

CREATING VALUE FROM RENEWABLE MATERIALS

A strategy for non-food crops and uses
Two year progress report

November 2006



dti


defra
Department for Environment
Food and Rural Affairs

Cover picture – Harvesting of Industrial Hemp – courtesy of Hemcore

Hemp is a versatile plant with many innovative uses. It is used in a range of industries, including the paper, automotive, textile, insulation, construction, energy and animal bedding industries.

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Published by the Department for Environment, Food and Rural Affairs.
Printed in the UK, October 2006, on material that contains a minimum of 100% recycled fibre for uncoated paper and 75% recycled fibre for coated paper.

PB12282

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Ministerial Foreword



David Miliband
Secretary of State for the Department
of Environment, Food and Rural Affairs



Alastair Darling
Secretary of State for the
Department of Trade and Industry

Following two years of work, we are very happy to see publication of this interim progress report on the joint Defra/DTI Strategy for non-food crops and uses.

In launching the Strategy in 2004, the Government outlined its commitment to the development of renewable materials to provide energy, fuels and industrial products. The Government had recognised the potential of these sectors and the key part they can play in helping to meet sustainable development targets and bringing benefits to industry competitiveness, the rural economy and the environment. For the first time in England, the Strategy provided a clear framework for engaging all those involved with renewable materials and a detailed action plan aimed at building supply chains and facilitating the future growth of renewables markets.

Two years on, the report points to some good progress in taking forward what has been an ambitious programme of work, cutting across the responsibilities of a number of Government Departments and involving a range of delivery partners. There are signs that the bio renewables industry is expanding in the UK. At the start of the supply chain we have seen increases in the numbers of farms and areas of land producing crops for non-food uses. At market level, there has been growth in both production and consumption of UK biofuels, increases in the use of biomass to produce heat and power, and exciting developments in phytopharmaceuticals and the use of renewable construction materials

We have also seen the continued growth of the work and reputation of the government funded National Non-Food Crops Centre (NNFCC) and the launch of the DTI Bioscience for Business Knowledge Transfer Network (KTN) in which NNFCC is a partner. These bodies and other KTNs have a key role to work directly with industry and bring together science and technology to create the step-changes in innovation that are essential for global competitiveness.

Now seems a very good time to take stock of what we have achieved and review our aspirations for the future development of bio renewables in the UK. The reasons for continuing to drive forward the renewable materials agenda are even more pertinent today than they were 2 years ago. Combating climate change is an increasingly pressing priority and, as we set out earlier this year in the Energy Review, we need to have a determined focus on developing renewable energy and to tackle the issue of energy security. Bioenergy and renewable materials can contribute very significantly to these objectives. One of the greatest challenges we all face is to live within the limits of our natural

Ministerial Foreword

resources. Renewable materials can contribute powerfully to the principle of 'One Planet Living' by helping to ensure that the products and energy we manufacture and consume respect the environmental limits of the planet.

As the report indicates, we need to consider how to optimise the benefits offered by renewable plant based energy and materials. The Strategy has always aimed to develop and enhance the renewables sector with a multi-pronged approach, including; direct and indirect incentives, research and development, communication and promotion. We will look to reprioritise and refocus some of the Strategy actions to take into account lessons learnt from our work so far, scientific progress and developments at an international level. This will remain a challenging programme of work – significant change and growth take time when dealing with a diverse and multi-layered sector such as this. Nonetheless with the commitment and skills of our delivery partners, we are in a prime position to move forward to the next stage.

We would like to thank the Project Board for their valuable report and the Government will publish a full response within the next three months.



David Miliband



Alastair Darling

Introduction and Background

What does this report cover?

- 1.1 This report has been prepared by the Project Board set up by Government to monitor the implementation of the Strategy for non-food crops and uses¹ (The Strategy). It outlines the content of the Strategy, reviews progress to date and suggests how it might develop over the next three years.

What are renewable materials – and why do they matter?

- 1.2 Renewable materials can be derived from agricultural crops grown for non-food uses and from other plant or animal sources. They are renewable because they can be used and replaced without irreversibly depleting reserves; this property also makes them a valuable resource in combating climate change. For this reason, renewable materials will continue to grow in importance as replacements for fossil materials used as fuels and as feedstocks for a range of products. Some renewable materials also have particular unique and beneficial properties which can be exploited in a range of products including pharmaceuticals and certain lubricants. The two years since the Strategy was launched have seen many exciting developments in the markets for renewable fuels and materials and this is set to continue.

What is the Strategy?

- 1.3 The Strategy for non-food crops and uses was published by Defra and DTI in November 2004 to provide a framework for the competitive and sustainable development of the renewables sector. It feeds into wider policies including the UK's Climate Change Programme (CCP) and Energy Review, the Government's Sustainable Farming and Food Strategy (SFFS) and the DTI Innovation Strategy.
- 1.4 The Strategy is centred around a long term vision *'that a significant proportion of the demand for energy and raw materials should be met through the commercial exploitation of science from crops, in a way which stimulates innovation, competitiveness of UK companies and the rural economy, enhances biodiversity and reduces greenhouse gas emissions and waste, (particularly biodegradable waste going to land fill and slows depletion of finite natural resources)*.
- 1.5 The Strategy relates to England. However, wider sustainable development and technology innovation policies surrounding the non-food crops agenda are important across the UK and the devolved administrations are also pursuing the issues. We have therefore involved the devolved administrations in drawing up this report.

¹ <http://defraweb/farm/crops/industrial/pdf/nfc-strategy.pdf>

1. Introduction and Background

The Strategy Action Plan and objectives

- 1.6 The Strategy sets out in an Action Plan (the Plan) a series of practical measures which Government and all those involved in the development, marketing and use of renewable materials derived from agricultural feedstocks can take to encourage the development of this sector.
- 1.7 The Plan comprises 50 individual actions divided initially into 11 work strands, which feed into the following three key objectives:
- To benefit the environment and human health by reducing greenhouse gases, cutting waste and pollution, helping biodiversity and contributing to the prudent use of resources;
 - To improve the economic competitiveness of the renewables industry through the development of new renewable feedstocks and innovative, high value-added products; harvesting nature's diversity to generate new businesses translating UK science for the global marketplace and generating value-adding high skill jobs; and
 - To produce social benefits by stimulating rural and urban economies through the establishment of local industries, providing improved employment opportunities and increased consumer choice.
- 1.8 These 3 objectives tie in with Government's broader priorities on sustainable development and it is this sustainability agenda as well as the other policies mentioned at paragraph 1.3 which have been the rationale for Government support for the development of non-food crops.

Delivering the Strategy

- 1.9 In developing the Strategy and Action Plan, Government recognised that delivery of the wide ranging objectives would not be achieved by the work of Defra, DTI or any other single body but would need engagement from all involved in renewable material, new bioproducts and bio energy supply chains. To help coordinate and oversee this work, the Project Board was established in early 2005. We include representatives from across government, industry, consumers, academia and other stakeholders such as the NFU and Natural England. Full details of the Board's membership and terms of reference are set out at **Annex A**.
- 1.10 The Government-sponsored National Non-Food Crops Centre (NNFCC) takes a lead role in delivering Strategy actions. To this end, NNFCC deploys in-depth technical expertise, an understanding of the key business sectors and skills in linking players in product supply chains from researchers to end users. Implementation of the Strategy also takes account of regional priorities so the NNFCC has been engaging with Regional Development Agencies and Government Offices for the English Regions to assist them in delivering the Strategy through their own regional programmes. The NNFCC is now a partner in DTI's Bioscience for Business KTN, which brings additional expertise and contacts in microbial and plant bioscience.

Measuring performance

- 1.11 The Strategy requires the Project Board to report on progress and outcomes achieved two years after its introduction. This report gives the Board's conclusions on the achievements of the Strategy to date and the challenges for the future. To examine the impact of the Strategy we have looked not only at progress with implementing the 50 actions in the Action Plan but have also attempted to evaluate the contribution this progress has made to the 3 key objectives set out above. One of our tasks over the last year has been to develop a set of performance indicators to assist with the exercise. Details of indicators and outputs we are seeking to measure are shown in the draft framework at **Annex B**. Work to develop these indicators is ongoing and it is likely that the framework will evolve as this work continues.
- 1.12 Because we are dealing with a dynamic and rapidly developing sector, firm data to support some of the indicators, particularly those relating to the size and values of the renewable products markets has not been readily available from established sources. Even where data is available, two years is too short a period of time to reveal any firm trends. We have therefore concluded that it would not be particularly insightful at this stage to include a separate report on performance statistics or analysis. We have, however, incorporated some available data into the text of this progress report and have used informed feedback from industry and other organisations closely involved in the renewable sectors to support some of our findings. Defra and DTI are continuing to work to develop the systems and contacts necessary to improve and refine data collection. We expect that it will be possible to report more fully on performance against the high level indicators by 2009, when Government is likely to commission a formal policy evaluation exercise on the Strategy.

Part 1: Where are we now?

What progress has been made with the Plan?

- 2.1 Realising the full benefits of renewable plant based materials and energy depends on the development of robust supply chains and markets to enable renewable products to compete effectively on cost, performance and security of supply. These changes must ultimately be delivered by industry but Government, through the Strategy, has an important part to play by providing the policies, direct and indirect incentives (eg. through procurement policies), regulation, research, information and promotion necessary to facilitate growth of the sector and realisation of the environmental and social benefits. Much of the Government's work over the last 2 years has therefore focused on putting the drivers and capacity in place to enable industry to deliver in the future.
- 2.2 This is an extensive and challenging programme made up of a mixture of short and long term actions. It is worth noting that in many cases the Strategy did not set a timetable for completing actions so we have applied our own milestones to take forward work. **Annex C** summarises progress with the 50 action points within the 11 work strands. **A total of 17 actions are shown as completed, 31 are still in progress and 2 have not been started.** A separate document providing more detailed information on progress with each action and, where relevant, flagging next steps can be seen at <http://www.defra.gov.uk/farm/crops/industrial/pdf/nfcstrategy-actionplan.pdf>.
- 2.3 Given the diversity of the Plan we have grouped the following summary under four main headings:
- Developing policies to drive the sustainable and competitive expansion of the renewable sector;
 - Communicating the renewables messages;
 - Ensuring we deliver the desired environmental outcomes;
 - Keeping one step ahead and planning for the future through research and development and international collaboration.

(A) Developing policies to drive the sustainable and competitive expansion of the renewables sector

Encouraging agriculture to grow the feedstocks

- The number of farms growing non-food crops under schemes in England rose by around 20% between 2003 and 2005;
- Area of land under schemes used to produce non-food crops in England estimated to have grown by at least 75% between 2003 and 2005 with corresponding overall values of crops produced rising by approximately 99%.

- 2.4 At the beginning of the supply chain, we need an agricultural industry which provides a reliable supply of suitable feedstocks. Implementation of the 2003 Common Agricultural Policy (CAP) reforms and actions under the Sustainable Farming and Food Strategy, (launched at the end of 2002), provide key incentives for farmers to innovate and seek new markets. The decoupled Single Payment was introduced in 2005 and under these arrangements farmers are able to grow energy crops on set-aside land. Where energy and fuel crops are grown on non set-aside land an energy aid payment of 45 can be claimed under a scheme which started in 2004. Other non-food crops grown for specified industrial purposes can also be grown on set-aside land under the 'non-food crop' scheme. In addition, in England, Defra has offered grants to establish the energy crops miscanthus and short rotation coppice under the England Rural Development Programme (ERDP). Further information on these schemes can be found in the glossary at the end of this report.
- 2.5 Defra and other stakeholders have promoted the production of crops for non-food uses as an important sustainable diversification option for farmers and there is evidence that the agriculture sector is responding. The number of farms growing non-food crops in England has increased by around 20% from approximately 4286 holdings in 2003 to 5120 in 2005².
- 2.6 An estimated breakdown of the non-food crop figures by main end uses is shown in the table below. The types of crops and plants being grown for non-food purposes in England continue to increase and develop. Crops such as wheat and barley and even mushrooms, usually grown for food, can also now be used to produce fuels and/or other materials including packaging, toiletries and pharmaceuticals. Novel or more specialised crops, although at present grown in quite small volumes, can command high prices.

Table 1: 2003-2005 Area, production and value figures for main non-food crops grown in England

	2003	2004	2005
Crop areas (ha)^(a)			
Oilseed Rape	57,997	33,541	53,401
Other	4,662	3,794	6,578
Industry	52,105	38,108	54,485
Fibre	3,586	1,599	1,208
Energy ^(b)	714	32,729	93,277
of which: Miscanthus	0	52	52
Short rotation Coppice	714	440	498
Oilseed rape	–	32,237	92,727
Total^(c)	119,064	109,771	208,949

² Information obtained from RPA based on returns relating to the non-food crops scheme and energy aid scheme.

Part 1: Where are we now?

