream arable crops. At the farming end of the supply chain producers will be more inclined to move into non-food markets if the returns are attractive compared with other potential uses of the land. The Common Agricultural Policy reforms to be implemented in 2005 provide a new stimulus to diversification which may provide significant opportunities for non-food markets for crops.

The building of supply chains, and delivery generally of the strategy's objectives, relies on a cohesive plan of action combining incentives, regulation, research and other forms of analysis, information and promotion. The successful development of markets depends on actions by industry, but – within EU constraints on state aids and single market rules – the Government will provide direct incentives, and indirect ones for example through procurement policies, to encourage non-food uses of crops where there are clear advantages for sustainability. The Government takes a strong responsibility for ensuring delivery of the benefits set out here, as these outcomes are public goods from which the nation will benefit, in terms of environmental, social and economic advance.

In the immediate future the Government is taking a series of actions to:

- Increase public funding of research on non-food crops and stimulate projects jointly funded with industry, and establish a major programme of demonstration projects
- Apply a concerted push to develop biomass as a key contributor to the renewable energy targets
- Set indicative targets for biofuels sales for road transport, following public consultation on implementation of the EU Biofuels Directive
- Use the CAP reform agreement to stimulate diversity in production
- Build the operations of the National Non-Food Crops Centre
- Establish workstreams to take forward key focus areas emerging from previous research and demonstrations and the recommendations of the Government-Industry Forum on Non-Food Uses of Crops
- Encourage use of crop-derived materials, where these are shown to have advantages for sustainability, through public procurement policies
- Develop regional strategies and networks to disseminate actions and good practice.

The Government has worked with stakeholders in producing this strategy and will take a strong lead in driving forward further developments for non-food crops. Because of the cross-cutting nature of the subject the strategy is published jointly by Defra and DTI with support of all other interested Government departments. As agriculture is a devolved activity the strategy relates to England but is relevant to sustainable development policies generally and some of the measures and policies discussed such as fiscal measures apply to the whole UK.

As renewable materials from crops have been promoted for a number of years and technological change is continuous this strategy has to be defined in the context of and alongside existing activity. It will therefore be made up of actions which are already in hand and those which need to be put in place. Within the strategy there are key strands:

- **Consumers** need to be able to make informed choices and raising awareness of the potential benefits of the use and disposal of non-food crops is important for success
- Raising **industry** awareness and promoting emerging opportunities and markets so that new products, processes and supply chains can develop
- Exploiting **technology development** and ensuring the UK's world-class science base is engaged
- Undertaking the **'blue sky' thinking** needed to give the UK an edge over the competition.

Action Plan

This action plan gives effect to the various strands of the strategy. Some of the actions are already in place, while others involve new initiatives the need for which has been identified in previous analyses and in the consultations which have led to publication of the strategy. Unless otherwise stated the actions fall to Defra to take the lead on delivery.

The details of the action plan are set out overleaf.

Eleven illustrative case studies have also been included in this strategy, the first of which is shown below.

Case Study:

Starch compound tyres

The new Goodyear GT3 tyre, with BioTRED technology is the first tyre to incorporate vegetable crop starch into the tread. It uses a starch-based filler compound to replace carbon black and silica that are conventionally used in tyres.

BioTRED reduces rolling resistance producing a 5% saving in fuel consumption. BioTRED also requires less energy in production, dramatically reducing CO_2 emissions. Other benefits include lower noise levels and improved handling in wet conditions reducing the risk of aquaplaning.

This new tyre technology has been fitted as original equipment to a wide range of cars from manufacturers such as Fiat, Ford, Rover and Peugeot. Over one million GT3 tyres have now been supplied to motorists since its launch in 2001.

Promoting non-food uses of crops through the provision of information and knowledge

The Government is providing support for the National Non-Food Crops Centre (NNFCC) which has been established to form a single centre of expertise on all non-food uses of crops. The NNFCC will work with Government and research organisations and all parts of the supply chain to disseminate research findings and build links between science, agriculture and industrial users. It will identify consortia for research proposals. The NNFCC will engage in a wide-ranging programme to take forward non-food crops, stimulate market development and analyse and support environmental advance through the use of these crops.

The NNFCC will manage on Defra's behalf the new programme of demonstration projects.

Government will use its own communication channels, and encourage others, to give information on beneficial non-food uses of crops and on areas, such as waste management, where the behaviour of the general public and of industry users will need to be changed if the benefits, for example of starch-based polymers, are to be delivered.

Government will support development of rural enterprises based on local processing and marketing of non-food crop products by providing advice and information delivered through the regional business advice networks. These include specific packages designed to assist start-ups and support innovation within small and medium-sized enterprises (SMEs). The NNFCC will work with regional partners including the Regional Development Agencies in developing programmes for advice and dissemination.

Actions begun:

- ✓ Build up the National Non-Food Crops Centre as single centre of expertise on non-food crops issues
- ✓ NNFCC managing major programme of demonstration activity
- ✓ Government support for start-ups and innovation for SMEs.

New actions:

- Develop communications strategy for non-food crops to provide information to the consumer to influence behaviour and support environmentally beneficial choices and to industry on new commercial opportunities
- Develop educational materials on the potential of non-food crops to substitute for fossil material
- NNFCC to work with Regional Development Agencies, Government Offices, local authorities, regional assemblies and advisory bodies to develop programmes for advice and dissemination of information
- Establish programme of business support and training for farmers to help co-operative working and new business development
- Prepare and host a range of case studies on the NNFCC website to publicise non-food crop uses
- Consider a programme of industrial secondments to the NNFCC
- Develop close co-operation between seed producers, farmers and industrial users by the development of NNFCC instigated networks.

Analysing strategic issues and identifying barriers to development of non-food crops

The Government-Industry Forum on Non-Food Uses of Crops was established in 2001 to provide strategic advice to Government and Industry on development of non-food uses of crops. The Forum completed its work in September 2004 and its role will be subsumed in the NNFCC which will provide a forum for discussion of both strategic and specific issues relating to non-food crops. The NNFCC will establish a strategy group which will provide expert knowledge and opinion to inform the NNFCC's advice to Government and to assist in analysis and recommendations for policy development.

Government will commission, or carry out, economic analyses on specific sectors where cost is inhibiting the uptake of renewable materials or where environmental or other wider benefits need to be considered in the evaluation of particular uses. Workstreams connected with the follow-up to the Innovation and Growth Team Report on the Environmental Goods and Services Sector are relevant and cover Technology, Regulation, Procurement and Skills. Linkage with Regional Economic Strategies will enable the exploitation of geographical advantages.

The Agriculture and Environment Biotechnology Commission (AEBC) provides the Government with strategic advice taking account of ethical and social issues as well as the science. The AEBC is looking at the potential role of biotechnology in non-food agriculture. It is conducting three specific case studies in biofuels, biopharmaceuticals and biomaterials. For each of these, they will carry out a gap and redundancy regulatory analysis and investigate the relevant policy interactions. The Commission also plans to explore public perceptions of biotechnology and non-food crops.

Actions begun:

- ✓ Completion of the Government-Industry Forum's work programme
- ✓ NNFCC to establish strategy group to provide strategic advice on the development of the non-food crops sector
- ✓ AEBC study on biotechnology and non-food agriculture under way.

New actions:

- Develop new programme of work and workstreams to take forward recommendations of the Government Industry Forum on the Non-Food Uses of Crops
- Commission sectoral analyses assessing economic and environmental impacts with the aim of defining 3-5 key sectors or products with the potential for early development
- Align sectoral analyses with Regional Economic Strategies to differentiate competitive advantages of geographic regions
- Following the AEBC study, Defra and DTI to define a strategy for the development of high value-added products including pharmaceuticals from crops.

Funding scientific research

Defra has doubled the expenditure on its non-food crops research programme in the period 2003/04 to 2004/05 to £2m per annum, and the budget is now increased by a further £1.3m to promote innovation through supply chain assessment and dissemination. This programme will target applications with clear potential for commercial uptake and for delivering environmental gains. As explained in the Defra Science and Innovation Strategy (May 2003) the R and D programme aims to provide knowledge required for development of a competitive agri-industrial materials sector while achieving improved environmental outcomes. It has specific components on bio-energy and other renewable material uses. A new Defra LINK-style programme for non-food crops is in preparation to grant-aid industry led pre-commercial R and D investment; this will be financed partly from the additional funding referred to above, with contributions from industry partners. The recently established Research Priorities Group will provide strategic advice on development of the Defra research programme.

The BBSRC Crop Science Review of April 2004 recommended that BBSRC should develop a strategy for research on non-food uses of crops to provide the science base to serve current and future producer and end-user requirements. The DTI's Innovation Report sets out a detailed action plan for translating scientific and technological discovery into new and profitable products and services. It also discussed the need for skilled jobs building on the science base to produce value-added products. In DTI's technology programme, the April 2004 call for a knowledge transfer network in bioprocessing may be relevant to the production of high value-added healthcare products from plants. Possible future calls are likely to feature sustainable consumption and production and bioprocessing R&D, subject to the views of the new Technology Strategy Board. The DTI also provides business support products for small and medium-sized enterprises including a 'Grant for Research and Development' and a Grant for Investigating an Innovative Idea which provides assistance to SMEs in buying-in specialist advice to plan specific ideas for innovation. [1]

The Government programmes complement industry-funded initiatives such as the innovation awards made by the Home Grown Cereals Authority.

