

Non-Food Crops The Commercialisation Issues -Peter Lillford



Supply Chains

Regulations / Controls

Market Drivers

Opportunities

Threats

R&D Requirements



NNFCC

National Non-Food Crops Centre

- Environmental issues are finally becoming major drivers: Specifically waste disposal and renewable alternatives to raw materials from fossil fuels
- Performance characteristics must be met
- Agricultural scale must meet demand
- UK is well behind N America and continental Europe



NNFCC

National Non-Food Crops Centre

Recent Market Research

- Developing products for “well-being” from natural raw materials

- Customer is:
 - more aware of environmental issues,
 - doesn't approve of animal testing,
 - wants plant-derived materials,
 - doesn't want to see the rainforests plundered

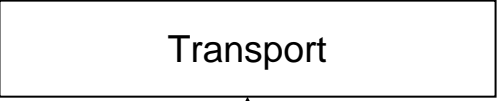
- Market Trends
 - Holistic products
 - Internal / external combinations

“Respect for customers...”



NNFCC

National Non-Food Crops Centre



Lubricants

Fuel

Energy

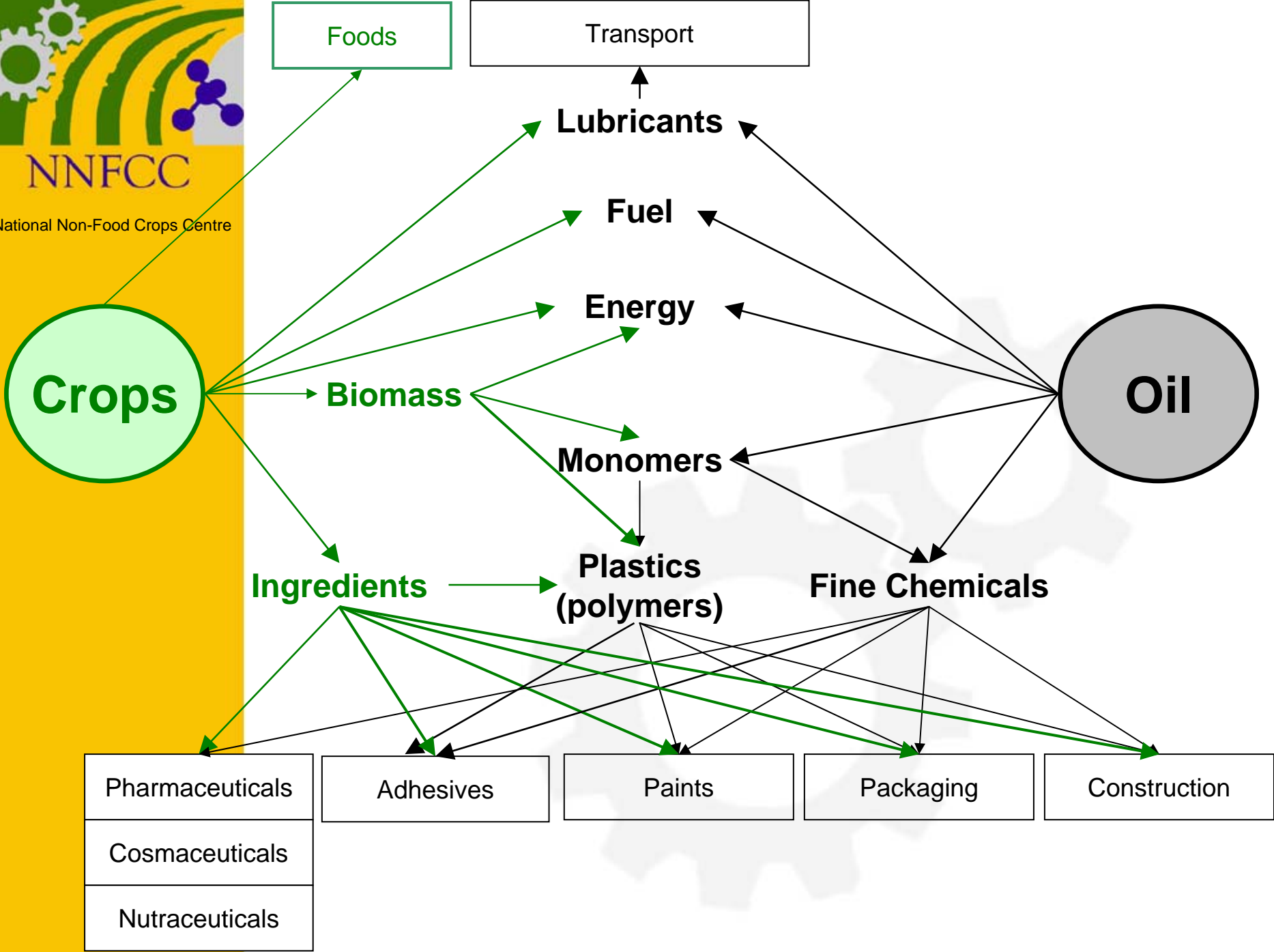
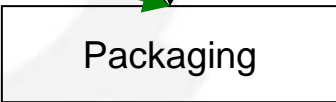
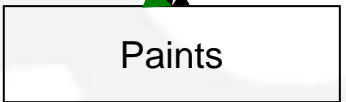
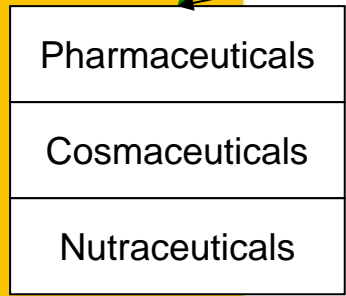
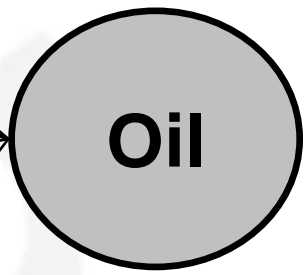
Biomass