Table 1: 2003-2005 Area, production and value figures for main non-food crops grown in England (continued)

	2003	2004	2005
Production (000 tonnes)			
00 Oilseed Rape	178	92	171
Other	11	9	27
Industry	113	76	114
Fibre	14	9	7
Energy ^(b)	27	124	334
of which: Miscanthus	0	1	1
Short rotation Coppice	27	17	19
Oilseed rape	–	106	315
Total	342	309	653
Value of production (£000)			
00 Oilseed Rape	24,038	12,445	24,848
Other	1,989	1,386	2,625
Industry	20,293	13,677	20,499
Fibre	1,329	951	731
Energy ^(b)	1,071	15,575	49,520
of which: Miscanthus	0	21	22
Short rotation Coppice	1,071	660	747
Oilseed rape	–	14,894	48,751
Total	48,720	44,034	98,223

Notes:

00 Oilseed rape is shown separately as it is not possible to identify the specific non-food end use of this crop (which is suitable for food/animal feed uses).

Crop categories comprise:

Other (mainly for pharmaceuticals)	poppy, linseed, barley, wheat, chamomile
Industry (mainly for lubricants, oils, chemicals)	linseed, crambe, high erucic acid rape (HEAR)
Fibre (mainly for composites, building products)	flax, hemp
Energy (for biomass power and biofuels)	short rotation coppice, miscanthus, oilseed rape

Some figures may not add due to rounding.

- Crop area & production figures have been compiled from a number of sources including the following: set-aside scheme data, woodland grant scheme, energy crops scheme, energy aid payments scheme, fibre processing scheme, Defra June farm survey, Defra minor crops survey.
- For the perennial energy crops, miscanthus and short rotation coppice, the figures presented represent areas of crop available for harvest in years indicated, but exclude areas either establishing or re-growing between harvest periods. Oilseed rape figures relate to plantings recorded under the energy aid scheme. Oilseed rape grown on main regime land is not included within this table as there is no way of identifying the end use of the crop.
- Some minor crops for which it has not been possible to estimate a value are excluded from this total. The area of these crops amounted to around 52ha in 2003, 15ha in 2004 and 32ha in 2005. Crops included: angelica, catnip, caraway, echinacea angustifolia, hemp, hyssopus officinalis, lemon balm, peppermint, rosemary, St Johns wort, spearmint, valerian and yarrow.

- 2.7 It is likely that these figures do not capture all non-food crops grown in England. 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 or not declared under any particular scheme; and part of the crop may be used as food while co-products are used as industrial raw materials or fuel. Some high value specialised crops intended for use in pharmaceutical products are covered by confidentiality clauses in contracts with purchasers and details can not be included in the above figures.

Using the feedstocks

- 2.8 Renewable feedstocks can be used to provide:

- (a) biomass for energy (heat and power);
- (b) liquid transport biofuels (at present mainly biodiesel and bioethanol); and
- (c) a wide range of other materials and products for use in industry such as starch based plastics and polymers, plant based lubricants, solvents and fibres for panelling for the automotive and construction industries. In addition they can be put to an array of novel uses in the production of pharmaceuticals, toiletries and antimicrobials.

Further detailed information on all of these various uses is at **Annex D**. The following section looks first at the main achievements in each of the above 3 areas and then provides a summary of more generic work and policies which have driven developments over the past 2 years.

Biomass

- Rapid expansion of energy crop plantings over the last 2 years and significant planned increases in future plantings;
 - Good industry response to opportunity for biomass co-firing in coal power stations, resulting in four fold increase in biomass derived electricity output between 2003 and 2005;
 - Commitment to implement many of the recommendations of 2005 Biomass Task Force Report, including additional capital support for biomass heating;
 - Clear recognition by Government of potential opportunities to increase use of biomass energy (as demonstrated in UK's Energy Review and Climate Change Programme).
- 2.9 As the data in Table 1 indicates, a significant proportion of non-food crops production is focused on crops grown for energy purposes (both heat and power and biofuels) and indeed we have seen considerable progress in developing and raising the profile of the whole UK bio energy industry over the past 2 years. EU and UK Government policy, direct fiscal incentives and target setting have driven this agenda. Purpose-grown energy crops, while still a relatively small industry, have expanded considerably in the last two years, particularly with increased interest in miscanthus (see Table 2 below). Supply chains are developing assisted by the The Bio-energy Infrastructure Scheme, which provides support for the harvesting, storing, processing and supply of energy crops and woodfuel to energy end-users. As announced In the CCP Review in March 2006, Defra intends to launch a further round of the Bio-Energy Infrastructure Scheme in England in 2006/07.

Part 1: Where are we now?

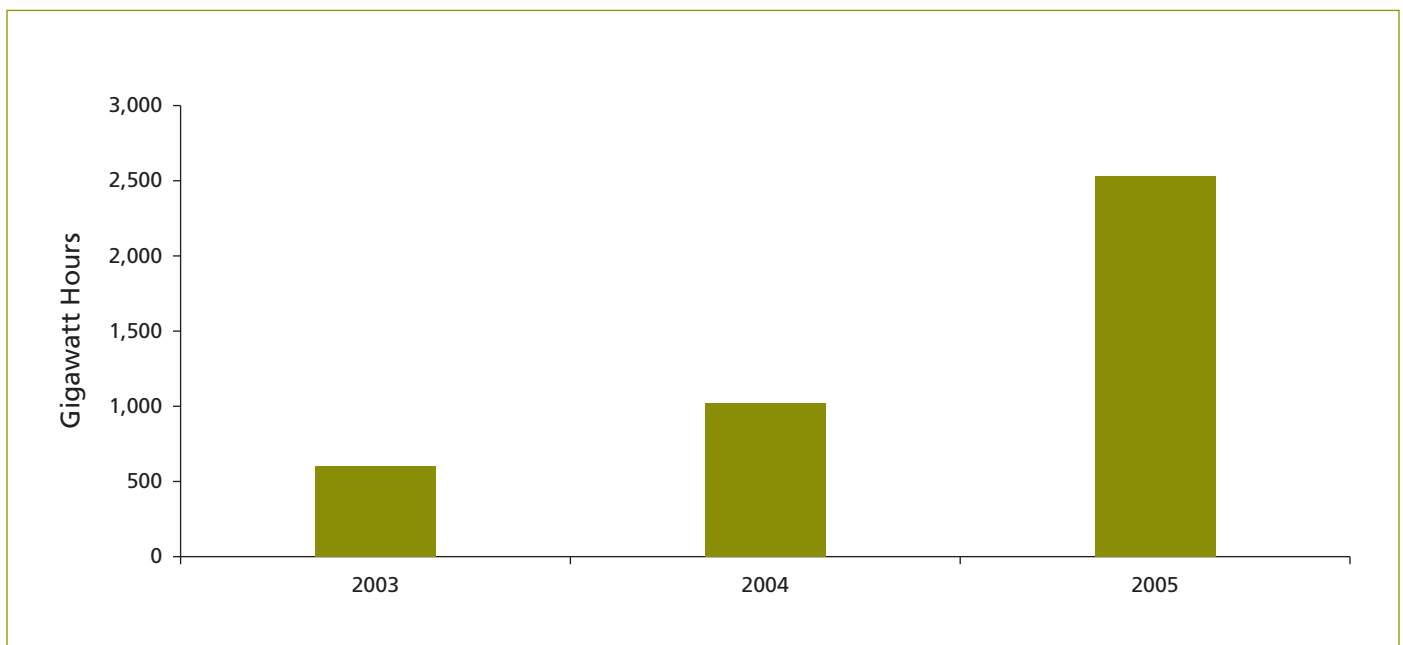
Table 2: Actual and approved plantings for miscanthus and short rotation coppice in England under the Energy Crops Scheme

ENERGY CROP	2001	2002	2003	2004	2005	2006	Applications for planting in 2007
Miscanthus (hectares)	0	52	52	354	1011	3356	12,627
Short Rotation Coppice (hectares)	233	298	391	498	788	1180	2,600
Total hectares planted	233	349	443	851	1799	4536	15227
Growth Rate (%)		50%	27%	92%	111%	152%	236%

Note Figures are cumulative

2.10 Much of this expansion has been stimulated by the development of co-firing biomass with coal in large power stations and the construction of new biomass fuelled generating stations supported by the Bioenergy Capital Grants Scheme, although there is also significant interest in smaller scale heat and CHP plants which the Biomass Taskforce (see below) saw as having particular potential.

Figure 1: Annual electricity output (GWh) from the biomass element of co-firing in the UK between 2003 and 2005



Figures supplied by DTI based on data collected under the Renewables Obligation (RO).

Note a wide range of biomass feedstocks can be used for co-firing. So far this has included a large proportion of imported feedstocks but potential to use UK supplies is growing with the increase in planting of purpose grown energy crops and the future requirement to use increasing quantities of purpose grown crops in co-firing under the Renewables Obligation.

- 2.11 Despite this growth, there remains considerable potential to exploit biomass more fully and increase its contribution to climate change objectives. Biomass currently only provides about 1% of UK electricity supply (or 2% if landfill gas is included).³ The Renewables Innovation Review (DTI 2004) put the potential for biomass energy at 6% of total supply (expressed as electricity) by 2010. More recently the **UK's Energy review**⁴, published on 11 July 2006 recognised the key role renewable energy, including biomass energy, can play in mitigating climate change and contributing to the security of energy supply. It offers further incentives for biomass including carbon credits under the Energy Performance Commitment and Supplier Obligation, increase in the Renewables Obligation and the introduction of carbon targets for the public estate.
- 2.12 New impetus for the biomass sector has also come from the **Biomass Task Force**⁵, which reported in October 2005. Government published its response to the report on 27 April 2006⁶ and Defra and DTI are working to implement the agreed recommendations, which include:
- Defra-funded capital grant scheme for biomass heat in the industrial, commercial and community sectors;
 - Establishment of a Biomass Energy Centre to provide advice and promotion;
 - Agreement in principle to continue grants for planting energy crops in the next England Rural Development Programme;
 - Commitment by Government Departments to consider biomass energy installation on their estate; and
 - Commitment to develop a UK-wide biomass strategy over the coming year.
- 2.13 Defra and DTI are continuing to work closely with other parts of government and more widely with the EU and at an international level, to ensure that the potential of biomass is taken into account in a number of ongoing cross cutting policy exercises such as implementation of the EU's Biomass Action Plan and revisions to both EU and English Waste Strategy and legislation. The UK participates in the new Global Bioenergy Partnership, a commitment from the G8 Gleneagles action plan which was launched in May 2006. This will form a focus for international dialogue on bioenergy and biofuels, promoting technology transfer, concerted research and policy discussion.

³ Source Biomass Task force report <http://defraweb/farm/crops/industrial/energy/biomass-taskforce/pdf/btf-finalreport.pdf>

⁴ <http://www.dti.gov.uk/files/file31890.pdf>

⁵ <http://defraweb/farm/crops/industrial/energy/biomass-taskforce/pdf/btf-finalreport.pdf>

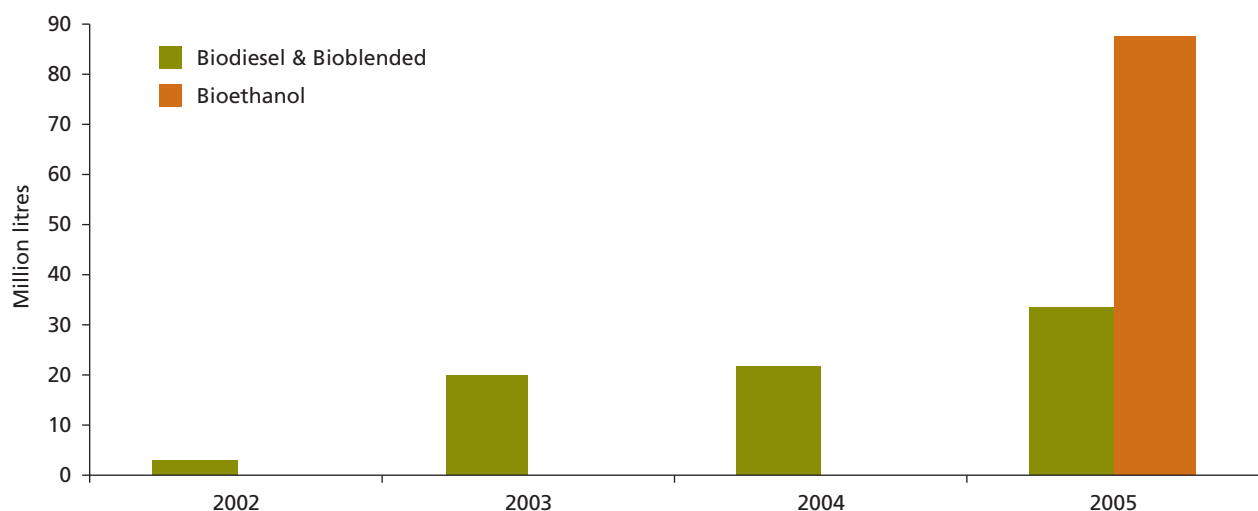
⁶ <http://defraweb/farm/crops/industrial/energy/biomass-taskforce/pdf/btfreport-govresponse.pdf>

Biofuels

- Five fold increase in biofuel sales in UK between 2004 and 2005;
- Introduction of Renewable Transport Fuels Obligation (RTFO) in UK from 2008, requiring land transport fuel supply companies to incorporate a rising percentage of biofuel reaching 5% in 2010;
- Energy Review signals intention to consider going beyond 5% in longer term, subject to infrastructure constraints, resolution of issues on fuel standards and acceptability of costs to consumers;
- Further measures to encourage sustainable development of UK biofuel production including possible Enhanced Capital Allowance scheme and introduction of environmental reporting scheme under RTFO.