There is an increasing interest in Europe and elsewhere in industrial biotechnology, as evidenced by the "EU Action Plan for the Life Sciences and Biotechnology" and the "Environment Technologies Action Plan" which specifically refers to bio-based environmental technologies such as biosensors, and bioremediation. The EU Competitiveness Council met in May 2004 and, at the behest of the UK and several other Member States, acknowledge industrial biotechnology, including biomaterials, as a key tool for delivering economic growth, competitiveness and sustainable industry development. These areas are expected to be major beneficiaries both of EU industrial policy and EU research expenditure – notably Framework Programme (FP). The EU has been actively encouraging relevant bids under existing FP6 priorities and has announced the establishment of two new European Technology Platforms – Plant Genomics and Sustainable Chemistry (including biomaterials and biocatalysts). There are also opportunities in plant genomics with a proposal under the next FP for "Plants for the Future".

The DTI will ensure that the UK continues to play a leading role in helping the EU develop a co-ordinated approach to a European Industrial Biotechnology Network (including aspects of agri-biotechnology) working with EuropaBio (the European Trade Association for Biotechnology).

[1] (http://www.dti.gov.uk/technologyprogramme/

All Government funding for research and development on non-food crops and uses will be targeted on areas where sustainable technologies show particular potential in the UK taking account of existing strengths and where there are particular prospects for sustainable development gains. UK science can also contribute to solving global problems.

Actions begun:

- ✓ Defra non-food crops research programme doubled to £2m per annum
- ✓ New programme on supply chain and assessment worth £1.3m per annum being rolled out.

New actions:

- Development of new LINK-style non-food crops programme
- BBSRC to develop a strategy for research on non-food uses of crops
- Output from supply chain programme to include publicity fact sheets available on the NNFCC website
- Develop, at the European level if possible, a central life cycle inventory database to support the sustainable development of the sector.

Contributing to the low carbon economy with renewable fuels and energy

DTI, Defra and the Forestry Commission will work together, with close involvement of the energy and farming industries and other interested parties, to ensure a vigorous and cohesive approach to the development of renewable energy from biomass.

Existing funding of £100m under the Bioenergy Capital Grants Scheme and the Energy Crops Scheme, with further grants currently under consideration, aims to stimulate the planting of around 15,000 hectares of energy crops by the end of 2007. A new Defra-led Bioenergy Infrastructure Scheme with funding of £3.5m was launched in October 2004 to provide additional support for the development of supply chains.

The Renewables Obligation remains a prime driver of development of renewable energy including production from energy crops and forestry. The Obligation was amended to encourage co-firing with biomass and this is expected to contribute significantly to development of the energy crop sector. The Government response to the Royal Commission on Environmental Pollution report "Biomass as a Renewable Energy Source" draws together and sets out the key activities the Government has in place to develop the biomass sector. Further support for bio-energy projects is being considered in the context of the Spending Review settlement, the Renewables Innovation Review and progress on existing projects. The Government will also continue to support development of energy crops through research to improve crop yields and disease resistance and through promotional work.

In addition to the above, the Government has commissioned an external study to assist both itself and the biomass industry in optimising the contribution of biomass energy to renewable energy targets, as well as to sustainable farming, forestry and the rural economy. The study team will work with the energy, agricultural and forestry industries, potential users of biomass and other stakeholders to identify barriers in the supply chain and ways of overcoming them. The study team is headed by Sir Ben Gill and includes expertise from the energy industry and an economic consultancy. It is due to report in October 2005.

A strategy for non-food crops and uses

A framework for future support of alternative transport fuels has been set out in the 2003 Pre-Budget Report. The 2004 Budget confirmed for three years a 20 p/litre duty reduction for biodiesel and bioethanol. The Government has consulted on the targets to be set under the EU biofuels directive for the percentage of the fuel supply to be met by biofuels in 2005 and 2010, and the means by which the targets could be delivered and is considering future policy.

Actions begun:

- ✓ Project development through the Bioenergy Capital Grant Scheme
- ✓ Introduction of the Bioenergy Infrastructure Scheme October 2004
- ✓ Amendment of the Renewables Obligation to facilitate co-firing
- ✓ Research to improve crop yields and disease resistance for energy crops
- ✓ Duty reductions introduced for biodiesel and, from 1 January 2005, for bioethanol
- ✓ Energy Act 2004 provides a framework that would enable the introduction of a Renewable Transport Fuels Obligation
- ✓ External year-long study commissioned to analyse issues relating to biomass development
- ✓ Publication of new planning guidance (PPS 22) to facilitate renewable energy projects
- ✓ Review of the climate change Programme which will take full account of the potential contribution of biomass fuel and energy.

New actions:

- DTI review of the Renewables Obligation in 2005/06 which will consider whether the effectiveness of the Obligation can be improved with regard to achieving renewables targets including waste management options other than conventional "mass burn" incineration technology
- In the review of the Rural Development Regulation and planning for the second England Rural Development Programme the Government will consider what measures are needed to support effectively the establishment and delivery of energy crops as part of a supply chain for biomass heat and power
- Government will confirm the 2005 target for the introduction of alternative transport fuels by the end of this year. Government will consider a longer term target and policy measures in the light of the recent consultation
- Further measures are under consideration to develop the biomass heat market in the light of the RCEP report.

Case Study:

Green, clean, renewable energy

Reproduced with permission of Gareth Gaunt

Reproduced with permission of John Strawson

'Biomass' from short rotation willow coppice is a sustainable source of heat and power for UK industries. With increasing pressure to reduce emissions of carbon dioxide, which contribute to global warming, there is a renewed interest in alternatives such as solid fuel biomass.

When Gareth Gaunt set about designing the Carlshead business complex to make use of redundant farm buildings, he wanted the heating and power system to be produced from a local renewable resource. He installed a Talbott Biomass 'C3' series heating system, which is fuelled by willow coppice grown on his own farm. Around 60ha of willow coppice provide the 100-120 tonnes of willow woodchips needed to produce all of the annual heating needs as well as 600 tonnes that is sold to a local power station for co-firing with coal. The system will allow Mr Gaunt to sell between £8,000-£10,000 worth of energy a year to his tenant, a high-tech software firm. The system requires little maintenance, just weekly filling of the fuel hopper and removal of the small amount of ash produced.

Gareth Gaunt's work on the conversion of traditional stone barns into an innovative business centre won one of Britain's top rural architectural awards, the Country Land and Business Association's Farm and Country Building Award. His enterprise has not only developed an environmental fuel source, but has also helped to support new job opportunities in the area.

Contributing to improvements in waste disposal and tackling pollution and health risks

A study by Imperial College shows that biodegradable polymers have life cycle advantages over petrochemical based alternatives in relation to fossil energy consumption and global warming potential. In the framework of the Waste Implementation Programme the Government will promote measures to divert biodegradable waste, including products manufactured from plants, away from landfill. The Government will work with the Composting Association and industry to develop sustainable disposal systems for this material, and to promote information including a logo for biodegradable packaging. As the benefits of biodegradable packaging can be lost unless the products are actually composted once they become waste, the Government will support technological advances, in waste management research and support, as well as in the development and use of renewable materials. It will ensure that waste disposal policies take full advantage of the opportunities offered by the available technologies for using these materials in industrial product manufacture.

The Government will draw on existing case studies and demonstration work to promote the use of biolubricants and biosolvents in areas where they can cut pollution and health risks and provide a viable alternative to mineral-based products.

Actions begun:

- ✓ Targets in place for the reduction of biodegradable waste going to landfill
- ✓ Logo developed to facilitate identification of biodegradable packaging
- ✓ Demonstration work commissioned on biolubricants and biosolvents to show benefits.

New actions:

- Assess and demonstrate the potential for mechanical separation systems, such as those using near infra red technology, for biodegradable waste
- Support the development of an eco-label for biolubricants, to be in place by end 2004
- In order to support uptake, prepare publicity material to show that biolubricants and biosolvents are technically robust, deliver environmental gains and are affordable
- NNFCC to liaise closely with the Waste and Resources Action Programme and the Waste Implementation Programme to ensure synergies are exploited and consistent messages disseminated.

Case Study:

Cleaning up the press

Many different solvents are used in the printing industry for removing ink and debris from machinery. The UK printing industry is the second largest user of solvents in the UK with many traditional solvents containing high levels of Volatile Organic Compounds (VOCs), which pose a potential risk to workers health and to the environment. There are moves across all industries to reduce the emissions of VOCs.