Monomers

**Plastics
(polymers)**

Ingredients

Fine Chemicals

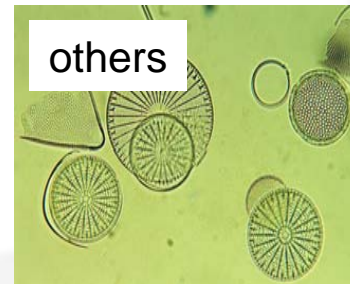




NNFCC

National Non-Food Crops Centre

Renewable Feedstocks



Global Biomass produced annually = 170×10^9 tonnes

- 75% carbohydrate: cellulose, hemicelluloses, starch, sugars
 - 20% lignin
 - 5% others: fats, oils, proteins..
- Valuable source of carbohydrate for energy, fuel and chemicals
 - Currently 6×10^9 tonnes utilised (3% of which are non-food uses)

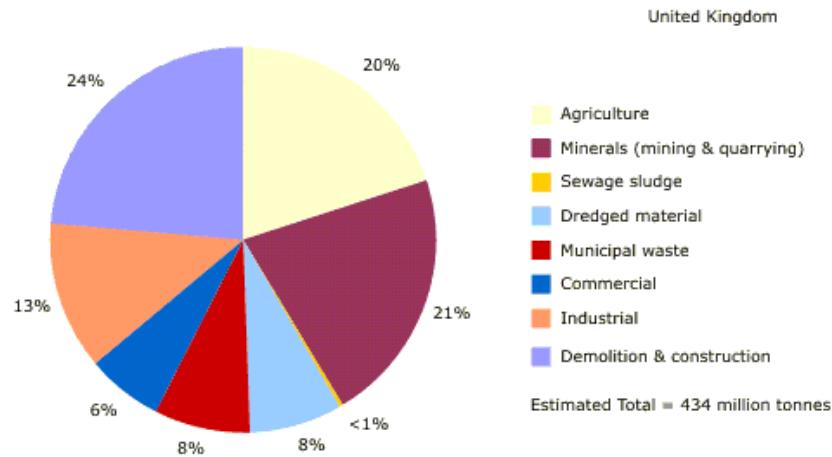


Nnfccc

National Non-Food Crops Centre

UK Waste: A rich source of biomass

Figure 2: Estimated total annual waste arisings by sector



Source: Department for Environment, Food and Rural Affairs; Environment Agency; Water UK

UK Waste = 434MT

Growth rate = 3-4% pa

UK has very high landfill rates

- Food industry by-products = 30MT
- Agricultural Waste 80MT (wheat straw = 10MT)
- Municipal Waste streams 25MT*
 - Garden waste 5MT
 - Paper and board 4.5MT
 - Compostable kitchen waste 4.5MT
- Timber & wood waste 2.8MT
- Brewers spent grain 0.5MT

* Data for England only



National Non-Food Crops Centre

What's Happening in the UK?