2.14 The size and profile of the biofuels sector in UK has grown over the past 2 years, stimulated by duty incentives and the announcement of the Renewable Transport Fuel Obligation. Consumption of bio diesel in the UK has risen from 19 million litres in 2004 to 33 million litres in 2005. According to European Bio diesel Board figures, UK production capacity increased to around 60 million litres in 2005. This is expected to be nearly 500 million litres by the end of 2006. Bioethanol consumption was 85 million litres in 2005. UK bioethanol production is expected to begin at UK plants in 2007. Overall in 2005 biofuels accounted for around 0.24% of total road fuels consumption, and this is the precursor to an anticipated step change for biofuels in the UK as we move towards the target of 5% substitution by 2010 under the new RTFO.

Figure 2: Quantities of biofuels released for consumption in UK



Source: HM Revenue & Customs

Note: Figures are net of trade i.e. they include imports and exclude exports.

Bio blended included here relates only to that proportion of the fuel liable at the biodiesel duty rate.

- 2.15 Biofuels represent a major market opportunity for the UK farming industry. There is, however, a world market for biofuel – for example palm oil which can be made into biodiesel, and Brazilian bioethanol made from sugar cane are highly competitive. Under World Trade Organisation rules the UK is not allowed to block or discriminate against imports so in the short term at least, it is likely that a significant proportion of supply will to come from imported feedstocks.
- 2.16 The challenge for the UK will be to develop a sustainable industry which can compete on the world market in terms of price, quality and environmental credentials. A number of companies are now building or planning biodiesel or bioethanol processing plants in the UK, which will include UK-grown oilseed rape, sugar beet or wheat as a feedstock. It is estimated that more than 497 million litres of biodiesel production capacity⁷ is available in 2006 in the UK. Bioethanol production is also expected to begin at several UK plants in 2007. The Government will introduce an Enhanced Capital Allowance scheme in 2007 for biofuel processing plants which will reward the most carbon efficient production designs.
- 2.17 When introduced in April 2008, the RTFO will include a requirement on fuel companies to report on the environmental credentials of the biofuels which they market, including carbon savings compared with fossil fuels which they replace. The Government has stated that this reporting requirement may be developed subsequently into a system of differentiated credits based on the fuels' carbon balance. This is expected to provide further stimulus to development of new-generation biofuel technology such as fermentation of lignocellulosic materials and biomass-to-liquid. These advanced technologies would allow fuels to be developed more efficiently from a wider range and potentially lower volume of feedstocks, providing greater carbon savings and lower costs. Although these 'second generation' technologies are largely at the pilot stage, there are considerable economic advantages to the UK if it is able to play a leading part in their development and deployment. Apart from potential incentives under the RTFO, collaborative activity will be needed with non-UK companies and international R&D programmes. The EU Biomass Action Plan recognises the crucial role of advanced biofuel technologies and strongly supports investment in R&D for new generation fuels.
- 2.18 These global opportunities are beginning to be recognised within UK industry. In June 2006 BP announced a partnership with the US science company DuPont to combine fuel technology and bio based science expertise to develop advanced biofuels. The British Sugar site in Wissington has been identified to produce biofuels and British Sugar are currently completing a feasibility study to conclude what mix of fuels the plant will make. The plant is due to come on stream in early to mid 2007 and it is likely that it will initially produce bioethanol. The feasibility of producing biobutanol at the site in future is also being investigated.

⁷ figure supplied by CSL represents estimated total capacity of all known UK plants during 2006 as of September 2006. Figure will not equate to 2006 production since plants are operating at a range of output capacities.

■ Case Study

The Somerset Biofuel Project

Somerset has become a focus for the introduction of bioethanol as a transport fuel into the UK. The Somerset Biofuel Project links a number of organisations in Somerset to help push bioethanol from 'field to wheel'.

As stakeholders in the project, Avon and Somerset Police became one of the first fleets in the country to use E85 biofuel – a petrol/bioethanol mix containing 85% bioethanol – in its vehicles. The force has taken delivery of 15 Ford Focus Flexible Fuel vehicles (FFV) capable of running on the E85 fuel. Other stakeholders in the project include Somerset County Council, Wessex Water and Wessex Grain who are also using the vehicles in their fleets. Ford has already seen growing interest from other fleet customers throughout the UK.

The E85 fuel used in the vehicles went on sale in the UK in March 2006 with the Morrisons supermarket chain being the first to offer the fuel, initially from its Norwich filling station, closely followed by further sites in East Anglia and Somerset.

The supply chain will be complete, when in Spring 2008 Green Spirit Biofuels, based at Henstridge, Somerset is set to start producing bioethanol from locally produced cereal grains. The plant will produce around 105,000 tonnes of bioethanol from 350,000 tonnes of wheat annually. Green Spirit already has plans to build its second bioethanol plant on Humberside. The proposed plant could produce up to twice that of the Henstridge plant using in excess of 600,000 tonnes of wheat.



Picture Crown Copyright courtesy of CSL

Renewable materials and products for industry

- Markets developing for a range of renewable materials including plant based pharmaceuticals and toiletries, biolubricants, chemicals and construction products.

2.19 We have been taking forward a number of cross cutting actions aimed at overcoming barriers and ultimately increasing the use of sustainable renewable materials for industrial purposes. We are still dealing with a relatively small industry, at least in terms of overall size and GDP, and because of this and the difficulties in collecting data explained in paragraph 1.12, it is not easy to make quantitative assessments about progress. However, although it is clear that other renewable materials have not achieved the same growth or profile as biomass energy or biofuels over the past 2 years, there have been some important developments. The renewable materials sector includes both low volume/high value and large volume/lower value markets. Critically, both of these require highly skilled, well educated and innovative workforces and can provide opportunities to develop and commercialise new intellectual property.

2.20 The following main material/product groups are considered to have made the most progress towards sustainable commercialisation in England:

- Biocomposites such as starch based packaging, automotive composites;
- Biolubricants – such as metal working fluids, hydraulic fluids, chain saw oils;
- Biopolymers and bioplastics;
- Biosolvents – particularly for use in printing;
- Chemicals and oleochemicals including inks, dyes, pigments;
- Plant based pharmaceuticals – including medicines and vaccines and personal care products; and
- Products for construction – including geo textiles, floor and wall coverings, paints, insulation, and hemp based building blocks.

2.21 The matrix at **Annex D** provides more information on these products and their stages of development. These include high tonnage sectors and so there is significant potential for renewables to replace conventional materials and products in UK and global markets. The figures set out in table 3 below give an indication of the size of EU markets for renewable materials and estimate the potential for further growth.

Part 1: Where are we now?

Table 3: Main markets for renewable materials in the EU

Market	EU Production (mio tonnes/ annum)	Raw Material	Significance of EU land area	% Renewable in EU (potential by 2010)
OIL				
	8.6			
Surfactants/ detergent/soap	2.4	Coconut, palm, rape, sunflower	*	20% (60 – 65%)
Lubricants	10.2	Rape, sunflower, palm, coconut	* * *	2% (20 – 30%)
Paints/coatings		Linseed, castor, sunflower, soya, tung	*	
Solvents	4 – 4.5	Rapeseed, coconut, soya (US)	* *	1.5% (12.5%)
Polymers	33	Soya, rapeseed, castor, linseed, sunflower	* *	1% (5 – 10%)
Linoleum	56 million m ²	Linseed oil, wood flour, cork dust, pine tree resins, limestone, jute backing	*	
FIBRE				
Texiles		Flax	*	
Paper and pulp	95	Flax, hemp, cereal straw	* *	<1%
Wood-based panels	2	Flax, hemp, cereal straw, miscanthus	* *	(10%)
Fibre reinforced composites	0.25 (automotive)	Flax, sisal, jute, kenaf, hemp	* * *	15% (20%)
Fibre cement composites		Hemp, flax	* *	
Packaging materials	0.1 (polystyrene equivalent)	Hemp, flax, cereal straw, miscanthus, RCG, sorghum	* *	
Filters + absorbents		Hemp shiv, flax shiv	*	
Insulation products		Flax, hemp	* *	4% (10%)
Starch-based products				
Paper and board	Data unavailable	Potato, maize, cereals	* * * *	[2.3 million tonne]
Plastics	40	Potato, maize, cereal, tapioca	* *	0.09 – 0.1% (2% potential)
Detergents	0.6	Maize, tapioca	*	(60 – 65% potential)

* * * * * significant EU land area required to meet demand

* marginal EU land area required to meet demand (more likely to be met by imports/by-products from existing processes)

Adapted from the European Parliament's Committee on Agriculture and Rural Development's report 'The Promotion of Non-Food Crops Study – 2005'

Supporting the development of markets for renewables

- Government measures to help fund installation of biomass (and other micro generation technologies') in schools and public sector buildings;
- Biomass heat and power systems and other renewable products included in guidance to public sector procurers; and
- Code for Sustainable Homes and strengthened planning policies on renewables in new developments could provide incentives for uptake of renewable energy and construction materials.

Government Procurement

- 2.22 For many of these products, cost and consumer awareness and confidence have been identified as barriers to uptake. To help address this, a section of the Strategy looks at how government procurement policies can be developed and applied to encourage the marketing of sustainable crop derived products. The first step is raising awareness and since the end of 2004 Defra has worked closely with the Office of Government Commerce to incorporate information on renewable products, including construction materials, biolubricants, bioplastics and packaging and biomass heating in a number of cross Government procurement publications such as the Office of Government Commerce's 'Achieving Excellence in Construction' and the practical guidance accompanying the 'Framework for Sustainable Development on the Government Estate'.
- 2.23 In addition, in its response to the Biomass Task Force Report, Government announced a range of support measures to help fund the installation of biomass and other microgeneration technologies in schools and other public sector buildings. Defra is also carrying out a mapping exercise to determine the suitability of its estate for conversion to biomass heating and subject to the outcomes, this will be extended to all major procuring partners.
- 2.24 There are some good examples of renewable products being incorporated into public procurement contracts but efforts need to continue to educate and actively encourage public sector procurers as a group to pursue the renewable options. This needs to be seen in the wider context of the 'sustainable procurement' agenda which seeks to ensure public sector expenditure delivers value for money in its widest sense. In June 2006, the business led Sustainable Procurement Task Force reported to the Government with recommendations for establishing the UK among the leaders in sustainable procurement across the EU by 2009. The Government has committed to fully respond in the Autumn.

Sustainable building and construction

- 2.25 There are significant opportunities for crops based materials and energy to contribute to the development of more sustainable building and construction industries and we have been focusing efforts in this sector. However, in addition to the usual barriers of cost and industry awareness, lack of technical information on renewable material performance, supply concerns and the need for specialised training in material use, are seen as key barriers to development.
- 2.26 To address this, NNFFCC have been working on a number of projects in 2006/07 which aim to develop and disseminate the technical, economic and environmental evidence base for renewable construction materials, including the drawing up of a technical manual for hemp-lime

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construction, a gap analysis of key environmental and performance data for non-food crop materials and comparative life cycle assessment for a variety of construction materials. NNFFC are also closely involved with several companies that are starting to take renewable construction materials into large, mainstream building projects.

- 2.27 The Government's **Code for Sustainable Homes**, which is due to be announced by the end of 2006 and 'go live' in April 2007, is intended to provide an incentive for the use of renewable biomass energy and renewable construction materials. The use of renewables will be essential in order to achieve the highest performance ratings under the Code and Defra has been working with Department for Communities and Local Government (DCLG) to ensure that relevant technical information is included in the detailed guidance on energy and materials which will accompany the Code.

■ Case Study

Sustainable Construction

An exciting example of non-food crops being used in the sustainable construction sector is the new 8000m² distribution centre being built for Adnams Brewers outside Southwold, Suffolk. Architects Aukett Fitzroy Robinson were given a strict brief to minimise environmental impact while producing a building to meet Adnams needs for years to come. The resulting design features a living grass roof but also incorporates diaphragm walls built with blocks made from hemp-lime and quarry waste. The walls are filled with Hemcrete™ a hemp-lime mix giving high thermal performance and excellent strength. The new building is expected to receive an "Excellent" rating under the BREEAM (Building Research Establishment Environmental Assessment Method) system, which assesses environmental implication of building materials, including life-cycle impacts. The hemp used in the construction was supplied by Hemcore in the UK.