Pictures Crown Copyright courtesy of CSL

Peter Best of BestPrint & Design Ltd was approached to participate in a short demonstration project to test commercially available plant-based solvents on his manually-cleaned printing presses. The plant-based solvents used were principally based on oilseed rape oil and its derivatives. No reduction in cleaning performance was observed, while the overall volumes of solvent used were reduced, which offset the additional purchase costs. Significantly lower levels of odour were associated with the plant-based products, which was seen as a significant improvement in the working environment.
BestPrint & Design Ltd was so taken with the performance that they have continued to trial the oilseed rape based cleaning product. "We were pleased to help in the trials of plant-based solutions and are seriously considering using them in the future." Peter Best, BestPrint & Design Ltd.

Contributing to sustainability in the building and construction industries

The Better Buildings Summit in October 2003 launched a Sustainable Buildings Task Group to deliver better, environmentally friendlier buildings. The Group examined the sustainability of building materials, including the major role which renewable materials can play in construction and insulation of buildings. The Group made its recommendations in May and Government responded in July.

The Framework for Sustainable Development on the Government Estate will incorporate the Task Group's guidance, as well as the advice of the Office of Government Commerce's "Achieving Excellence in Construction" standards, to highlight the contribution crop-derived materials can make to the targets set for Government buyers.

Defra on behalf of the Government-Industry Forum on Non-Food Uses of Crops commissioned a detailed report from the Buildings Research Establishment and the Construction Industry Research and Information Association on the potential uses of sustainable building materials. The study looked at products which are available now and are likely to become available in the future. It showed that there is great potential for non-food crops to reduce the environmental impact of construction.

Actions begun:

✓ Publicise and disseminate BRE/CIRIA report on sustainable building materials.

New actions:

- Ensure that the new National Code for Sustainable Building, recommended in the Sustainable Buildings Task Group report, takes account of the potential of crop-derived building materials
- Commission work to define priority options for the use of crop-derived building materials, establish technical detail and demonstrate methods of use.

Case Study:

Wool Insulation – adding value to low value fleeces

Thermafleece is a wool-derived insulation material used in the construction industry for a wide variety of roof, wall and floor insulation tasks. Second Nature UK, based in Cumbria, utilise a blend of coarse coloured wools from breeds such as Swaledale, Herdwick, Welsh Mountain and Scottish Blackface to provide a market for material which in recent years has low market value.

The ability of Thermafleece to absorb and release water vapour improves the ability to retain warmth in winter (increasing peak temperatures by up to 4ºC) and cool in summer (reducing peak temperatures by up to 7ºC) compared to traditional glass-fibre insulation. In addition, 'Thermafleece' uses only 14% of the energy required to produce conventional glass-fibre insulation. It is both durable, and fire and insect proof. It is easier to handle and install than traditional insulating materials, where protective clothing and masks are required during installation. It can be recycled for other environmentally friendly applications.

In 2004, Second Nature, set up by farmer Christine Armstrong, won The Queen's Award for Enterprise for development of Thermafleece. Thermafleece insulation is approved by the British Board of Agrément (BBA), which provides independent testing of products for the construction industry. Thermafleece is currently being used in individual building projects, in local authority housing and by the National Trust for renovation and conservation schemes.

Increasing use of sustainable products through Government procurement policies

Procurement policies will be applied to encourage environmentally friendly products and services, including use of crop-derived materials.

In applying the Framework for Sustainable Development on the Government Estate the Government will maximise opportunities for the sustainable use of renewable materials. It will implement the report of the Sustainable Procurement Group to ensure that environmental standards are applied in public procurement of goods and services.

The Government will also incorporate the work of the DTI Innovation and Growth Team for the Environmental Goods and Services Sector to ensure that Government procurement will, where possible, stimulate markets for innovative environmental technologies, including novel uses of crops.

Actions begun:

- ✓ Potential for crop-derived materials highlighted in the Framework for Sustainable Development on the Government Estate
- ✓ Defra considering opportunities for the use of biomass heating in offices.

New actions:

- Defra will consult on the potential to add non-food crops derived materials to the Market Transformation Programme/Quick Wins list which sets out current and future minimum standards for government buyers
- Prepare product datasheets which will enable public procurement nationally and regionally to give a lead on the use of crop-derived products.

Case Study:

Pro-active environmental procurement

Pictures Crown Copyright courtesy of CSL

For the last four years Defra has had a policy on procurement of printing services which requires suppliers to use plant-based inks, where possible, as well as aqueous paper coatings and recycled paper.

Approximately 1000 different publication titles are commissioned each year by Defra under such procurement contracts. Plant-based inks are now commercially available in the UK from a variety of printing materials supply companies. These inks are successfully used by all 35 printers on Defra's preferred supplier list on all conventionally printed materials.

Use of plant-based inks benefits both the environment and the health of the print industry workforce. The benefits include a reduction in use of hydrocarbon solvents and volatile organic compounds (VOCs) in the workplace and a lessening of the risks associated with contamination while working in close proximity to presses.

The introduction of plant based inks fits well with Defra's overall procurement policies, which require all products used and purchased by the Department to be as environmentally friendly as possible.

Biodiversity

Changes in farming practices will impact on biodiversity. Local impacts have to be considered when national and international climate change targets and other benefits are being delivered. Development of the non-food crops sector should make as positive a contribution as possible to sustainability in its widest sense including biodiversity.

Actions begun:

- ✓ Scrutiny of applications to plant energy crops includes a determination of the need for an environmental impact assessment, consultation with statutory authorities and assessment of soil, water and landscape impacts
- ✓ Implementation of CAP reform with the further development of cross compliance to deliver biodiversity benefits
- ✓ Review of the potential impacts of energy policy on UK biodiversity, including assessments of energy crops and forestry residues, commissioned by Defra.

New actions:

- Commission parallel study (see third action above) on other non-food crops to identify significant impacts of crops and their management systems on biodiversity including an assessment of the effect of increasing diversity of crop production
- Prepare best practice guidance to help farmers maximise profits from non-food crops whilst delivering biodiversity benefits
- Develop a case study on maximising crop yields (and profits) while minimising impacts by using low input systems and managing field margins and other non-productive areas sensitively to protect and enhance biodiversity
- Assess the potential to develop an accreditation scheme for non-food uses of crops to certify sustainability.

Using CAP measures to promote non-food crops

The decoupled Single Farm Payment will be introduced in 2005, giving a strong stimulus to diversification of farming and innovation. Environmental safeguards will apply both for food and non-food crops under the cross-compliance conditions. A new aid for fuel and energy crops has been introduced from January 2004.

There is scope to combine elements of the new environmental Entry Level and Higher Tier Schemes on the same holding with energy crops. Other schemes under the England Rural Development Programme will continue to the end of 2006; these include the Energy Crops Scheme which aids the establishment of crops for heat and power generation, and the Rural Enterprise Scheme which funds diversification projects including those involving non-food crops. Discussions in the UK and EU on a successor programme to the ERDP will take full account of the ongoing potential contribution of non-food crops.

Actions begun:

- ✓ Publicise how CAP reform can stimulate diversity in production
- ✓ Discussions of successor programme to ERDP take account of potential of non-food crops.

New actions:

- Initiate collaborative working with other Member States to develop non-food crops policies and support through, for example, research and development at the European level
- Consult industry on future of flax and hemp processing aid within the context of CAP reform.

Using environmental regulation to achieve environmental outcomes with benefits for non-food crops

The DTI's Innovation Report identified the importance of the regulatory environment in achieving desired environmental outcomes in a way that promotes innovation and business opportunities. A cross-government project team led by DTI is looking at three areas of environmental policy: eco-design, vehicle emissions and the Integrated Pollution Prevention and Control Directive (IPPC). From the results of these studies, in addition to sector-specific recommendations, general guidance will be produced on how to make regulations innovation-friendly. This guidance will be published by DTI and incorporated into Cabinet Office recommendations on policy appraisal. Taxes like the landfill tax encourage consideration of alternative products which can be recycled or disposed of other than to land. Incorporating the intention to grow non-food crops in Regional Economic Strategies will mean that Strategic Environmental Assessments will consider impacts.

Actions begun:

- ✓ Projects on the eco-design of televisions and the application of regulations implementing the Integrated Pollution Prevention and Control Directive (IPPC) have been completed
- ✓ A project looking at the effects of innovation in car design and other measures on vehicle emissions was completed in October
- ✓ Development of alternative packaging materials in response to the introduction of the landfill tax.

New actions:

- ■ A joint Defra-DTI high level conference will be held using these pilot projects as a basis for discussions between business and government on how to make environmental regulation more innovation and competitiveness-friendly.

Case Study:

Natural fibres for biocomposites

Natural fibres are becoming an established industrial material in the motor industry. Hemp and kenaf fibres, reinforced with polymer resins and moulded into a composite panel, are now used to produce car panels in place of conventional, non-renewable materials such as glass fibre or aramid.

Natural Fibre Panels. Pictures Crown Copy courtesy of Daimler Chrysler

Materials containing natural fibres have a number of advantages over conventional alternatives. Natural fibre panels are typically 20% lighter than glass fibre reinforcements, which improves fuel efficiency throughout the life of the vehicle. Using natural fibres also helps to safeguard the health of the workforce by reducing the risk of allergies and irritation associated with working with glass fibres. In addition, natural fibres have been associated with reduced tool wear in the moulding process and have better acoustic properties, reducing cabin noise.