- Biomass for Burning
 - Short rotation willow and wheat
- Bio Fuels
 - Bio-Diesel already being manufactured & sold
 - First bioethanol plant planned
- Bio-Plastics / biocomposites
 - Innovations in packaging, but a long way to go with other materials (small scale)
- Oleochemicals / lubricants
 - Well established industry, still innovating.
- Pharmaceuticals/Nutraceuticals
 - A return to plants as factories? For natural secondary metabolites and/or recombinant proteins
- And the rest...
 - CHP, Essential Oils, Insulation, Flavours and Fragrances, Fabrics,



NNFCC

National Non-Food Crops Centre

Non-Food Crops

Bio-diesel in the UK

- Petroplus, Teeside; ULSD + bio-diesel blend (5%)
- Rix Biodiesel, Hull; biodiesel blend





National Non-Food Crops Centre

Biodegradable Lubricants

Resurgence in vegetable oil based lubricants

- Environmental legislation
- Lubricity
- Biodegradability, Low toxicity
- High load carrying, Low evaporation
- Ready and Sustainable supply

Current total EU lubricants market approx 4.2M Tonnes

- biolubricants 0.1M Tonnes
- 1.3M T predicted for 2010

Predicted that 90% of lubricants will eventually be crop based

Common Crop Sources: Rapeseed, Sunflower, Soya, Palm

Base oil or synthetic ester with additives



Biodegradable Cutting Fluids

Metalworking oils – engine manufacture

- ❖ Performance
- ❖ Cost competitiveness
- ❖ HSE benefits (negate oil mists)



Commercial Successes:

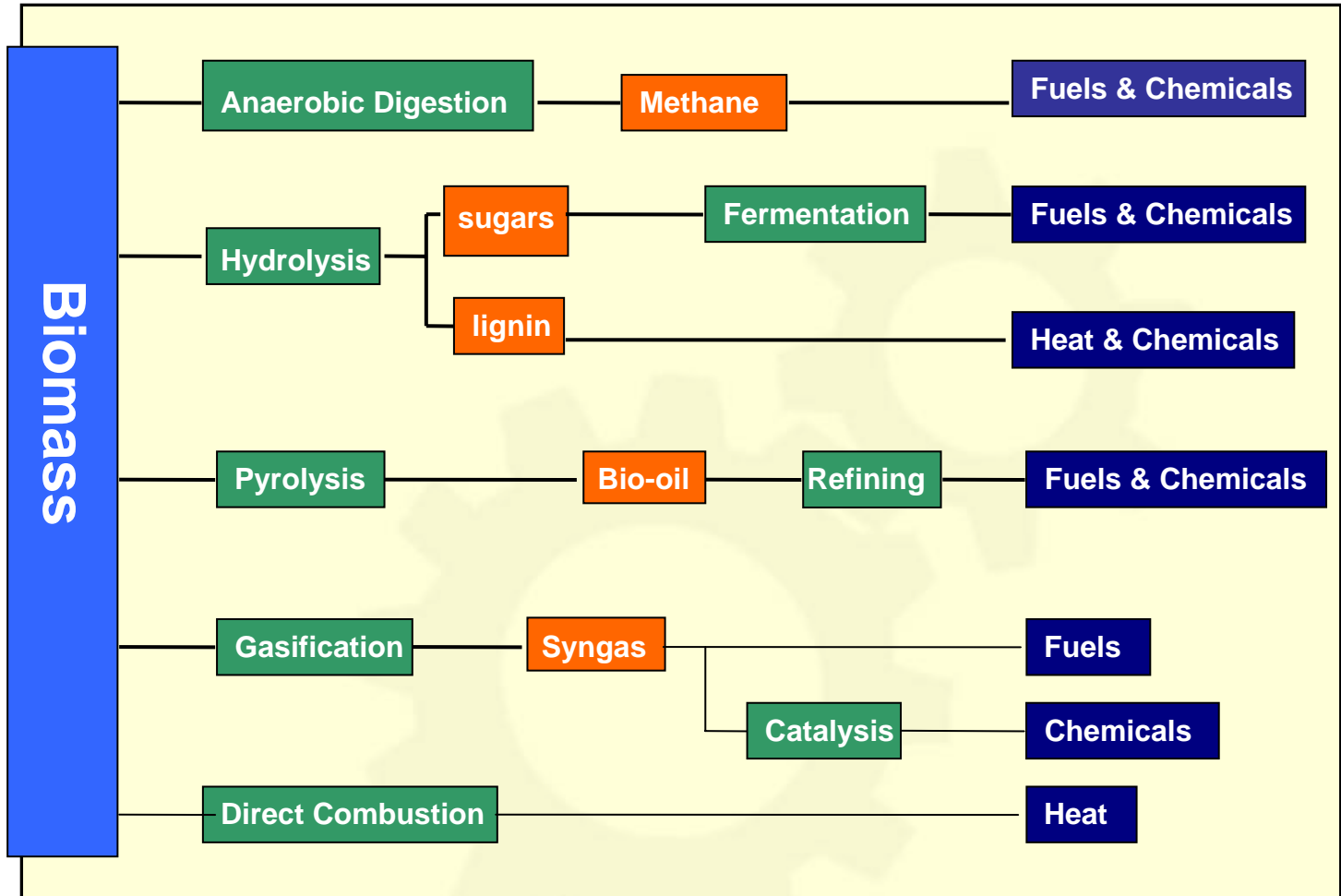
- ❖ Ford/Houghton
- ❖ Mercedes-Benz/Fuchs