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Incentives for renewables under the planning system

2.28. The Government recognises the powerful effect which the planning system can exert to stimulate renewables as a key element of building sustainable communities. Planning Policy Statement 22, Renewable Energy, issued in August 2004, set out policies to support the development of renewable energy projects. On 8 June 2006, The Planning Minister issued a statement making clear the Government's expectations that all local authorities should set requirements for on site renewable energy in developments. In addition the Government is working towards a new planning policy statement on climate change which we hope will provide further stimulus to the development of renewables.

Encouraging sustainability and innovation through environmental legislation

2.29 At a more general level the Government has been working to ensure that its wider environmental policies and legislation take into account the sustainability benefits and business and innovation opportunities which renewable plant derived energy and materials can offer. Defra and DTI held a series of workshops in 2005 to identify and integrate key elements of work on the environment and innovation across both departments.

2.30 Work in areas such as public procurement and innovation forms part of a wider joint DTI/Defra programme on **Sustainable Consumption and Production (SCP)** which is one of the UK priorities for sustainable development set out in **Securing the Future**⁸. The Strategy on non-food crops makes an important contribution to the delivery of the Government's aims on SCP, which looks to bring through products and services which reduce environments impacts; improved production processes and shifts in consumption towards goods and services with lower impacts. An SCP Action Plan to develop this approach further, building on the commitments in Securing the Future, is planned to be published in 2007, along with the development of a products framework that will include promotion of cross-cutting initiatives to drive product changes as well as a focus on the product areas with the largest impacts, including food and drink, housing, clothing and transport. A focus on specific products will provide further opportunities to examine the role that non-food crops can make to SCP aims.

(B) Promoting the Renewables message

- NNFFCC grows in scope and reputation since launch in 2003;
- Establishment of Thematic Working Groups to engage all players in supply chains for biolubricants, biopolymers and plant based pharmaceuticals;
- Development of a communication strategy for renewable materials.

2.31 Effective communication and dissemination of knowledge and information are a central part of the Strategy and we have given this high priority over the past 2 years. Communication work forms the core of NNFFCC's remit. The Centre now employs 13 staff including a dedicated communications team of 3 and a regional delivery officer who is assisting in the regional and sub regional delivery and promotion of non-food crop technologies and products.

⁸ See <http://www.sustainable-development.gov.uk/publications/uk-strategy/index.htm>

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- 2.32 A key part of the overall communication work is to stimulate commercialisation of renewable products through technology transfer. This area has grown considerably since 2004. NNFCC now has funding for 4 technology transfer managers: this funding provided partly by the DTI, (as part of the resource for the Bioscience for Business KTN) and partly by Defra. The Centre has also established successful Thematic Working Groups to help link supply chains across key industry sectors including biolubricants, biopolymers, and plant-derived pharmaceuticals.
- 2.33 Other NNFCC promotional activities have been built up to include a helpdesk, regular newsletters, attendance at external conferences including events targeted at farmers, industrialists, school children and the general public. The NNFCC website is continually being refined and updated and has become a key tool for educating and disseminating information to all involved in non-food crops supply chains, from growers to scientists, to industrial users and consumers. The number of unique/one off visits from all over the world to NNFCC website has risen from just over 30,000 in 2004 to over 50,000 in 2005.
- 2.34 The Project Board has worked with Defra to develop an overriding renewable materials communications strategy, to complement NNFCC's publicity work. This focuses on the need to engage industry, other parts of the public sector, and the general public in the push towards a more renewable based economy. Educating children – the growers, scientists, industrialists and consumers of the future – is also a vital part of the communications strategy. The strategy has been developed alongside, and links into, publicity work related to wider policies on climate change and sustainable consumption and production.



NNFCC demonstrating renewable materials to primary school children during York Science Week

(C) Ensuring we deliver the right environmental outcomes

- Recognition of the contribution that biomass, biofuels and renewables materials can make to climate change agenda in the UK Climate Change Programme;
- Planned certification schemes to ensure sustainability of biofuel feedstocks produced in UK and likely to extend to EU;
- Continued investment in R&D to examine the environmental impacts of energy and other non-food crops; and
- Production of agronomy information sheets on 10 non-food crops to include advice on good environmental practices.

Climate Change

2.35 The UK's latest Climate Change Programme*⁹ which was published on 27 March 2006, recognises the benefits non-food crops used as feedstocks for energy, transport fuels and products can offer in the drive to mitigate against green house gases (GHGs). The RTFO was one of the major items in the Programme and it is forecast to save 1.6mtC by 2010. The CCP also estimates that plantings up to 2006 under the Energy Crops scheme are expected to lead to savings of 11ktC in 2010. Additional savings from a new scheme with plantings from 2007 onwards, could be around 13ktC in 2010, rising to 43ktC by 2020. Using crop derived renewable raw materials to replace the fossil fuel based components in products such as plastics and chemicals can also provide GHG savings, subject to efficient production and proper disposal, and the CCP estimates that this could lead to savings of 0.1MtC per annum in the UK by 2010.

Biodiversity and the landscape



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⁹ <http://defraweb/environment/climatechange/uk/ukccp/pdf/ukccp06-all.pdf>

Part 1: Where are we now?

- 2.36 Agriculture, particularly when it involves major changes in practices or land use, can have profound effects on biodiversity, in both positive and negative terms, and these must be taken into account in considering the expansion on non-food crops in the UK. The Strategy recognises that efforts to promote growth in the renewables sector and in particular to increase areas and yields of non-food crops must be carefully balanced against the possibility of adverse environmental impacts.
- 2.37. So far, oilseed rape grown for transport fuels (and other industrial purposes) and energy crops take up the majority of land used to cultivate non-food crops in England. Bioenergy crops are subject to the same cross compliance requirements under the CAP Single Payment scheme as all other crops and these aim to promote sustainable and environmentally friendly farm management practices. Aid paid for crops grown under the energy crops scheme in England is also subject to environmental assessment of individual applications and work is continuing on wider-scale strategic assessment. For biofuels the potential environmental effects, for example from conversion of forest land in tropical countries to palm oil plantations, are well recognized and it will be crucial for future policy development to take account of these concerns. The EU Biomass Action Plan recognizes this issue and work is proceeding in the UK and elsewhere on the development of reporting system to highlight sustainability of biofuel feedstocks.
- 2.38 As explained earlier in the report, it is likely that bioenergy crops will continue to dominate the land used to grow non- food crops in the short to medium term. The Defra Agricultural Change and Environment Observatory (ACEO)¹⁰ which was launched in July 2005, will play an important part in monitoring the impact of land use and farm management changes on the environment. Environmental assessments will need to take into account a wide range of factors including what the non-food crops are replacing (ie. fallow land or land previously used for food production), location and geography (ie. overall cropping patterns, soil types and hydrology), and the crop management practices being followed.
- 2.39 Government and other interested organisations have invested in a number of research projects looking at the environmental impacts of specific bioenergy crops, including short rotation coppice, miscanthus, oilseed rape, cereals and sugar beet. In general these underline the need for environmental assessments to take into account the various geographical and land management factors outlined above. Work is continuing and a Defra-funded 3 year R&D project started on the 1st May 2006 at Rothamsted to directly assess the impacts of perennial bioenergy crops on biodiversity and to develop and test models to assess the impacts of different scales of plantings on biodiversity and water use.
- 2.40 Research has also been conducted on other non-food crops. The Centre for Ecology and Hydrology completed a first stage desk study on environmental impacts of crambe, borage, hemp and miscanthus. This flagged the possible benefits to wildlife from these relatively low input crops, particularly given the diversity they can add to the farmed landscape, leading in turn to a wider range of habitats. It is anticipated that further long-term work to confirm these findings through field trials will be funded by Defra.

¹⁰ The ACEO website can be accessed at : www.defra.gov.uk/farm/policy/observatory/index.htm

2.41 Another common recommendation from these various scientific studies is the need for good biodiversity practice to be effectively communicated and ideally embedded in farm management procedures. Defra have issued specific guidance on best practices for growing miscanthus and short rotation coppice. General guidance on good biodiversity practice for other crops, whether grown for food or non-food purposes, is also available in literature on the cross compliance rules, which form part of the Single Farm Payment scheme, and through non-government organisations such as LEAF. NNFCC and CSL are producing information sheets on crop agronomy for 10 of the main non-food crops and these will include some information on best practice for maximising yields taking into account sound environmental practices. Further details of individual studies and reports referred to above can be obtained from Defra:

Tel: 020 7238 5249, E-mail: industrialcrops@defra.gsi.gov.uk

Cutting waste and pollution

2.42 The Strategy recognises that moves to increase the use of renewable biodegradable products such as packaging must take into account the need to ensure that products will be reused or, at the end of their life, managed in a sustainable manner. This may involve recycling, composting or energy recovery. Work in this area has been challenging and relied heavily on engagement with those parts of Defra and the Environment Agency responsible for waste policy and implementation. The key is to devise successful systems to identify and segregate biodegradable waste from mixed municipal waste streams.

2.43 NNFCC have been investigating various mechanical waste separation systems as well as other options such as labelling and publicity to encourage consumer separation schemes and are continuing to consider the best approach for the UK. **A revised English Waste Strategy** is due to be published in the New Year. A main aim of the strategy will be to divert increasing amounts of biodegradable waste from landfill. The consultation document published earlier in the year proposed higher composting and recycling targets for household waste and also foresaw the need for more use of energy from waste as a viable waste management tool within the waste hierarchy. The development of the Waste Strategy will inform NNFCC's further work in this area.

(D) Keeping one step ahead – planning for the future through research and development and international collaboration

- Significant increases in R&D spending by Defra and DTI on renewable bio energy, transport fuels and materials over past 2 years;
- NNFCC a partner in the new DTI Bioscience for Business KTN launched in October 2005;
- NNFCC, Defra and DTI proactive in a number of EU and wider international organisations dealing with renewable materials and bio energy.

2.44 The final key strand of the Strategy concerns the need for longer term strategic planning and thinking, to ensure that the developing renewables sector is equipped to respond to the social, economic political and environmental challenges and drivers of the future.

Part 1: Where are we now?

- 2.45 **Road mapping studies** have been carried out on biopolymers and pharmaceuticals to look strategically at the economic and environmental opportunities and barriers to development in these sectors. The findings of these studies will inform the approach NNFFC take to drive forward these sectors. One important aim will be to look at how the opportunities can be tied in with Government's priorities at a regional level so that we can make the most of the competitive advantages of geographic regions. NNFFC and Defra have begun work on aligning these analyses to Regional Economic Strategies and this will continue.
- 2.46 There has been important investment by Government in **renewables R&D** over the past 2 years. Defra's non-food crops R&D budget doubled from £1m to £2m from 2004/05 and has funded a variety of projects including programmes aimed at improving the yields for energy crops and providing best practice advice to growers and processors of renewable materials used in high value sectors where quality is of the essence. There have been a number of successful collaborative LINK Projects which have developed materials that are very close to commercial exploitation, including resins from oilseed rape, and emulsions and extracts from oats and marsh mallow and astragalus plants used in cosmetics.
- 2.47 A new R&D programme on 'Supply Chain Assessment and Development' was rolled out in 2004 and covered 13 projects. Outputs are currently being assessed by a panel of Defra officials and experts in the field, and will be used to help identify what further targeted R&D may be required for future investment.
- 2.48 Defra announced a new LINK programme in conjunction with the Biotechnology and Biological Sciences Research Council on 3 November 2005. This is devoted to renewable materials and provides grant aid to private sector led research. The programme has established a good level of support with considerable interest from industry. So far there have been approximately 58 interested consortia and 3 projects have been approved for funding and will receive a total of approximately £600k from Government sponsors.

Table 3. Total Defra expenditure on R&D relating to non-food crops

2003/04	2004/05	2005/06
£1.4M	£2.5M	£3.1M

Note. Figures relate to all projects with at least some Defra funding, either solely funded and led by government or co-funded and led by industry.

■ Case Study

Use of Bioscience to produce Anti-Malarial Medication from Artemisia

Artemisia annua is an annual herb originating from Asia, which is also grown as an ornamental plant in the UK. Artemisia is the source of the anti-malarial drug, artemisinin which is used to prepare Artemisinin-based Combination Therapies (ACTs), which are highly effective against the principal malarial parasite, *Plasmodium falciparum*. ACTs are currently used in over 100 countries to treat multi-drug resistant malaria. 51 countries have now adopted Artemisia-based anti-malarials as front line treatments. This may require up to 132 million treatments per year. World Artemisia production is currently only able to supply around a quarter of this demand, though work is in place to increase this. Synthetic production has been examined, but, the complex biochemistry of Artemisinin, combined with the need to keep the cost of treatment low, make this approach difficult.

In the UK, Botanical Developments Limited, in partnership with NIAB, East Malling and Frontier Agriculture, has evaluated existing Artemisia germplasm to identify the best lines for enhanced cultivation. Agronomic and extraction issues have also been investigated.