The market is potentially large, as the UK alone currently produces around 240,000 tonnes of composite materials for car panels every year, and natural fibre composites are taking an increasing share of that market. Ford has introduced natural fibre reinforced panels on all new Mondeos, and Hemcore Ltd in the UK process hemp fibres for the European motor industry.

Instigate blue sky thinking to underpin long-term development of the sector

In an age of rapid technological change market developments need to be monitored closely. The development of partnerships in the EU has the potential to ensure Member States share expertise in a way which avoids duplication of effort and underpins competitiveness in a global market. Potential developments in the longer-term need to be evaluated to maintain a competitive edge.

New actions:

- The NNFFC will identify emerging opportunities and markets and support technology development from other countries
- Develop key strategic partnerships at a European level to help the EU to compete in a global non-food crops products market
- Explore and evaluate the longer-term potential of non-food crops as a source of raw material in a more modern and technologically advancing society.

Chapter 1: Scope and context of the strategy

1. The Government's Strategy for Sustainable Farming and Food (SFFS)[2] stated in December 2002 that it was committed to extending the competitive non-food uses of crops, and agreed with the recommendation of the Policy Commission on the Future of Farming and Food that we needed a long-term strategy for creating and exploiting opportunities for non-food crops. This document aims to set out accordingly the reasons for supporting non-food crops and the long-term objectives, with an action plan for delivering them.

2. Much of the development of non-food uses of crops which is in prospect relies on scientific discovery, both in plant science and in industrial technology, and its translation to the market. Many of the uses are highly innovative and will contribute to the Government's objectives to promote enterprise, innovation and competitiveness, and achieving the vision of the UK as a key knowledge hub in the global economy. As well as informing and influencing policy development, the successful exploitation of research will enable industry to deliver innovative products and services to the market. A key outcome sought from the strategy is to maintain and enhance the UK's scientific capability and to pull through innovation. The development of non-food crop uses will require research and innovation at every stage of the production process and generate many opportunities for improving the competitive position of UK industry. Innovation is therefore a key cross-cutting theme which we will build into all of the strategic priorities set out below.

3. Government has a commitment to promote sustainable development which otherwise would not be achieved through operation of market forces. Sustainable development requires achievement of four objectives at the same time: social progress, environmental protection, prudent use of natural resources, and high and stable levels of economic growth and employment. Both the SFFS and the science and technology strategy summarised here are permeated by the overall vision of sustainable development. The strategy can make a significant contribution to the sustainable development 'headline indicators'[3] for biodiversity, waste management and agricultural productivity.

4. Defra has defined five strategic priorities which will direct policies within this over-arching aim. Non-food crops may be able to contribute to these priorities in the following ways:

[2] (http://www.defra.gov.uk/farm/sustain/newstrat.htm.)

[3] (http://www.sustainable-development.gov.uk/indicators/headline/index.htm)

Climate Change and Energy	Plants can be used to produce fuel for transport, heat and electricity, substituting for fossil fuels and thereby assist in reducing carbon emissions and climate change. They can also substitute for fossil materials in a wide range of other industrial applications such as polymers in plastics, lubricants, building materials and feedstocks for chemical production.
Natural Resource Protection	Subject to environmental safeguards (eg to avoid depletion of water supplies from large-scale biomass production) non-food crops can increase biodiversity in the farmed landscape, or at least have a neutral effect compared with food production.
Sustainable Consumption and Production	Plant-derived products have potential to provide: • alternatives to non-renewable materials in ways which reduce economic costs and environmental impacts. • innovative, higher value added products which meet more consumer needs and improve business competitiveness while reducing energy use, pollution and waste.
Sustainable Rural Communities	Non-food crops can generate new business opportunities in rural areas, providing additional diversity and innovation beyond the enhancement provided by a more sustainable food chain.
A Sustainable Farming and Food Sector	Non-food crops can provide new markets and opportunities for agriculture. This is of special significance following the CAP reforms decoupling support from production of particular crops. In this respect non-food crops are not different in nature from food crops, but through their potential additional environmental benefits they can help to deliver a more sustainable farming sector contributing to society's wider needs.

5. The non-food crops strategy complements and builds on existing policies, including:

- the Sustainable Development Strategy[4]
- the Waste Implementation Programme[5]

[4] (http://www.defra.gov.uk/environment/sustainable/index.htm.)

[5] (http://www.defra.gov.uk/environment/waste/review/factsheet1103.pdf)

- the Framework for Sustainable Consumption and Production (Defra and DTI 2003)[6]
- the 2003 Energy White Paper[7]
- the Innovation Report[8]
- the programme for implementing the 2003 CAP reform agreement[9]
- the Defra and DTI Science strategies[10]
- the England Biodiversity Strategy[11]
- the Renewables Innovation Review[12]
- the Soil Action Plan[13].

6. Following a recommendation from the House of Lords Select Committee report in 1999, the Government-Industry Forum on Non-Food Uses of Crops (GIFNFC)[14] was created in 2001 to provide strategic advice, and has published three important annual reports with a series of case studies. Issues highlighted by the Forum, which have informed the development of this strategy, include:

- The need to evaluate whether particular uses of renewable materials are environmentally sustainable
- The role of science and innovation especially bioscience
- Impact of the CAP
- The role of awareness, demonstration activities and public procurement
- Fiscal measures.

7. In 2003 the new National Non-Food Crops Centre[15] was established, funded with contributions from Defra, DTI and industry. Its role is to disseminate information, to identify opportunities and to bridge the gap between research findings and commercial markets. As set out in the Action Plan below, the NNFCC's role will be developed further with the new programme of demonstration projects and, with the winding up of the Government/Industry Forum, provision of strategic advice on issues relating to non-food crops. The Agriculture and Environment Biotechnology Commission also offers strategic advice to Government on biotechnology issues which impact on agriculture and the environment, including non-food agriculture.

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6 (http://www.defra.gov.uk/environment/business/scp/index.htm)

7 (http://www.dti.gov.uk/energy/whitepaper/)

8 (http://www.dti.gov.uk/innovationreport/)

9 (http://www.defra.gov.uk/farm/capreform/index.htm)

10 (http://www.defra.gov.uk/science/S_IS/default.asp)
(http://www.dti.gov.uk/scienceind/strategy.pdf)

11 (http://www.defra.gov.uk/wildlife-countryside/ewd/biostrat/index.htm)

12 (http://www.dti.gov.uk/energy/renewables/policy/introduction.pdf)

13 (http://www.defra.gov.uk/environment/land/soil/actionplan.htm)

14 (http://148.252.1.12/gifnfc/index.asp)

15 (http://www.nnfcc.co.uk)

8. Public intervention may be justified in cases of 'market failure' where the market on its own does not provide sufficient incentive to produce the desired goods. For example the problem of climate change arises because there are insufficient incentives to reduce greenhouse gas emissions. Using farmed crops for industrial purposes is not an end in itself. The government needs to look at how best to address market failures by using the best methodologies to assess all of the costs and benefits of non-food crops. It is important that the market produces the correct incentives especially given the limitations on availability of land and other resources and their other potential uses both for industrial and non-commercial purposes.

9. The term 'use' is treated as involving some form of further industrial process, and does not cover the use of plants for amenity or ornamental purposes. This strategy does not explicitly address forestry policy whose objectives are set out in the England Forestry Strategy[16], but it does take account of the areas such as energy policy where farm crops and forestry play complementary roles. Farmers have the opportunity to diversify through the use of farm woodlands, complementing the use of energy crops. The strategy is relevant to products from forestry such as high-value chemicals, and also to 'crops' from animal production such as wool.

10. The strategy does not at this stage set overall quantified targets for non-food crops, but it assimilates the targets and obligations already agreed by Government, for instance in relation to renewable energy and waste, and will include targets to implement the EU Biofuels Directive[17] when these are set. One challenge for an overall target is how to combine meaningfully relatively low-value products, which may be grown on a large scale, with high-value speciality products which may use very little land. The strategy does nevertheless aim to stimulate increased production of sustainable non-food crops, and it will be monitored to gauge success against this yardstick. A clear conclusion from the discussions which have fed into the strategy to date is that significant expansion of non-food crop production in the UK, which in international terms is currently low, is both possible and desirable.

Case Study:

Plant-derived therapeutics

Sativex is a plant-derived product under development for the relief of symptoms of multiple sclerosis, neuropathic and rheumatoid arthritis pain. Sativex is derived from hemp (Cannabis sativa) and contains extracts of cannabinoids THC (Delta-9 Tetrahydrocannabinol) and CBD (cannabidiol), Sativex's principal active components.

Severe neuropathic pain has proved difficult to treat and current evidence suggests that none of the currently available drugs are effective in more than 50% of patients, so there is a need for new alternatives.

Reproduced with permission of Springdale Crop Synergies Limited

The drug has been developed by GW Pharmaceuticals and is currently being assessed by the UK Medicines and Healthcare products Regulatory Agency to enable release under licence in the UK.