NNFCC

National Non-Food Crops Centre

Biomass to Chemicals and Fuels





UK Chemicals & Energy Resources

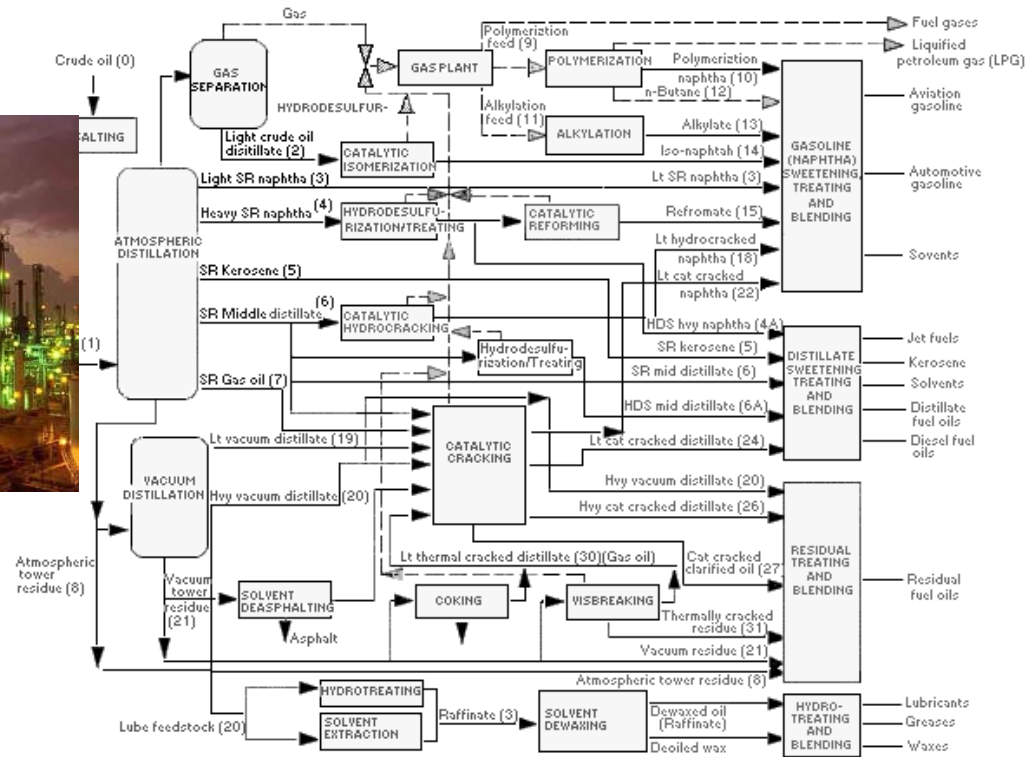
- Globally ~ 350MT organic chemicals produced from fossil fuel feedstocks (70,000 products).
- Value of Global Chemical Industry \$1.8 trillion (UK £42 Billion)
- UK Consumes 4.5MT of plastics pa
- Petrochemicals consume 7% of fossil fuel production
- UK will be net Oil/Gas importer by 2010
- Chemicals production moving to areas of advantaged feedstocks