Research into Artemisia has also been given a welcome boost with an award of £7m to the Centre for Novel Agricultural Products (CNAP) at University of York by the Bill and Melinda Gates Foundation. The award will be used to apply fast-track breeding technologies to *Artemisia annua* to create new, non-GM cultivars which have increased yield of artemisinin making combination therapies cheaper and accessible to victims of malaria who can not currently afford them.



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Part 1: Where are we now?

- 2.49 DTI announced funding under its Technology Strategy for a new Knowledge Transfer Network (KTN) on Bioscience for Business on 18 October 2005. This brings together expertise in renewable feedstocks and high value plant-made products together with biocatalyst expertise and marine and freshwater biotechnology. The Bioscience for Business KTN has been working with industry to determine priorities for focusing research and development investment more strategically. The overall aim is to match the UK's world class knowledge and skills in bioscience with the needs of industry. A number of other KTNs have also been established in areas which impact on non-food crops such as materials, chemicals, and low carbon fuels, and an integrated 'network of networks' is expected to ensure that synergies, information and resources are shared more effectively.
- 2.50 There are currently 7 projects running under the DTI Technology Programme which relate to non-food crops with start dates in 2005 or 2006 and which are anticipated to run for two or three years with an overall total spend of £5.3M in total. All Technology Programme projects are expected to have a commercialisation time frame of 5-7 years. DTI has also had 2 calls for collaborative R&D and technology validation under its Technology Programme for the exploitation of plant and microbial bioscience and a call on bioenergy.
- 2.51 A lot of effort has been put into monitoring and where appropriate, contributing to developments in renewable policy, regulation, research and technology outside the UK. The NNFCC plays an active part in the European Renewable Raw Materials Association (ERRMA), which represents the national activities of the member states in industrial crops. It also participates in the Renewable Raw Materials Working Group of DG Enterprise in the EU Commission. NNFCC led a Global Watch mission to Germany, Netherlands, and Finland to look at second-generation biofuels and will lead a 2007 mission to North America on co-production of ethanol and higher-value chemicals.
- 2.52 The Bioscience for Business KTN has carried out missions to China and Japan in 2006 and UK Trade and Investment carried out a visit to Canada to visit companies involved in renewable materials in July 2006.
- 2.53 Defra and DTI have been involved with the EU Commission's Framework Research Programmes which have provided funding for research into bio energy and renewable materials. The UK hosted a Science to Support Policy project on non-food crops and uses, through the EU's Framework 6 programme. As part of this an EPOBIO¹¹ workshop involving UK academic and industry partners looked at the future of biorefineries and how these might help the design of new generations of plant based bioproducts for the market over the next 10-15 years. The Government has also been contributing to a two-year OECD study on 'Bioeconomy to 2030: Designing a Policy Agenda'. Outputs from this varied international work can help inform the future direction of non-food crops policy in the UK.

¹¹ EPOBIO is an international project to realise the economic potential of plant derived raw materials funded through the European Union's 6th Framework Research Programme.

Part 2: Where do we want to be? The next three years and beyond

- 3.1 There have been some important achievements during the first 2 years of the Strategy but there is still much more to do. In compiling this progress report we have revisited the aims and objectives of the Strategy and consider that these remain valid for the next three years. However, there have been some substantial changes in the political landscape and developments in bioscience and technology which need to be factored into the Strategy. There have also been some useful lessons learnt from our work to date, which we consider Government and stakeholders will need to address if we are to make real steps towards the longer term vision of increasing the proportion of UK's energy and materials derived from renewable organic feedstocks, to the benefit of the environment and the UK's competitive position. To maximise progress in this fast moving area it will be necessary to refocus, reprioritise and in some cases extend the wide ranging actions which made up the original Strategy Action Plan.
- 3.2 The increasing world price of fossil based fuel, and the high priorities afforded to the climate change and environment agendas in the UK will continue to drive development of the bio economy. **The last 2 years have confirmed that for a viable renewable sector to succeed the UK needs to concentrate on providing the right economic infrastructure.** The expansion of the biomass and bio fuel sectors has been underpinned by a mix of policy incentives such as Task Force and road mapping studies, EU or Government applied targets, fiscal incentives and indirect incentives in the form of government sponsored R&D and publicity. **Over the next 3 years Government must continue to demonstrate long term and cohesive commitment to the sustainable development of UK biomass and biofuel industries if they are to reach their potential.**

Building the pillars of a new bio-based economy – the biorefinery concept

- 3.3 We feel that there are some useful lessons to be learnt from developments in renewable industries and technologies outside the UK. In particular we have been excited by the growth of large **biorefineries** in the US. Driven by the need to supply their rapidly expanding biofuel markets, petrochemical companies are investing in these large scale facilities with potential not only to produce transport fuels from crops but also, at the same time, to use a wide range of new processing technologies to generate power, heat, chemicals and other valuable materials from the by products and residues.
- 3.4 We believe that in the longer term, biorefineries represent a real opportunity for the UK to build a range of renewable feedstocks and products on the back of the required increase in biofuel and bioenergy capacity. In the shorter to medium term, progress towards biorefineries is likely to underpin developments in a number of product sectors as technologies permit the conversion of biomass to basic chemical feedstocks from which a range of products can be produced.

■ Case Study

Biorefinery



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The biorefinery concept is that of an integrated facility that uses biomass as a feedstock for conversion into a range of differentiated products such as transport fuels, bulk and fine chemicals and using waste biomass for heat or power. The approach is similar to that of petroleum refineries involving a wider range of processes and techniques.

Maximizing the value of biomass feedstock by near complete utilisation increases the cost effectiveness while reducing waste streams. The most advanced examples of biorefineries are emerging in the US. Recently US based GS AgriFuels announced plans to build a plant to produce a range of biofuels from a range of feedstocks. The multi-fuel, multi-feedstock approach will use standard fuel production technologies as well as a number of proprietary

technologies including innovative pre-treatment, process intensification, gasification, catalytic, and carbon capture technologies, synergistically at small-scales to enable the refining of many forms of biomass into biofuels such as biodiesel and bioethanol.

In Europe, the first steps towards the commercial development of ethanol from plant biomass (lignocellulose) have been announced by Abengoa Bioenergy. A pilot scale biomass plant is currently under construction located next to the company's existing cereal ethanol plant in Salamanca, Spain. Commissioning is expected to start by the end of 2006. Current plans for the biomass plant are to process 70 tonnes of agricultural residues, such as wheat straw, each day and produce over 5 million litres of fuel grade ethanol per year.

- 3.5 **More work needs to be done to develop the necessary advanced technology, both in terms of research and of commercial development.** Whilst the US and Germany are at present leading players in these fields, the UK has considerable relevant research strengths, particularly in biocatalysis. **However, successful technologies require the integration of the most appropriate chemical, thermal and biochemical processes available, and this should remain a key focus of the Strategy and of the work of the NNFCC and KTN. It is vital that those parts of government, industry and academia involved with bio-renewables in the UK are aware of these opportunities and encouraged to participate in the development of new technology.**
- 3.6 Defra and DTI have commissioned a scoping study to look at the possibilities for producing and developing 2nd stage biofuels in UK. **We endorse this work and suggest that, depending on the results, further road mapping work be carried out to consider the potential for establishing larger scale whole crop biorefineries in the UK.**

Priorities for the next three years

3.7 **We are convinced that the Strategy, incorporating the additional work on biorefineries outlined above, remains the most appropriate framework for developing a sustainable and competitive renewables sector in England.** To maximise the contribution to the various economic, environmental and social objectives discussed earlier in this report, efforts in the short to medium term should continue to focus on developing the following industry sectors which have demonstrated real potential for further growth:

- Bioenergy (biomass and biofuels);
- Plant based pharmaceuticals, nutraceuticals and bio-actives;
- Renewable construction materials; and
- Renewable chemicals (including monomers, polymers, oils).



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3.8 **The delivery approaches set out in the Strategy should be seen as a flexible toolbox.**

The precise mechanisms for progressing each of the sectors will obviously vary, depending on the current status of the sector and the nature and priority afforded by Government to the objectives being pursued. However, the following cross cutting themes are relevant to the economic development of all of the sectors over the next 3 years:

Communication, dissemination, education and training

3.9 **We need to continue to raise awareness of the non-food crops strategy and potentials of sustainable renewable materials.**

Defra and its stakeholders have developed good communications links with the farming industry and it is important that these continue to relay messages about renewables. Attention now also needs to focus on those involved in supplying, innovating, processing, manufacturing, selling, and ultimately purchasing the wide range of sophisticated and often high tech renewable products which are coming to market. **Because the renewable materials agenda does not recognise Departmental or inter-disciplinary boundaries, work should focus initially on increasing awareness across the public sector so that synergies in policies, and opportunities to make use of any additional delivery channels and networks can be exploited.**

3.10 Whilst NNFCC, the Bioscience for Business KTN and other stakeholders will continue to play a vital role in delivering the non-food crops message there is also a need for a firm Government steer. **The overriding communications strategy developed by this Project Board should be implemented by Government and stakeholders over the next 3 years.** The forthcoming communications strategy for biotechnology which the DTI is developing with the Bioindustry Association's (BIA) Industrial Biotechnology Committee is expected to include renewables and should provide another important communication route.

3.11 The DTI's 'Business Link' service, control of which transferred to England's 9 Regional Development Agencies in 2005, is an important 'one stop shop' for small and medium size enterprises. Business Links provide advice and support on a range of issues including; grants and support, R&D, training, sales and marketing. **Business Links could provide a useful tool for those involved with renewable materials and it will be important to ensure that the service is properly promoted and updated with information relevant to the renewable sector.**

3.12 **Outstanding work on developing educational material for schools should be taken forward as a priority, and be expanded to look at incorporating renewable materials and energy modules into higher education and possibly vocational training courses.**

Integrating supply chains

3.13 To bring more renewable products to market we need robust, reliable, economically viable supply chains. **NNFCC have made good progress here through the establishment of Thematic Working Groups and developing links with key players. We must build on this.**

3.14 **Regional organisations should also have an increasing role to play in supporting supply chain development at a local level.** Rural Development Service, has transferred to RDA's who are now managing the scheme commitments they have inherited.

- 3.15 Substantial work is continuing to determine the precise shape of future investment under the next Rural Development Programme (RDP) for England, 2007-13. The RDAs will be a co-ordinated investment-led approach to rural development. They will, within the national framework, develop regional priorities for the next Programme, working closely with Natural England, the Forestry Commission, and regional stakeholders and partners. This will include looking at how best to support the establishment of sustainable supply chains for non-food crops.

Adding value to production chains

- 3.16 **To increase commitment from those already growing renewable feed stocks, and ensure security of supplies in UK, Government and stakeholders should explore ways of adding value to non-food crop production chains.** Many opportunities exist, for example, for farmers to add value from the development of simple on farm production facilities through to the use of large scale co operatives. **We suggest that investigations be carried out to identify suitable markets in the non-food crops sector and consider how best to provide the education and infrastructure needed to encourage growers to maximise the benefits they receive from growing crops to supply the UK renewable industries.**

Sustainable Procurement

- 3.17 Renewable materials and bio energy have the potential to contribute to Government's aims and targets for renewable energy, carbon savings, natural resource protection and biodiversity enhancement on the public estate. **More can be done to use sustainable public procurement to push up demand for bio renewables and the Government should set out how this can be achieved in its response to the report of The Sustainable Procurement Task Force.**
- 3.18 The London 2012 Olympic Games and Paralympic Games present important opportunities for procuring and showcasing of sustainable renewable building materials and other commercial products. **Government should work closely with the Olympic family on these issues.**

More R&D, innovation and demonstration

- 3.19 **R&D and demonstration work should continue to be targeted at bioenergy and renewable material projects which show most potential to translate into the production of marketable sustainable products and technologies. Government has played an important role in facilitating and supporting collaborative research but should also now seek to work in a more joined up way so that synergies can be exploited across the public sector.** Further opportunities may arise from the proposed Sustainable Consumption and Production Innovation Platform under DTI's Technology Programme: this will focus initially on the built environment and could provide a useful means for incorporating renewable products into any large scale demonstration projects funded through the platform.
- 3.20 **Maintaining, and indeed enhancing, bioscience capacity, knowledge, and skills within the UK is vital to the future development of a competitive bio-renewables industry.** Bioscience has the potential to extend and increase the range of renewable products. Opportunities for applying bioscience to non-food crops are likely to increase further, particularly in the production of pharmaceuticals and, in conjunction with other technologies, in the development of second generation transport fuels. The successful integration of bio-based

processing routes with clean (green) chemical technologies and efficient thermal and mechanical techniques will be required to realise the full potential of biomass in the production of materials, fuels and chemicals. This is an important challenge and one which the NNFCC should continue to address with industry stakeholders.