[16] (http://www.forestry.gov.uk/forestry/hcou-4ucf8j)

[17] (http://www.dft.gov.uk/stellent/groups/dft_control/documents/contentsservertemplate/dft_index.hcst?n=10249&l=2)

Chapter 2: Environmental outcomes

Tackling global warming

11. Burning fossil fuels, laid down many millions of years ago, exacerbates global warming through emission of carbon dioxide. Methane, another powerful greenhouse gas, can be emitted when organic matter degrades in anaerobic conditions such as landfill. Burning of plant biomass is regarded as CO_2 neutral since the CO_2 released is closely matched by the quantity absorbed during the growth of the plant, subject to the amount of energy used in production and processing of the crops. *Electricity and heat* can be generated from crops such as willow and miscanthus and from wood, by combustion and steam generation or more advanced technologies such as pyrolysis and gasification. *Motor vehicles* can run on petrol and diesel substitutes made from plants.

12. The Government has set demanding targets for the UK's contribution to tackling global warming, going beyond those in the Kyoto Protocol, with a UK target to reduce greenhouse emissions by 20% compared to 1990 levels by 2010. The Government also wishes the UK to be on path to cut emissions by some 60% by about 2050. To realise these targets will require a radical shift to a low-carbon economy with fundamental changes to practices in industry and society. They cannot be achieved without a major shift to renewable sources of fuel, energy and materials for product manufacture. Looking at ways to reduce transport distances could also play a part in this process.

13. Latest figures (March 2004) indicate that UK carbon dioxide emissions rose in 2003 although the UK remained on course to meet the Kyoto targets. The Government is currently reviewing the UK Climate Change Programme to assess the potential for strengthening existing policies or introducing new ones to achieve our climate change objectives. The potential use of renewable materials will be an important factor in this review.

14. The longer-term goals for cutting carbon emissions were announced in the Energy White Paper in 2003, in which the Government set out a far-reaching strategy for moving to a low-carbon economy. The White Paper confirmed the target of 10% of electricity to be produced from renewable sources by 2010, with the aspiration to double this by 2020. The Government has announced plans to increase the level of the Renewables Obligation to 15.4% by 2015/16, to give more confidence to the renewables industry through providing increased certainty post 2010. The 2010 target and 2020 aspiration pose a considerable challenge and the Government is looking to the biomass sector (including energy crops and forestry) to make a substantial contribution. A substantial programme of Government support is in place to stimulate biomass energy and further measures are under consideration.

15. Co-firing of biomass in power stations with fossil fuel is seen as a useful way to stimulate the market for energy crops and develop supply chains. Amendments to the Renewables Obligation that came into effect on 1 April 2004 have changed the rules on co-firing to encourage energy crops. Co-firing developments on a significant scale using energy crops grown in England are now in prospect.

16. The Renewables Innovation Review in 2003 recommended that particular encouragement should be given to development of small biomass plants, using proven technology. These are regarded as posing fewer risks than larger plants using advanced technology and would require fuel to be transported over shorter distances. The Review concluded that it would be feasible, taking account of land availability and other constraints, for biomass to contribute around 6% of the total UK electricity supply by 2020.

17. Many projects are in place or planned to switch to *renewable heat generation*, including combined heat and power (CHP), using energy crops or wood. The Government is strongly encouraging these developments, and other public bodies including Regional Development Agencies and local authorities have a major role to play in introducing local or regional strategies for renewable heat and power generation. A key to success with these strategies is an integrated approach to the development of supply chains from production and collection of biomass through to generators and end users. Policy for biomass energy also needs to be consistent with other Government commitments, including the targets for recycling of waste wood packaging. Steps need to be taken to avoid the diversion of this type of wood for energy use rather than recycling, when there are alternative sources of wood available as biomass.

18. The impact of *transport* on the environment can be reduced through better, cleaner vehicles and fuels. The Government's Powering Future Vehicles Strategy provides a framework, alongside the Energy White Paper, for decisions and actions which will promote the development and take-up of low-carbon vehicles and fuels. The Alternative Fuels Framework in the 2003 Pre-Budget Report set out the rationale for decisions on government support for biofuels including their contribution to sustainability.

19. As noted above, the need for further measures to meet the UK's targets for reducing emissions is being considered in the review of the UK Climate Change Programme. It is clear however that the transport sector, which produces one quarter of the UK's total carbon emissions, must make a full contribution and carbon savings from biofuels could play a significant part.

20. Crops producing biofuels (biodiesel and bioethanol) used in place of conventional fuels currently deliver greenhouse gas reductions of around 55%, though future technologies offer the prospect of even greater carbon savings. Blends, with conventional fossil fuels, of up to 5% can be used without engine modification or significant changes to the supply chain. Existing technologies for biofuel production are well established in many parts of the world using esterification of oil crops or fermentation. More advanced technologies, including use of straw and woody material, are under development. These currently face cost barriers but in due course may make a significant contribution, potentially including the development of hydrogen fuels.


Oilseed rape crop

21. The Government is supporting biofuels through a duty reduction of 20p per litre for biodiesel which will be extended to bioethanol from 1 January 2005. The incentive for biodiesel has triggered sales which are now around two million litres per month from over 130 outlets in the UK, based on production from waste cooking oil and imported product. The EU Biofuels Directive requires Member States to set indicative targets for the use of biofuels. The Government consulted on the implementation of these targets in the UK and is considering the development of future policy on biofuels. As well as targets the consultation considered the possibility of a Biofuels Obligation, enhanced capital allowances and taxation based on the inputs to production rather than the final product. Responses to the consultation are now being evaluated. Substituting 5% of fossil fuels with biofuels could lead to around 1 million tonnes of carbon saving in 2010.

22. Renewable plant materials can contribute to cutting greenhouse gases in many further ways where they substitute for fossil-based materials. By using physical, chemical and biochemical processes renewable materials can be converted into a wide range of products for industrial

manufacture including polymers, lubricants, solvents, surfactants and speciality chemicals and healthcare products. A study carried out for the European Commission in 2001 under the European Climate Change Programme[18], estimated that more extensive use of renewable materials in manufacturing (in areas other than fuel and energy) could reduce EU carbon dioxide emissions by about 8 million tones by 2010 – or a much higher amount of perhaps 30 million tonnes if indirect reductions associated with product performance improvements were taken into account.

Protecting resources

23. Fossil fuels are a finite resource and their continued use is unsustainable in the longer term. As they diminish, they will become harder and more expensive to extract. Already, North Sea oil and gas production is declining. By 2006 the UK is expected to be dependent on imported gas, and to be a net oil importer by 2010. Much of the UK's economically viable deep-mined coal is likely to be exhausted within 10 years. Composted material has potential to substitute for peat. Agricultural land is also finite but, provided that it is cared for, it is a constant or improving resource capable of providing energy and materials from crops in a sustainable way for as long as they are needed.

24. A principle set out in the SFFS was that we should sustain the resource available for growing food and supplying other public benefits over time. These resources include soil, equipment and farming skills. Diversifying farming, including growing crops for non-food uses, helps to maintain the resource capability to grow food, fuel or materials as required, enhancing resilience against economic or environmental risks including interruption of external supplies and climate change.

Reducing Waste

Case Study:

Packaging materials from wheat

Ecobloc produced by Green Light Products Ltd is a wheat-based packaging material, with characteristics similar to those of expanded polystyrene. It is completely biodegradable and non-toxic. Over 2,600 tonnes per year of UK wheat flour is now processed into starch and extruded into many packaging material forms. Ecobloc is currently used to protect fragile items and electrical goods used in electronics and other industries during transit and storage.

Pictures Crown Copyright courtesy of CSL

Ecobloc provides benefits both to industry and the environment through its simple disposal procedure. Unlike conventional plastic packaging products, Ecobloc does not have to be separated from cardboard and it can simply be recycled with cardboard reducing both costs and time. Where disposed of as waste, Ecobloc will not persist in the environment and will biodegrade naturally.

Formed in 1994, Green Light Products aim was to provide a low cost alternative packaging material that was completely biodegradable. In 2003 Green Light Products won the Home-Grown Cereals Authority (HGCA) Enterprise Award scheme, and were awarded £37,000 to fund development of this new generation of eco-friendly packaging.

[18] (http://www.defra.gov.uk/environment/climatechange/CM4913/summary/index.htm.)

25. England currently produces 29m tonnes of municipal waste each year, 77% of which goes to landfill. The quantity of waste arising is increasing by about 2.5% each year. Landfill sites are becoming increasingly scarce with particular problems in the South East and North West. In addition, the EU Landfill Directive requires the UK to reduce the volume of biodegradable municipal waste being sent to landfill. Materials derived from crops, including packaging made from starch based polymers, can make a contribution to reducing the volume of landfill waste, provided that arrangements are in place for an increase in the amount of biodegradable material actually composted or otherwise used in ways which avoid disposal to landfill or other environmental damage. Such biodegradable packaging would lose its benefit and become a disbenefit in terms of the UK's Landfill Directive objectives if the material is sent instead to landfill. The Government will therefore encourage the development of schemes to increase the composting of these biodegradable materials. In the first instance this would be best achieved by companies promoting the use of biodegradable packaging where it is retained within their control and can be directed to an appropriate disposal route.