Safeguarding the environment

- 3.21 Although we suggest that action should focus on the above areas, other outstanding parts of the Strategy Action Plan should continue to be progressed. **In particular, aligning expansion of the renewables industry with the complex mix of environmental objectives is an ongoing task which must be pursued and co-ordinated with wider Government policies.** As mentioned previously the impacts on issues such as biodiversity and waste management must continue to be monitored. The potentials of biomass energy, biofuels and other renewable materials are recognised in the Climate Change Programme and there is a commitment to assess their contribution to climate mitigation on an annual basis. **The changing conditions climate change is bringing may have implications for the types and yields of crops and plants which can be grown in the UK, and this will need to be considered in longer term policy making on land use and farming issues in general, as well as informing specific thinking on renewables.**

Delivery Bodies

- 3.22 **It will be important for NNFCC to build on the good progress it has made in delivering Strategy actions. A strong focus also needs to be maintained on regional delivery. Although we have begun to embed renewables, particularly energy, into the plans and policies of some regions, more needs to be done to consolidate this work and increase coverage across the regional network.** The planned development of dedicated renewable agencies in some regions is to be welcomed and the recent introduction of regular meetings of Sustainable Farming and Food Strategy regional steering committee chairs should continue to be a useful vehicle for communicating strategic messages on bioenergy and renewable materials policies.

Conclusion and arrangements for monitoring future delivery and measuring success.

- 3.23 Good progress has been made in delivering the ambitious programme of work set out in the non-food crops Strategy. It is clear that Government led initiatives have played a key part in enabling delivery of the non-food crops agenda. Refocusing the Action Plan as outlined above will allow the Government to consolidate and build on achievements to date and move closer to the goal of developing a sustainable robust and eventually self-sufficient renewables industry in UK.
- 3.24 As this report shows, it is easier to measure processes than outcomes at such an early stage in a long-term work programme. The collation of data to support the high-level performance indicators we have devised is continuing and should help to measure changes on the ground. **These changes are what will help steer the future direction of the Strategy and Government should continue to invest in the collection of necessary statistical and economic evidence.**

- 3.25 Although the Strategy draws together a number of existing targets, mainly on bioenergy, we do not think it is practical to set separate overall targets for renewable materials use at this stage. **We do, however, consider that given the wide ranging nature of the Strategy and its action plan, it would be useful for Government to consider introducing some further aspirational goals or objectives to focus efforts over the next 3 years. It should make clear where it wishes to see most progress by 2009.** We have identified bioenergy, plant based pharmaceuticals, renewable chemicals and construction materials as the sectors we consider offering most potential for sustainable and competitive growth in the UK. We have also outlined a number of common actions which should help to bring about progress. **Government should now examine more precisely the extent of economic growth which is feasible in the areas we have flagged, and where possible, set realistic milestones and goals to encourage this growth.** This will send clear messages of intent to all involved in delivery of the Strategy from grower, manufacturer, through to consumer.
- 3.26 Our work has also demonstrated the importance of keeping up with developments in bio renewables at a global level. Despite the progress of the last 2 years, it is fair to say that the UK is still some way behind the success of leading players such as the US, Germany, parts of Scandanavia. **In assessing the performance and overall success of the Strategy it may be useful to bench mark UK performance against achievements and practices in other countries.** This will obviously need to take into account the different political priorities and circumstances of other nations but should provide opportunities to learn from best practices at an international level.
- 3.27 The work of this Project Board is now complete. Government is considering detailed plans for overseeing implementation of the Strategy work programme up to 2009 and will announce the new arrangements in its detailed response to this report.

Part 3: Devolved Administrations

This section provides a summary of key recent achievements in Wales, Scotland and Northern Ireland who, although not technically covered by the Strategy, have been using it as a model for development of non-food crop policies in their regions.

The Welsh Assembly Government

- 4.1 To date, there is no overarching policy for developing non-food crops in Wales – this work has been taken forward under other Welsh Assembly policies and programmes. These include Farming for the Future, the Wales Woodland Strategy and various funding programmes including Leader Plus and Objective 1. The area of non-food crops is being considered further under the developing Horticulture Strategy for Wales. Major developments to date include:

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

- 4.2 *The Centre for Alternative Land Use (CALU)*. This centre was established in 2004 as part of the Farming Connect initiative. Based at the University of Wales, Bangor, it acts as a pan-Wales technology transfer site for non-food crops, farm woodland, biomass, alternative livestock and horticulture.
- 4.3 *The Technology Transfer Centre*. Launched on Anglesey as part of the Biocomposite Centre, on 12 October 2006, this will focus on the development and demonstration of low carbon impact technologies using biomass and clean processing technologies to derive materials for commercial use.
- 4.4 *LEADER Plus*. This EU funded programme gives the opportunity to pilot new and innovative ideas for economic, social or environmental benefit. The projects are then demonstrated to the rural community as opportunities to be taken forward.

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

Biofuels

- 4.5 Under the Sustainable Development Action Plan agreed in October 2004, the Welsh Assembly Government committed to a project to “investigate the benefits and barriers to promoting the uptake of alternative fuels in Wales, such as biofuels, biogas, natural gas and hydrogen.”

Biomass and Woodfuel

- 4.6 The Woodland Development and Biomass Steering Group has been set up, comprising of key individuals involved in the sector. It aims to deliver the remaining action points under the Woodland Development and Biomass Strategy of 2002, and examine how the existing and emerging policies on farm woodland and biomass relate to the development of the sector in Wales.

- 4.7 The Forestry Commission Wales are investigating and encouraging the development of the woodfuel market as part of the Wales Woodland Strategy, in terms of market development for low value timber.

Funding Scientific Research

- 4.8 A number of industrial crop related projects taking place in Wales and funded from a variety of sources, including Welsh Assembly Government, Defra, Supergen, BBSRC and others. Centres taking forward this work include: the Biocomposite Centre, Bangor, Institute of Grassland Research (IGER), The Wales Biomass Centre, University of Glamorgan, and the Carmarthenshire Hydrogen Energy Group (CHEG).
- 4.9 Areas being developed by these bodies include: industrial uses of non-food crops for the plastics industry, use of high sugar grasses to produce transport fuels, production of hydrogen from starch, beet and grass using bacteria from natural sources, and investigation of plant medicinal properties for human and animal application. Some projects are undertaken in partnership with other major organisations.

Contributing to the low carbon economy with renewable fuels and energy

- 4.10 Wood Energy Business Scheme (WEBS) administered by the Forestry Commission Wales, was launched in March 2004. It provides grant support for the installation of woodfuel heating/ power generation and processing equipment, and has been successful in kick-starting demand in the woodfuel market in Wales.
- 4.11 Biofuels – in addition to the UK Government's UK wide initiatives mentioned in Defra's part of this review, the Welsh Assembly Government is committed to promoting and encouraging the uptake of cleaner fuels and vehicles in Wales. The Deputy Minister for Enterprise, Innovation and Networks is currently undertaking a study into reducing carbon emissions in Wales.
- 4.12 Biomass Energy Strategy – currently being developed by the Welsh Assembly as Wales' input into the UK Biomass Strategy. This will examine supply and demand for Welsh biomass feedstocks for energy generation. Due to be completed in 2007.

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

- 4.13 The Welsh Assembly Government (WAG) has set local authorities a specific composting target for municipal waste. By 2010, 15% of municipal waste is to be composted. Separated material includes kitchen and garden waste.
- 4.14 WAG has funded a new post for a Wales Compost Co-ordinator within the Wales Environment Trust. Duties of this post include setting up a network of demonstration plants for the composting of kitchen and garden waste. The first such plant, at Bryn Quarry was launched in mid September 2006.

Contributing to sustainability in the building and construction industries

- 4.15 Planning policy in Wales promotes sustainability through its Technical Advice Notes (TANs) for use by local authorities when considering new developments. Design guidance for building developments encourages the maximisation of energy efficiency, the use of sustainable materials and reducing waste and pollution. Guidance is also available for renewable energy projects.

Increasing use of sustainable products through Government procurement policies

- 4.16 The Welsh Assembly Government employs a sustainability policy in its office and property management. Of note are proposals to install at least two biomass boilers in two of the three new Assembly buildings being constructed over the next few years. This will stimulate further the biomass and woodfuel market in Wales and demonstrate the feasibility of such heating systems.

Biodiversity

- 4.17 Wales Biomass Centre, Cardiff University, have been carrying out work on monitoring of insects, birds and small mammals in SRC and energy grasses over the last 15 years across Wales and England. Experiments have been carried out comparing the ecology of energy crops with that of different land uses on adjacent sites.

Using CAP measures to promote non-food crops

- 4.18 A total of 949.9 ha of non-food crops were grown in Wales in 2005, giving a total yield of 2,626.91 tonnes. This included winter and spring rape, hear rape, linseed and barley. Aid for Energy Crops – a total of 29.11 ha was planted in 2005.

The Scottish Executive

Biomass

- 4.19 Much of the activity in non-food crops in Scotland is centred around biomass. In January 2004 the Scottish Executive's Forum for Renewable Energy Development in Scotland (FREDS) established the Biomass Energy Group to consider how biomass, especially forestry products, could make a meaningful contribution to Scotland's renewable energy mix and thus deliver significant environmental and employment benefits. The group's representatives were drawn from industry, academia and other government agencies.
- 4.20 The group produced the report: *Promoting and Accelerating the Market Penetration of Biomass Technology in Scotland* which identified a number of actions to achieve a viable biomass energy industry in Scotland. The report has been instrumental in securing ministerial and financial support for developing the sector. The Deputy First Minister, announced in May 2006, £7.5 million over 2 years (2006-07 and 2007-8) to support the development of the biomass sector. This will be delivered through the Biomass Support Scheme which will launch later this year.

4.21 Other activities going on in this area are:

- Development of a Biomass Action plan for Scotland; timescale for launch is end of the year;
- Working with UK government Departments to ensure a joined up approach to biomass across the UK including the publication of a UK biomass strategy; and
- Supporting 2 woodfuel information officers working across Scotland, to bring suppliers and customers together to develop a sustainable market for wood.

Research on Non-Food Crops

4.22 SEERAD supports strategic research through four grant funded Research Programmes. One of these covers work on “Sustainable Agriculture – plants” and within this programme there is research which underpins understanding of genetics, genomics, pathology and physiology of crop plants. Although this work is primarily focussed on crop plants of relevance to Scottish agriculture, it is also relevant to a wide variety of plant types including non-food crops as well as natural vegetation. Some work in the Programme on “Environment – Land Use and Rural Stewardship” is also relevant to non-food crop production through studies aimed at understanding the environmental impacts of changing agricultural practices, including the introduction of new crops. Details of all the work undertaken as part of the Research Programmes may be found at www.scotland.gov.uk/srg.

4.23 SEERAD has also funded a number of projects which are specifically aimed at research on non-food crops, through its contract research fund. Recent projects, some of which are joint funded through Defra LINK programmes, are listed below.

- Assessment Of Plant Germplasm For Bioactive Molecules
- Development Of Myrica Gale As A Source Of Natural Products In Toiletries And Household Care Products (sweetgale).
- Advanced composite construction materials from non- wood fibres (Fibstruct).
- Antioxidant – Based Industrial Products From Oats (abipo)
- Review Of Greenhouse Gas Life Cycle Air Pollution Impacts And Economics Of Biomass Production And Consumption In Scotland.

Department of Agriculture and Rural Development, Northern Ireland

4.24 Northern Ireland has also focussed their efforts on bioenergy. Over the past two years, the Department of Agriculture and Rural Development (DARD) in Northern Ireland has led an Inter-Departmental Group in a comprehensive study of the potential market for, and sustainability of, small-scale embedded heat and power and heat-only systems in the rural economy. Whilst this study dealt primarily with the use of renewable energy sources for the generation of electricity and heat, it also extended to the use of biofuels for transportation.

Part 3: Devolved Administrations

- 4.25 Drawing on this work, the Inter-Departmental group produced a set of recommendations for DARD action to take forward a renewable energy Strategy. The recommendations included proposals to:
- increase awareness of renewable energy through education and training;
 - offer the rural community technical support;
 - further the development of renewable energy technology and processes through research and development, and;
 - pilot and assist projects.
- 4.26 Towards the end of 2005, the Department launched a formal consultation on the recommendations. Responses to the consultation were generally supportive, indicating action should be taken sooner rather than later to advance the field of renewable energy. It was thought important to have a vision, and action plan, for sustainable communities, prioritising technologies which have the greatest benefit to them and the rural economy.
- 4.27 Both the recommendations from the Inter-Departmental Group and the responses to the consultation will shape DARD's forthcoming Renewable Energy Strategy, which is likely to focus on:
- (i) the opportunities for alternative land uses to broaden the economic base of agriculture;
 - (ii) the integration of sustainable waste management with renewable energy production, and;
 - (iii) the opportunities to deploy renewable energy technologies within the rural economy, particularly small-scale, embedded heat and power systems.
- 4.28 The development of the Renewable Energy Strategy will build on existing DARD work in the field of renewable energy. For example, the Forest Service opened a 3 year Challenge Fund for Short Rotation Coppice (SRC) Energy Crops in August 2004, with the aim of increasing the amount of SRC willow grown for an energy end use. By the end of the three years, it is expected that the fund will have supported the planting of 700 ha of SRC. The Fund has been successful in creating a new renewable fuel resource and many valuable lessons have been learned. Amongst these, it has become clear that the process works best when growers combine their resources to supply specific local energy users.
- 4.29 Under the new Rural Development Regulation Programme 2007-2013, it is proposed that the Woodland Grant Scheme (WGS) will support the establishment costs of first afforestation on agricultural land, which may include short rotation coppice. This programme is currently being finalised.
- 4.30 The Forest Service has also been working with wood processors to create stability in the wood supply chain and promote long term business planning. In response to this initiative, a major sawmill has invested in facilities to produce 2MW of electrical energy and 10 MW of heat using wood chips and sawdust produced on site, as well as producing wood pellets for combustion off site. The economic contribution from this wood based energy operation is serving both to strengthen the financial performance of the sawmill operator and to underpin the demand for home-grown timber.

- 4.31 From 2004, an EU Aid to Energy Crops Scheme has been available in Northern Ireland. Energy crops are defined as crops supplied essentially for the production of biofuels, and electric and thermal energy produced from biomass (Council Regulation (EC) No 1782/2003 Article 88). Aid of €45 per hectare can be payable in respect of energy crops grown. Aid is conditional on the producer having a contract in place with a processor. Aid is not payable for energy crops grown on land that is required to be set-aside from production but, as previously allowed, set-aside land can still be used to grow energy crops.
- 4.32 DARD also has a significant research base in renewable energy technologies extending back over many years and has commenced work on developing a new 5-year research and development strategy in which it is anticipated that work on renewables will be an important element.

Environment And Renewable Energy Fund

- 4.33 On 27 February 2006, the Secretary of State for Northern Ireland announced the Environment and Renewable Energy Fund – a cross-cutting two year funding package of £59m. This is intended to accelerate actions to make greater use of cleaner and more sustainable sources of energy, reduce energy consumption and, by enhancing skills, innovation and job creation prospects, build sustainable communities in Northern Ireland. It will also enhance energy efficiency and help to alleviate fuel poverty.
- 4.34 DARD has been successful in a number of bids to the Fund, totaling £3.7 million over a two year period, namely:
- Funding the creation of a Renewable Energy Centre of scientific excellence at the Hillsborough site of the new Agri-Food and Biosciences Institute (AFBI) – a DARD sponsored NDPB.
 - Funding research and development in renewable energy technologies within AFBI.
 - Funding the College of Agriculture and Rural Enterprise (CAFRE) to take forward a technology transfer programme on renewable energy programmes to increase awareness among the rural community and enhance its knowledge to exploit the opportunities that currently exist.
 - Establishing biomass fuel heating demonstration projects within the CAFRE estate.
- 4.35 There will also be a series of actions within the Fund to increase public and stakeholder awareness, disseminate information and knowledge and encourage deployment of renewable technologies.

Glossary

ACEO	Agricultural Change and Environment Observatory. A Defra led programme set up in 2005, initially for three years, to monitor, and where possible anticipate, the impacts on the environment of the 2003 CAP reform measures and other key drivers of agricultural change.
CAP	Common Agricultural Policy
CCP	Climate Change Programme
CHP	Combined Heat and Power
CSL	Central Science Laboratory
DCLG	Department for Communities and Local Government
Defra	Department for Environment, Food and Rural Affairs
DTI	Department of Trade and Industry
EA	Environment Agency
ERDP	England Rural Development Programme
ERRMA	European Renewable Raw Materials Association
EU	European Union
GHG	Green House Gas
KTN	Knowledge Transfer Network
LEAF	Linking Environment And Farming
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
NNFCC	National Non-Food Crops Centre
OECD	Organisation for Economic Co-operation and Development
R&D	Research & Development
RDA	Rural Development Agency
RDP	Rural Development Programme
RPA	Rural Payment Agency
RTFO	Renewable Transport Fuels Obligation
SCP	Sustainable Consumption and Production
SFFS	Sustainable Farming and Food Strategy
EPOBIO	Realising the Economic Potential of Sustainable Resources – Bioproducts from Non-Food Crops. EPOBIO is an international project funded through the European Union's Sixth Framework Programme (FP6) to realise the economic potential of plant-derived raw materials.

List of aid schemes for growing non-food crops in England between 2003 and 2006

Energy Aid Scheme	EU scheme started in 2004 for crops grown not on set-aside land for the production of energy (for heat, electricity or transport fuel).
Non-food Crops Scheme	This was part of the Arable Area Payments Scheme but was replaced by the Single Payment Scheme in 2005. It relates to the production of specified industrial crops grown on set-aside land not for food or feed use.
The Energy Crops Scheme	This was introduced in England in 2000 and provides grants for establishing miscanthus and short rotation coppice. The current scheme closed to new applications in July 2006. New arrangements for supporting the establishment of energy crops are due to be announced under new ERDP.
Fibre Processing Aid Scheme	EU scheme introduced in 2001 with aid paid on the tonnage of flax or hemp straw produced.
Woodland Grant Scheme	England scheme to support management of existing and planting of new woodland. Started in 1997 and closed in 2004.
English Woodland Grant Scheme	Funded stewardship of existing woodland and creation of new woodland where there is public benefit, particularly in terms of improved biodiversity or public access. Started in 2005 and replaced the Woodland Grant Scheme. The scheme closed in July 2006.

Project Board Membership and Terms of Reference

The Project Board consists of 11 full members. There have been a few changes in representatives over the last 2 years and details of membership over that period is as follows:

Andrew Perrins/Iris Anderson (Chair)	Defra, Industrial Crops Division
Stefan Antosik	GW-Pharma Ltd
Dr Sue Armfield	Department of Trade and Industry, Head of Industrial Biotechnology, Bioscience Unit
Fiona Bryant	East of England Development Agency
Prof Ian Graham	University of York, (Centre for Novel Agricultural Products)
Anna Hope	English Nature
Richard Howell	Environment Agency
Peter Kendall/Paul Temple*	National Farmers' Union
Dr Tom MacKenzie	Uniqema Ltd
Nick Monger-Godfrey#	John Lewis & Waitrose
Dr. Jeremy Tomkinson	National Non-Food Crops Centre

* Also represented by Matthew Ware and David Proudley

Also represented by Iain Dalton

A number of associate Project Board members have provided support and advice on specific issues over the past 2 years. As well as colleagues from within Defra and DTI, we have been assisted by:

Lucy Bjorck	RSPB
Helen McKay	Forestry Commission
Helen Sweeney	Government Office, North West
David Turley	CSL

Terms of reference for the Project Board for the Strategy of Non-Food Crops and Uses

The Board shall:

- Monitor the delivery of the *Strategy for Non-Food Crops and Uses*. A brief statement of progress will be included in the minutes of each meeting.
- Monitor and advise Defra and DTI on integrating the implementation of the strategy with EU and regional priorities and other relevant government Strategies such as Defra's Strategy for Sustainable Farming and Food and DTI's Technology Strategy.
- Alert Defra and DTI of any serious anticipated delays or difficulties in delivering the Strategy as they become apparent, and advise on any amendments and reprioritisation of actions required to the Strategy Implementation Plan to reflect changing circumstances.
- Advise Defra and DTI on the delivery of large or complicated commitments.
- Advise on further research required to underpin the delivery of the Strategy, such as assessment of particular crops for biodiversity or other environmental impacts.
- Actively assist in the delivery of the Strategy where appropriate, for instance by providing information, assisting with communication, soliciting stakeholder commitment and by other activity.
- Work with Defra and the DTI to develop a series of measures to evaluate the outcomes of the Strategy, and advise on any further research or work needed to develop indicators.
- Advise on further work which should be considered at the end of the reporting period to further the aims of the *Strategy*, taking into account changing circumstances in the intervening period.
- Prepare a written report on the implementation of the *Strategy*, its outcomes, and further work required, to Defra, the DTI, and the Sustainable Farming and Food Strategy Implementation Group, by November 2006.

Performance indicator framework for Non-food crops strategy

ECONOMIC SUSTAINABILITY							
Strategic Outcomes	Outcomes		Headline Indicators		Core Indicators		Process Indicators
More competitive farming	New markets	H 1	Size of market	1.01 1.02	Crop areas & volume/ value of UK NFC* No. of farms growing NFC		
	Expansion/security of income/markets	H 2	Relative economic performance of farms growing NFC/productivity	2.01 2.02 2.03 2.04 2.05	Crop yields Trade in NFC (UK sourced/imports/exports) Income from growing NFC* Net profit or margin* Relevant scheme funding		
More competitive industry	Economic growth New & profitable products	H 3 H 4	GVA of sector Size of market for NFC derived products	3.01 3.02 3.03 4.01 4.02 4.03 4.04 4.05	Comparative unit costs of NFC raw materials Comparative processing costs of NFC raw materials Value added Market share of NFC in various sectors* Number of jobs in sector Security/continuity of supply chain (UK vs imports) Government/public procurement Technical performance of NFC derived products		
Innovation	Successful exploitation of new ideas	H 5	No. of successful new NFC based products/rate of development and substitution	5.01 5.02	Recognised product specification/quality standards New Business Start-ups	5.03 5.04 5.05 5.06 5.07 5.08 5.09	Investment in R&D (public/private/joint) Partnerships, Link Programme, Research Council Projects – numbers, funding DTI Technology Programme investment Capital investment Uptake of ERDP funds for NFCs No. of patents Number of products being trialled at different phases of development

ECONOMIC SUSTAINABILITY (continued)							
Strategic Outcomes	Outcomes		Headline Indicators		Core Indicators		Process Indicators
Communication, education and training	Stimulus to market development	H 6	Raised awareness and understanding (farmers/industry/consumers)	6.01	Awareness (farmers/industry/consumers)*	6.04	NNFCC website – hits
				6.02	Confidence (farmers/industry/consumers)	6.05	Demonstration projects (funding/numbers)
				6.03	Demand (industry/consumers)	6.06	NFC Communication Strategy
						6.07	Knowledge transfer
ENVIRONMENTAL SUSTAINABILITY							
Strategic Outcomes	Outcomes		Headline Indicators		Core Indicators		Process Indicators
Climate change	Reduced greenhouse gas emissions/carbon savings	H 7	Fuel/energy from NFC sources	7.01	Proportion of fuel derived from NFC sources		
	Waste management	H 8	Market share of biodegradable products	7.02	Proportion of biomass used for energy (electricity & heat)		
				8.01	Proportion of packaging derived from biodegradable NFC materials*		
				8.02	Waste disposal route & associated energy recovery (landfill, composting, other)		
Protection of the landscape, environment and non-renewable resources	Sustainable use of natural resources	H 9	Substitution level for fossil fuels/mineral oils for products in various sectors	9.01	Use of NFC for industrial manufacture in various sectors*		
	Protection of the environment and landscape	H 10	Environmental impact	10.01	Crop inputs (fertiliser/pesticide/water use)		
				10.03	Crop diversity & extensification		
				10.04	Habitat		
SOCIAL SUSTAINABILITY							
Strategic Outcomes	Outcomes		Headline Indicators		Core Indicators		Process Indicators
Better public health and workplace H&S	Reduced health risks	H 11	Workplace exposure & risk assessment	11.01	Comparative hazard classification of NFC derived products		
				11.03	Use of NFC derived materials		
More integrated and productive rural communities	Alternative markets and source of income	H 12	Human capital formation	12.01	No. of farms growing NFC		
				12.02	Employment and income from growing NFCs		
				12.03	Employment in various related industry processing sectors		
				12.04	Skills and training		

*Possible suitable headline indicator

Potential markets for NFCs:

biofuels
 fibres
 polymers, plastics
 lubricants
 solvents
 surfactants
 dyes and paints
 healthcare & pharmaceuticals

Summary of the strategy for non-food crops and uses action plan

Promoting non-food uses of crops through the provision of information and knowledge	Progress to date
1. 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	Progressing
2. Develop education materials on the potential of non-food crops to substitute for fossil materials	Progressing
3. 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	Progressing
4. Establish programme of business support and training for farmers to help co-operative working and new business development	Progressing
5. Prepare and host a range of case studies on the NNFCC website to publicise non-food crop uses	Progressing
6. Consider a programme of industrial secondments to the NNFCC	Progressing
7. Develop close co-operation between seed producers, farmers and industrial users by the development of NNFCC instigated networks.	Progressing
Analysing strategic issues and identifying barriers to development of non-food crops	
8. Develop new programme of work and workstreams to take forward recommendations of the Government Industry Forum on the Non-Food Uses of Crops	Progressing
9. 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	Progressing
10. Align sectoral analyses with Regional Economic Strategies to differentiate competitive advantages of geographic regions	Progressing
11. Following the AEBC study, Defra and DTI to define a strategy for the development of high value-added products including pharmaceuticals from crops.	Progressing