26. The Government's plans for reducing and eventually reversing the steady increase in waste are set out in Waste Strategy 2000 and the response to the Strategy Unit Report "Waste Not, Want Not"[19]. The strategy sets out the measures and targets for reducing, reusing, recycling and composting waste all of which can reduce the volumes going to landfill. The UK's Packaging Regulations, which implement the EC Directives on Packaging and Packaging Waste, are of particular relevance since the recovery and recycling targets to be met by obligated businesses apply to all packaging of whatever materials. This includes biodegradable packaging. It will therefore be important that, alongside steps to encourage the use of such biodegradable materials, steps are also taken to develop the capacity for composting these materials, and to inform consumers and business users of the importance of doing this. It is also important that biodegradable polymers degrade fully and do not impede composting processes or contaminate the composted end product. The European and UK standards EN13432:2000 and BSI PAS 100 (BSI 2002) are relevant here. Producers, ie businesses with producer responsibility obligations, that use such packaging will need to be aware of the importance of seeing that the material is actually recovered.

27. The Government is already strongly encouraging the composting of green waste – at home, at municipal civic amenity sites and when separately collected by local authorities. Plant-based manufactured products can likewise be added to the composting waste stream. The Government has also made clear, through the waste hierarchy, that energy from waste is a viable sustainable waste treatment and is, after reuse and recycling, preferable to landfill. Linking this to energy policy, incineration with 'energy recovery' may therefore in some circumstances, where this forms part of local authorities' waste management strategies, be a sustainable method of disposing of biodegradable material.

[19] (http://www.defra.gov.uk/environment/waste/review/index.htm.)

28. The Government is also working with the Composting Association and other bodies to develop appropriate sustainable disposal systems. There is a 'biodegradable' logo for packaging material, based on a Europe-wide standard with independent certification. The Composting Association is the certifying body in the UK. The biodegradable packaging industry is discussing with the European Commission a proposal for a voluntary 'Environmental Agreement' to apply this standard. As part of its Waste Strategy, the Government has also set up a development group to identify measures to improve the marketing of waste-derived compost to all sectors. An example of a particularly beneficial use would be to return composted waste for increasing soil fertility for crops such as short rotation coppice, improving further the sustainable cycle of production.

29. Government action complements the considerable development work taking place in industry. The Home Grown Cereals Authority for example has funded development of a loose fill packing material made from wheat flour and water which is used to cushion delicate consumer goods within cardboard boxes – see case study on page 30. It can be readily composted, is safe to wildlife and produces no harmful residues when composted or burnt. Similar products made from starch-based polymers have considerable potential. The Government will also seek to draw on useful approaches adopted in other countries, such as the German 'Kassel project' in which a large amount of biodegradable packaging was made available and labelled, with intensive publicity to encourage consumers to separate the compostable waste. Reaction to the pilot was generally favourable, with 89% of respondents saying that it was a good or very good idea. 65% of the biodegradable packaging was composted, and there was no increase in the amount of conventional plastic being left in the compostable waste by consumers.

30. Other EU Waste Directives and future targets under the 6th Environmental Action Programme set a range of obligations which need to be addressed in relation to the disposal of waste of many kinds, including motor vehicles, hazardous chemicals, packaging, batteries, oil and electrical goods. Renewable materials may provide cleaner alternatives or better processing methods to reduce and manage these waste products, provided that they are recovered, recycled or disposed of appropriately.

Reducing pollution

31. Oils from crops, because they biodegrade, can produce lubricants which are environmentally superior to those derived from mineral oils. As an example of good current practice the Environment Agency and Forestry Commission require such biolubricants to be used by their staff or contractors in equipment such as chainsaws. They also require biodegradable hydraulic oils to be used, to reduce the risk of pollution if a pressure hose bursts. Most biodegradable hydraulic oils have been made from modified mineral oils because of perceived performance issues with the crop-based equivalents, but Defra has commissioned work to trial and demonstrate the use of crop-based hydraulic oils under UK conditions.

Case Study:

Plant-based lubricants

Plant-based lubricants can be produced from plant oils and fulfil the same functions as mineral oil lubricants, while reducing environmental impacts associated with their uses. Plant-based lubricants typically exhibit much faster rates of biodegradation than traditional mineral oils, i.e. measured in days rather than years.

Chain bar lubricants derived from plant oils have been successfully used by the Environment Agency since 1997, and more recently by the Forestry Commission.

The majority of work carried out by these organisations and on their behalf by contractors is conducted in environmentally sensitive areas, commonly near watercourses. Both the Environment Agency and the Forestry Commission took a long-term pro-active approach, to substitute all lubricants for chain bars with plant-based lubricants.

All plant-based lubricants used by the Environment Agency must not invalidate warranties and guarantees given by the Original Equipment Manufacturers and must be biodegradable and non-toxic according to recognised Organisation for Economic Co-operation and Development (OECD) tests. No major difficulties were encountered when switching to plant-based lubricants for chain bars.

32. Use of plant-based cleaning materials (biosolvents) in the printing industry could reduce the use of volatile organic compounds which can create workplace health and fire hazards. About 40,000 tonnes of solvents are used in each year in the UK printing industry. Some other European countries and the USA use a much higher proportion of biosolvents. Because their mode of use is different from that of mineral solvents, there is an educational barrier to overcome to bring about change. Defra is funding further technical assessment and demonstration work on these issues.

33. In addition to greenhouse gas benefits, biofuels for transport are generally considered marginally better than fossil fuels in terms of air quality, with clear advantage for particulate emissions.

Biodiversity and landscape

34. Agriculture has an effect on biodiversity in and around the fields on which it is practised. Factors which increase yields – minimal waste, weeds and pests – tend to reduce the food supply for wildlife. The introduction of more intensive and specialised arable and grassland systems over the last fifty years is believed to have contributed to a major decline in the populations of farmland birds and other wildlife.

35. Whether a particular non-food crop has a beneficial or detrimental effect on biodiversity depends largely on local circumstances – what crop it is replacing, and whether it is adding to diversity of cropping in an area or creating a new monoculture. Ploughing up semi-natural habitat such as unimproved grassland to grow arable crops would be bad for biodiversity. There are variations between crops – for example oilseed rape, particularly if spring sown, is generally considered better for farmland birds than winter wheat. Some non-food crops such as plants to produce essential oils can typically be grown with low inputs of chemicals. An admixture of short rotation willow coppice in an area of intensively managed grassland has been shown to bring positive benefits in terms of habitat and food supply for wildlife.

36. Defra has a specific Public Service Agreement target to reverse the decline in farmland bird populations. This is particularly relevant where potential large-scale changes are in prospect such as the use of substantial areas of farmed crops for fuel and energy production. The decision to be taken on UK biofuels targets, and measures to deliver them, will take this factor into account together with other environmental and economic considerations. The rate of decline in the farmland birds index continues to slow in line with the Defra target.

37. There is potential under EU rules for set-aside land to be used for some types of non-food crop production and substantial areas of set-aside land are already used for these purposes (figures in para 67 below). All crop production qualifying for the new Single Payment under the CAP reform agreement will be subject to environmental cross-compliance rules. In addition the planting of trees (including coppice) on a significant area requires an environmental impact assessment, as does the planting of any crop on previously uncultivated land where this would have significant environmental effects. Environmental assessment is a condition of grants under the Energy Crops Scheme. This provides a safeguard against both local adverse effects and wider effects such as depletion of water supply.

38. The effects of introducing non-food crops may be more subjective in the context of landscape and trends in land use changes would need to be considered. But a patchwork of different crops is considered typical of the farmed landscape in parts of England and non-food crops will tend to add to this diversity and provide a wide range of habitats.

Courtesy of David Smallwood

39. The effects of changes in farming practices on wildlife will continue to be an important part of research programmes. The Government has commissioned a review of the potential impacts of energy policy on UK biodiversity, including assessments of energy crops and forestry residues. This study, which has been let under Defra's Horizon Scanning programme, is due to be completed in December 2004.

Chapter 3: Industrial innovation and bioscience

40. The Prime Minister has stated that "We want the UK to be a key knowledge hub in the global economy, with a reputation not only for world-class scientific and technological discovery but also for turning that knowledge into new and profitable products and services"[20].

41. Plants can synthesise an immense range of compounds. As 'cell factories' they contain structures which can be used by the physical, chemical and biochemical sciences to produce useful materials as fibres, starch, oils, solvents, dyes, resins, proteins, speciality chemicals and pharmaceuticals.

42. The UK is extremely well placed with its science and technology base to play a leading role in innovative use of renewable materials to benefit the competitiveness of UK industry while contributing to environmental improvements. Science and technology is expected to contribute particularly to development of high-value novel products as well as enhancing production technologies for products with large-scale uses.

43. Many industrial applications of crop materials are already in use. For example it has been estimated that 15% of global oleochemical production from plants enters non-food markets. About half of the 9m tonnes of starch produced in the EU from maize, wheat and potatoes is used for non-food purposes. In recent years there has been a strong increase in interest in particular applications, such as biofuels and the use of natural fibres in building construction and as a replacement for fibreglass in composite materials for example in vehicle manufacture. Some of these are bulk applications while others are of particular interest to small and medium-sized enterprises seeking highly innovative specialised markets.

44. A little over 10% of the UK's petroleum consumption is as a chemical feedstock rather than energy. There is considerable scope for replacing this with plant-derived feedstocks for fermentation and other processes to produce an equivalent or greater range of final products.

45. Physical and chemical sciences can combine to produce new applications. Defra is for example funding development of new polymer resins to create fully biobased composites, such as boards in which the fibre component is made from hemp, flax or timber and the resin binder from rapeseed oil rather than the commonly used synthetic chemical resins. The Building Research Establishment has assessed favourably uses of hemp and other renewables as building materials and insulation products.

46. In some cases cost is a significant barrier to development of renewable materials, but this will improve as technologies evolve and economies of scale come on stream. Some renewable products have distinct advantages of functionality such as biodegradability, lack of toxicity and delivery of specialised functions such as controlled release of drugs from starch-based capsules.

[20] Rt. Hon.Tony Blair, Prime Minister Foreword to the Innovation Report (http://www.dti.gov.uk/innovationreport/)

47. An assessment carried out for the European Climate Change Programme in 2001 (quoted in para 34 above in relation to greenhouse gas savings) gave the following estimates of prospects in the EU for the main sectors, based on expected evolution without specific new policy initiatives to stimulate a shift to renewables:

Market Sector	Total Consumption Market (1988) ('000 tonnes)	Renewable Consumption (1988) ('000 tonnes)	Potential in 2010 ('000 tonnes)	Potential Share in 2010 (%)
Polymers	33,000	25	500	1.5
Lubricants	4,240	100	200	5.0
Solvents	4,000	60	235	5.9
Surfactants	2,260	1,180	1,450	64.0

48. Bioscience has the potential to extend and increase the range of beneficial products identified above. The Government-Industry Forum on Non-Food Uses of Crops commissioned a study on the opportunities for applying bioscience to non-food crops from the Institute of Innovation Research, University of Manchester[21]. In reviewing the study, the Forum was keen to identify the opportunities for greatest benefit to the UK and was particularly impressed with the opportunities for high value speciality crops in controlled glasshouse conditions.

49. The study noted the potential opportunity to use the increased knowledge of biological materials gained through genomics to improve the efficiency of downstream processing of crops. One potential application is the use of GM enzymes to process crops which may not themselves be genetically modified, for instance in the processing of biomass by enzyme hydrolysis to yield bioethanol. The Strategy Unit's study on the costs of benefits of GM crops[22] noted that future developments of GM crops could potentially offer benefits of greater value and significance in the UK. Many of these opportunities are in the non-food and medicinal uses of crops.

50. The commercialisation of these uses in the UK is subject to the Government's precautionary approach to all GM applications, and approval is subject to the strict safety regime for human health and the environment required by the European legislation. The Secretary of State for Environment, Food and Rural Affairs made clear in her statement on GM policy[23] that there is no case for a blanket ban on GMOs, but that each request for authorisation must receive a comprehensive prior assessment of any potential risk to human health or the environment. These assessments involve considerable cost and rigour and no applications for consents for non-food crops or uses in the UK have yet been made.

[21] Prospecting Bioscience for the Future of Non-Food Uses of Crops, Institute of Innovation Research, University of Manchester, January 2004

[22] Field Work: weighing up the costs and benefits of GM crops. Strategy Unit, July 2003

[23] Hansard, 9 March 2004, Column: 1382.

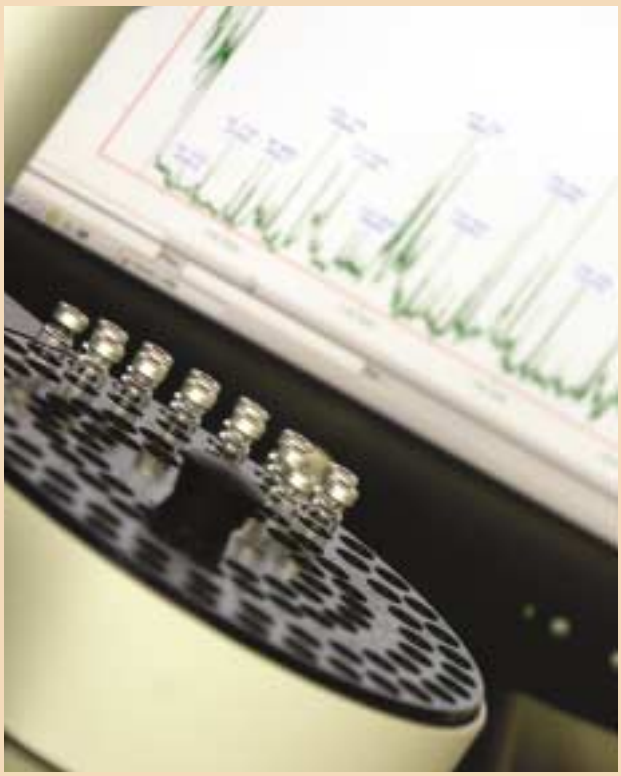
51. The promotion of non-food crops must take account of other objectives such as trade liberalisation. It is not essential for all the science, growing, processing and use to take place in the UK for the UK to derive benefit. Technology developed here may be licensed to countries with a climate more suited for a particular crop. In other cases, new crops may be grown in the UK on the basis of science done in other countries, or crops grown elsewhere may be processed in the UK and marketed here or exported as value added products

Case Study:

Plant-derived vaccines

There is an urgent need for cheap and effective vaccines and medicines in developing countries. Most vaccines are too expensive and cannot be produced in sufficient quantities to make a global vaccination programme possible.

The use of genetically modified plants to produce these medicines has been explored for almost 15 years. Plants are the most efficient producers of protein, requiring simple nutrients, water and light, and production of pharmaceuticals in plants is likely to be cheaper than current conventional methods. The potential exists to "farm" pharmaceuticals on a commercial scale in small contained areas, allowing the production of large quantities of pharmaceutical products. This will be important for major diseases such as HIV/AIDS, malaria and tuberculosis for which the global requirement will be extremely high.



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Many researchers around the world have demonstrated the proof of concept for these recombinant "plant-derived pharmaceuticals". In Europe, a research consortium comprising scientists from eleven EU countries and South Africa have just been awarded 12 million euros (£8m) from the EU's 6th Framework Programme to perfect the technologies for the production of plant derived antibodies and vaccines against HIV/AIDS, rabies, tuberculosis and diabetes from genetically modified plants. Clinical trials of the first plant-derived products are planned to take place in 2008.

Chapter 4: A new direction for farming

52. The SFFS underlined the need for farm diversification, to help to sustain jobs and provide new employment opportunities through new markets and new sources of income. Innovative non-food uses of crops, and their by-products which may hitherto have been regarded as waste, can contribute strongly to these opportunities.

53. The major reform of the CAP agreed in 2003, by allowing the decoupling of support from particular products, will give new flexibility and provide a strong impetus to farmers to innovate and to seek new markets. In the UK the new decoupled single payment will be introduced at the earliest opportunity in 2005. The CAP reform agreement also introduced a new payment of 45 euro/ha for fuel and energy crops grown on non set-aside land (subject to an EU maximum of 1.5 million ha.), and continues to permit the growing of crops for specified non-food purposes on set-aside land.

54. The need for continual improvements in efficiency has led to an increasing level of specialisation on UK farms. Specialisation may reduce costs, increase efficiency or simplify management, but can leave the farmer vulnerable to increased risks from weather, pests, diseases, or changing markets. A more diverse business may be cushioned, when one enterprise fails, by the income from the others. Crops for fuel or raw materials are likely to have different price dynamics and may prove to be complementary to other farming enterprises, and hence help to protect farm incomes.

55. In the present day significant development of non-food crops will only occur if markets exist with the user industries, and if the return to the farmer is attractive compared with other potential uses of the land. The position for UK non-food crop areas in 2003 is shown below. 93,527 ha of non-food crops were grown on set-aside in 2003. These figures do not necessarily give the whole picture: a number of crops can be used for either food or non-food uses; non-food crops may be grown on non-set-aside land; and part of the crop may be used as food while co-products are used as industrial raw materials or fuel.

2003 UK figures

Crop	Area (ha.)
Forest material (1)	2,803,000
UK agricultural land area	18,449,000
UK arable land area	4,507,000
UK "set aside" arable area	681,000
Oilseed rape for industrial use (on set-aside only) ('00' and high erucic acid rape (2))	82,142
Flax	1,976
Hemp (3)	2,438
Short rotation coppice and miscanthus for energy use	1,822
Crambe on set-aside (4)	3,596
Essential oils and herbs on set-aside (5)	52
Linseed (of which 1,915 ha. on set-aside (6))	36,915
Poppy	1,500
Other non-food crops on set-aside	4,000

Notes:

(1) Not included in the agricultural land area, but shown for comparison. Forest products can complement short rotation coppice as a renewable fuel source.