Funding scientific research	Progress to date
12. Defra non-food crops research programme doubled to £2m per annum	Completed
13. Development of new LINK-style non-food crops programme	Completed
14. New programme on supply chain development and assessment worth £1.3 m per annum being rolled out	Completed
15. BBSRC to develop a strategy for research on non-food uses of crops	Progressing
16. Output from supply chain programme to include publicity fact sheets available on the NNFCC website	Progressing
17. Develop, at the European level if possible, a central life cycle inventory database to support the sustainable development of the sector.	Progressing
Contributing to the low carbon economy with renewable fuels and energy	
18. Energy Act 2004 provides a framework that would enable the introduction of a Renewable Transport Fuels Obligation (See also action 24)	Completed
19. External year-long study commissioned to analyse issues relating to biomass development	Completed
20. Publication of new planning guidance (PPS 22) to facilitate renewable energy projects	Completed
21. Review of the Climate Change Programme which will take full account of the potential contribution of biomass fuel and energy	Completed
22. 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	Completed
23. 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. (Roll out of regulation will also impact on actions 3 & 10)	Progressing

Contributing to the low carbon economy with renewable fuels and energy (continued)	Progress to date
24. 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 (See also action 18)	Completed
25. Further measures are under consideration to develop the biomass heat market in the light of the RCEP report.	Progressing
Contributing to improvements in waste disposal and tackling pollution and health risks	
26. Develop logo to facilitate identification of biodegradable packaging	Completed
27. Carry out demonstration work on biolubricants and biosolvents to show benefits	Not started
28. Support the development of an eco-label for biolubricants, to be in place by end 2004	Completed
29. In order to support uptake, prepare publicity material to show that biolubricants and biosolvents are technically robust, deliver environmental gains and are affordable.	Progressing
30. 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.	Progressing
31. Assess and demonstrate the potential for mechanical separation systems, such as those using near infra red technology, for biodegradable waste.	Progressing
Contributing to sustainability in the building and construction industries	
32. Publicise and disseminate BRE/CIRIA report on sustainable building materials.	Completed
33. Ensure that the new single National Code for Sustainable Building, recommended in the Sustainable Building Task Group report, takes account of the potential of crop-derived building materials	Progressing
34. Commission work to define priority options for the use of crop-derived building materials, establish technical detail and demonstrate methods of use.	Progressing

Increasing use of sustainable products through government procurement policies	Progress to date
35. Potential for crop-derived materials highlighted in the Framework for Sustainable Development on the Government Estate	Completed
36. Defra considering opportunities for the use of biomass heating in offices.	Progressing
37. 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	Progressing
38. Prepare product datasheets which will enable public procurement nationally and regionally to give a lead on the use of crop-derived products.	Not started
Biodiversity	
39. Commission study on other non-food crops (ie non energy 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	Progressing
40. Prepare best practice guidance to help farmers maximise profits from non-food crops whilst delivering biodiversity benefits	Completed
41. 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	Progressing
42. Assess the potential to develop an accreditation scheme for non-food uses of crops to certify sustainability.	Progressing
Using cap measures to promote non-food crops	
43. Publicise how CAP reform can stimulate diversity in production.	Completed
44. Discussions of successor programme to ERDP to take account of potential of non-food crops. (See also action 23)	Progressing
45. 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	Progressing
46. Consult industry on future of flax and hemp processing aid within the context of CAP reform.	Completed

Annex C

Using environmental regulation to achieve environmental outcomes with benefits for non-food crops	Progress to date
47. 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	Completed
Instigate blue sky thinking to underpin long-term development of the sector	
48. The NNFCC will identify emerging opportunities and markets and support technology development from other countries	Progressing
49. Develop key strategic partnerships at a European level to help the EU to compete in a global non-food crops products market	Progressing
50. 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.	Progressing

Non-Food Crops Uses Current Technology Status Review

Market Sector	Stage of development*	UK feedstocks (current or potential)	Other crop feedstock examples	Examples of applications	Drivers for implementation	Barriers to uptake
Biolubricants						
Metal working fluids	C	Oilseed rape (OSR)	Sunflower, crambe, nut oils, soya bean	Ford Motor Company using vegetable based fluids in some of its manufacturing plants	Performance, cost, Health and Safety (COSHH), improved working conditions	Changes to manufacturing systems
Slip agents	C	HEAR, crambe	Soya bean	Erucamide from both Crambe and HEAR oil, used as a slip agent to reduce friction in manufacture of plastics. Also used on supermarket carrier bags to aid opening	Performance	
Total loss lubricants	C	OSR	Sunflower, nut oils, castor oils	Environment Agency and Forestry Commission insist on the use of vegetable based lubricants in its chain saws	Biodegradability, environmental procurement policy and performance	Cost relative to conventional oils
Hydraulic fluids	C	OSR	Sunflower, OSR, nut oils	Environment Agency and Forestry Commission require environmentally 'considerate' lubricants to be used in sensitive areas, these can be vegetable based or synthetic esters.	Biodegradability, environmental procurement policy	Hydraulic equipment must be flushed out and may need alternative seals
2-stroke engine oils	C	OSR	Sunflower, castor oil	British Waterways are currently phasing-in the use of lubricants based on renewables for its marine engines	Biodegradability	Cost relative to conventional oils
Mould Release Agents	C	OSR	Soya bean	Concrete mould release agents used in construction industry	Reduced environmental impact	
Drilling mud additives	R	OSR	Palm	Vegetable oils for offshore drilling operations (VOODOO) (Link project 1997) assessed the potential for using OSR oil for drilling fluids, results were favourable but not taken up commercially.	Biodegradable, risk of sea pollution with conventional mineral oil fluids	Water based alternatives are also available
Fibres						
Automotive textiles	C	Hemp		Interior car panels, parcel shelves, door linings	ELV directive, cost performance-weight saving, health and safety.	
Clothes manufacture/ textiles	C (mainland Europe) R, (C mainland Europe)	Flax, hemp Nettles	Cotton	Traditional linen. Hemp in mainland Europe for textile industry STING project currently investigating nettles as a fibre crop for the UK	Eco-friendly market, fashion	Lack of processing facilities and scaling up of production

Annex D

Market Sector	Stage of development*	UK feedstocks (current or potential)	Other crop feedstock examples	Examples of applications	Drivers for implementation	Barriers to uptake
Fibres (continued)						
Building Composites	C	Hemp	Hemp, tropical fibres e.g. kenaf, kapok, coir	Hemp/lime mix used to produce building blocks as a substitute to concrete. e.g. new Adnams brewery distribution centre. Straw fibreboard	Sustainable construction, high thermal and strength performance	Awareness and examples of use
Insulation	C	Sheep's wool, hemp, flax		Sheep's wool insulation marketed as Thermafleece by Second Nature. Hemp insulation in Europe (Germany)	Sustainable construction. Performance favourable compared to glass fibre	Costs currently higher than conventional insulation products. Awareness and lack of distributors
Biosolvents						
Printing solvents/ cleaning solvents	C	Oilseed rape	Soybean, coconut, palm, sunflower	Solvents for use in the printing industry have been trialled in UK. Performance good in some applications but slow uptake by industry	Health and safety, potential for reducing/ eliminating operator exposure to VOC's	Cost. Not suitable for all applications. Change in working practice
Biopolymers						
Bioplastics-packaging	C (Germany, US)	Wheat, potatoes, oilseed rape	Maize, potatoes, soya, sunflower	Polylactic acid from starch fermentation used to produce bioplastics by Rodenburg, Germany; Cargill Dow, US. Starch polymers used for biodegradable packaging e.g. bags, nappies etc.	Bioplastics may be biodegradable, can be diverted from landfill and composted	Disposal/waste segregation issues. Biodegradable plastics not suitable for all applications
Bioplastics	C (US)	Sugar beet	Maize	Production of bio-propanediol which is then polymerised to produce engineering plastics (DuPont)	Equivalent performance to oil derived plastics	
Incorporation in tyre manufacture	C		Maize	Goodyear manufacture BioTRED tyre, maize starch used in composite to improve tyre performance and fuel economy	Performance, eco-market	Cost/awareness
Plasticisers	R	Crambe, OSR	Castor oil	The BioComposites Centre at the University of Wales are currently developing a polymer plasticiser from an ester of brassylic acid which is derived from crambe oil. Plasticisers are used to transform unplasticised PVC (uPVC) into a plasticised flexible form such as flexes, tubing and hoses	Need for alternative to conventional dioctyl phthalate about which there are health concerns. Indications are that performance is as good as conventional plasticisers	Development is ongoing to improve manufacture and purification techniques

Market Sector	Stage of development*	UK feedstocks (current or potential)	Other crop feedstock examples	Examples of applications	Drivers for implementation	Barriers to uptake
Biocomposites						
Automotive biocomposites	C (mainland Europe)	Hemp		Hemp produced in UK exported for this purpose, used by major car manufacturers and accounts for 80% of hemp use	ELV vehicle directive, other performance and health & safety benefits	Processing carried out in Europe, relatively small Hemp acreage in UK
Packaging	C (NZ) C	Potatoes, Wheat	Maize	Potatopak (NZ) produce biodegradable disposable plates, cutlery, punnets/trays from potato starch Wheat based packaging (polystyrene alternative) produced in UK	Biodegradability	Unit cost/ promotion, only suitable for short life applications in some cases. Disposal/waste segregation
Energy						
Small scale heat/CHP generation	C	SRC, miscanthus, forestry residues, cereal grains, cereal straw		Numerous examples of small scale heating systems running on SRC/forest residues. Harper Adams University College has installed a small scale combined heat and power plant	Alternative farm income, local supply chain, capital grants	Investment costs. Grid connection and contractual obligations limits electricity generation. Slow development of UK supply chains
Large scale power generation	C	SRC, miscanthus, forestry residues, cereal straw	Olive and other crop by-products	SRC used for co-firing in power stations such as Cottam and Drax. Miscanthus may also be used. Elean power station uses cereal straw as main fuel source	Renewables Obligation, tradable ROC's	Competitor biomass costs. Slow development of UK supplies
Biodiesel	C	OSR	Palm oil, waste vegetable oils, soy oil, sunflower oil	Numerous commercial plants in production or under construction. Significant tonnage of OSR exported to Germany for biodiesel production	Renewable Transport Fuels Obligation. Duty reduction	Engine warranty issues. Technical constraints with some blends
Bioethanol Biobutanol	C R	Sugar beet	Maize	British Sugar is currently constructing a bioethanol plant at its Wessington site. British Sugar in collaboration BP and DuPont are looking at the feasibility of producing biobutanol	Renewable Transport Fuels Obligation	User awareness. Engine warranty issues
Bioethanol	C	Wheat, sugar beet	Maize	Green Spirit Ltd. to construct bioethanol plant at Henstridge, Somerset. Other ethanol plants at planning stage. First E85 bioethanol pump opened in Norfolk.	Renewable Transport Fuels Obligation	

Annex D

Market Sector	Stage of development*	UK feedstocks (current or potential)	Other crop feedstock examples	Examples of applications	Drivers for implementation	Barriers to uptake
Phytopharmaceuticals						
	C/R	Poppy, Artemisia, daffodil, <i>Cannabis sativa</i>		Currently around 28 drugs produced commercially from plants to any significant degree worldwide. Current UK research projects include examining the potential for growing Artemisia for novel malaria treatment and galanthamine from daffodils	Some plant derived drugs found to perform better than synthetic counterparts, innovation	Stringent regulatory framework-expensive to register products
Speciality						
Personal care	C	Various; calendula, hemp, lavender, echium	Numerous camelina, marigold, camomile, coconut	Wide range of products in this sector	Marketing and media	Cheap imports
Paints and surface coatings	C	Linseed	OSR, castor oil	Linseed oil paint, putty etc.	Technical performance, drive to reduce VOC's	
Nutraceutical	C	Borage, evening primrose, echium	Borage, evening primrose	Borage marketed as Starflower as health supplement, also used in baby foods and cosmetics	Marketing and media	Cheap imports and overseas production, novel foods approval issues
Dyes	C (on very small scale in UK)	Woad (Indigo)		Used only for small-scale natural dyeing purposes. India currently supplies most of the world's consumption of natural indigo.	Renewable, craft/speciality market	Synthetic alternatives. Cost, performance, environmental concerns with mordants (fixing agents). Not suited to dyeing synthetics.
Agro-chemical adjuvants	C	OSR	Sunflower	Used to improve efficiency of agrochemicals	Performance and crop safety	
Surfactants	C (mainland Europe)	Various, probably not UK.	Camelina, pot marigold, camomile, soybean, coconut oil	Ecover currently market a range of detergents and cleaning products based on vegetable surfactants ingredients	Eco-friendly consumers, market	Cost
Printing Inks	C	OSR, linseed	Soya bean, linseed and others	Small market in UK, not suited to lithographic systems	Measures to reduce use of VOC's in the workplace	Some technical limits to use

*Stage of development in UK except where otherwise stated

C= Commercialized

R= Research & Development

Back cover pictures:

Spray application of Hemcrete (a construction material made from hemp shiv and lime binder) – courtesy of Limetec

Internal car panels made from natural hemp fibre – courtesy of Daimler Chrysler

Biomass boiler – courtesy of CSL



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for uncoated paper and 75% recycled fibre for coated paper.

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PB12282

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