(2) Grown to produce erucamide, a slip agent in plastic films, lubricants and industrial oils.

(3) For many potential applications including fibre boards for construction and the automotive industry, insulation, horse bedding. Further uses are made of hemp oil.

(4) Used in slip agents, plasticizers, lubricants.

(5) For cosmetics, fragrances and personal care.

(6) Producing machine oil, paints, varnishes and linoleum.

56. Overall these areas of non-food crops form a relatively small proportion of the UK agricultural area. There are however clear prospects of significant expansion in the short and medium term:

- Planting of energy crops (short rotation coppice and miscanthus) is expected to increase rapidly in the next two years in response to developments in the energy market stimulated by Government incentives and farmer interest in diversification
- Crops such as hemp and crambe, which have hitherto been grown on a small scale for niche markets, show prospects for significant expansion. It has been estimated for example that the area of crambe could expand in the short term to 50,000 ha with gross margins of £500/ha
- Oilseed rape is currently being grown for export for biodiesel production, providing returns comparable to those available for oilseed crops for the food market. The development of a UK biofuel industry has the potential to provide a major new market for UK-grown crops.

Case Study:

Slip agents from plants

Crambe (Abyssinian Mustard) oil is a major source of erucic acid, which typically comprises 58% of the oil, used to produce erucamide. Erucamide is commonly used as a slip agent in the plastics industry and acts a lubricant to ease the production of plastic parts. It is used to provide a thin layer on the surface of extruded plastics thereby reducing friction. It is commonly used as a surface treatment on carrier bags to help prevent them sticking together.

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Traditionally erucamide has been derived from High Erucic Acid Rape (HEAR), but Crambe gives rise to a higher yield of erucic acid per unit of processed oil. The thermal stability of the erucamide derived from Crambe is also superior to that derived from HEAR which is an advantage where shelf life and colour are important issues.

Crambe was introduced commercially in 2000. The crop area has increased from approximately 400 ha in 2000 to 4,000 ha in 2004, with a demand for up to 20,000 ha predicted for 2005. The UK produces oil of excellent quality and significant future demand is anticipated.

57. As explained in Chapter 3, there are also prospects for considerable expansion, provided the industrial markets develop, in production of crops for polymers, lubricants and solvents. In the case of polymers, to benefit UK agriculture it is likely that the starch feedstocks would come from wheat, where the industry will be competing with imported maize and potato starch.

58. Non-food crops can generate employment in processing and marketing. It has been estimated that a 100,000 tonnes bioethanol production plant for example would create 60-85 jobs on the production site and in fuel blending and transportation and sustain 550 jobs in agriculture. (To put these figures in context, roughly ten bioethanol plants of this size would produce fuel at a level equating to the 'reference value' for an indicative target in the EU Biofuels Directive for 2010). Some industrial applications will require significant capital investment and development of infrastructure and research capacity. All of this would inject revenue into rural areas and enhance local employment.


Eden project. Crown Copyright courtesy Eden project

59. A recurrent theme of the report of the Policy Commission on the Future of Farming and Food was the need for reconnection between farmers and their consumers. Many recommendations made in that report and picked up in the SFFS were about restoring the missing link between grower and consumer. While these focused on the food sector, non-food crops offer similar opportunities where consumer perceptions and understanding can help to build markets. Defra has commissioned work at the Royal Botanic Gardens and the Eden Project to develop ways of engaging public interest in non-food uses of crops, and stimulate consumer demand for renewable materials. With power generation there is a need to engage people in debate about how some of their heat and electricity needs can be supplied from local crops, not least so that local planning decisions can be seen in the light of the need for sustainable development. If children are to grow up with understanding of sustainability they need to know not only where their food comes from, but also about the crops that help to make their clothes, their soap, the materials which make up their houses and the fuel which heats them.

60. Technological development will play a key part in the introduction of new and enhanced farming techniques, complementing development work with industrial processes. Examples are

- A barrier to the use of hemp as a textile fibre is that it has to be left in the field to "ret" before the fibre is extracted. The fibre suffers losses of both yield and quality if there is persistent rain after harvest. Defra is supporting work on new methods of harvesting hemp to separate the fibre mechanically without retting and work on the identification of varieties and traits better suited to the UK
- Industry is assessing possibilities for harvesting of 'whole crops' for fuel or energy production, which would remove the need for separation of grain and straw
- Most plant breeding work is carried out in the private sector. Defra funds development work to support 'public-good plant breeding', including the development of improved varieties of energy crops in pursuit of significant cost reductions and environmental gains.

61. The expansion of non-food crops envisaged in this strategy has significant implications for how agricultural land will be used in future. The scale of the change in land use will depend on many factors, especially the rate of development of large-scale uses for fuel and energy. Taking the figures in Chapter 2 above for biomass electricity, and transport fuel at the level of the EU indicative target for 2010, a land area of roughly 1.3 million hectares of land would be required, equating to about 7% of the UK's agricultural land. This assessment does not take account of yield increases for arable crops which are expected to continue. It would be expected that some of the land classified as set-aside under the CAP would be used for non-food crops. This assessment also implies some displacement of food crops by non-food crops, which could for example reduce the UK's exportable surplus of cereals and use some of the land which could be released as a result of reforms to the EU sugar regime. Individual farmers will only grow non-food crops on a significant scale if they provide an attractive return, but beyond the economic factors non-food crops can provide extra value through the environmental benefit they can bring. A shift of agricultural resources towards producing materials for industry would therefore bring overall advantages for sustainable development.

Chapter 5: Delivery and monitoring of the strategy

62. The lead Departments which have drawn up the strategy, Defra and DTI, will establish a Project Board responsible for closely monitoring its implementation. This Board will include representatives of industry, NGOs and consumer groups. It will prepare a report on progress and outcomes achieved two years after its publication. As indicated in the Action Plan above, partner organisations including other Departments and the NNFCC will play a key part in delivery, and they will contribute to the assessment of results achieved. The group to be established to inform the NNFCC's strategic advice will be asked specifically to assess the results of the strategy and options for its further development.

63. Implementation of the strategy needs to take account of regional priorities. Each of the English regions, through the Government Offices for the Regions and the Regional Development Agencies, has drawn up its own regional implementation plan for the SFFS[24]. These plans will be developed further, and the Government has asked the regional bodies to take specific account of this non-food crops strategy in setting and monitoring their specific targets.

64. Indicators to measure outcomes from the strategy include areas of non-food crops grown and volumes used by industry. Further work will be put in hand to consider ways of extending the range of indicators. This will take account of the sustainable development criteria for assessing specific uses, prepared by the Government-Industry Forum on Non-Food Uses of Crops (listed in Appendix 1). The work will review the need for further research in areas such as assessment of particular crops for biodiversity and other environmental criteria.

65. This strategy forms an overview of the current state of development of non-food crops and measures for realising their potential benefits. It will be kept under review and the report referred to above will be a focus for discussion on its further development. All organisations and individuals with an interest in the subject are encouraged to continue to contribute ideas and comments, direct to Government or through the arrangements established with the NNFCC to provide strategic advice on the issues relating to the use and development of non-food crops and their integration in wider Government policies.

November 2004

[24] (http://www.defra.gov.uk/farm/sustain/regstake.htm)

Appendix 1

Sustainability criteria set by the Government-Industry Forum on Non-Food Uses of Crops for assessment of particular non-food uses:

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.

Glossary

AEBC	The Agriculture and Environment Biotechnology Commission
BBSRC	The Biotechnology and Biological Sciences Research Council
BRE	Buildings Research Establishment
BSI PAS 100 (BSI 2002)	The British Standards Institution's Publicly Available Specification for Composted Materials
CAP	Common Agricultural Policy
CHP	Combined Heat and Power
CIRIA	Construction Industry Research and Information Association
CNAP	Centre for Novel Agricultural Products
CO_2	Carbon dioxide
Defra	Department for Environment, Food and Rural Affairs
DfT	Department for Transport
DTI	Department of Trade and Industry
EN13432:2000	European harmonised standards for packaging recoverable through composting and biodegradation
ERDP	England Rural Development Plan
EuropaBio	The European Trade Association for Biotechnology
FP	Framework Programme
GIFNFC	Government-Industry Forum on Non-Food Uses of Crops
GM	Genetically modified
GMOs	Genetically modified Organisms
IPPC	Integrated Pollution Prevention and Control
LINK	A means by which the Government encourages collaborative research for innovative and industrially-relevant research to support its wealth creation and quality of life goals.
NFU	National Farmers' Union
NGOs	Non-Governmental Organisations
NNFCC	National Non-Food Crops Centre
OECD	Organisation for Economic Co-operation and Development
PPS	Planning Policy Statement
RCEP	Royal Commission on Environmental Pollution
SFFS	Strategy for Sustainable Farming and Food
SMEs	Small and Medium-sized Enterprises
VOCs	Volatile organic compounds

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