NNFCC

National Non-Food Crops Centre

Modern Oil Refinery



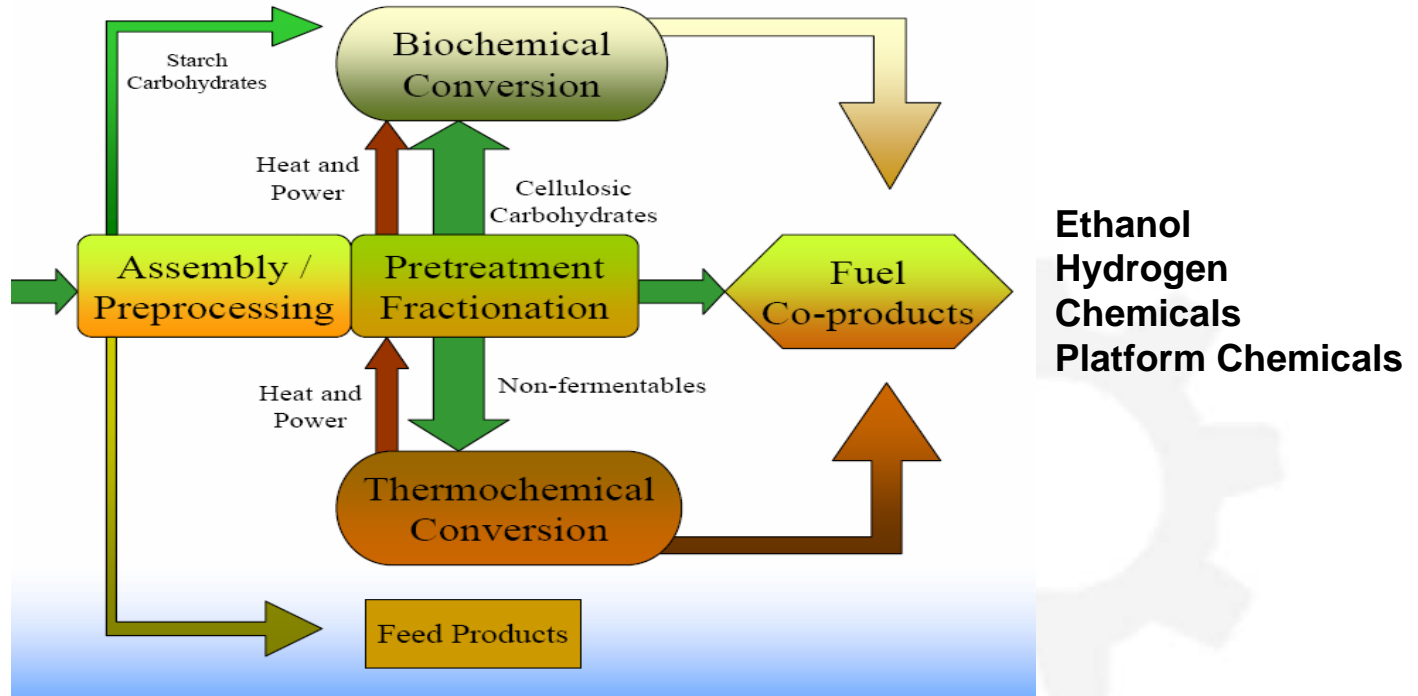
- Highly integrated
- Fuels, chemicals, power, materials
- Large volume markets
- Numerous thermal & catalytic processes
- Whole crude oil feedstock utilisation
- Evolved over 150 years
- Originally one product: kerosene lamp oil



NNFCC

National Non-Food Crops Centre

Biorefinery Concept

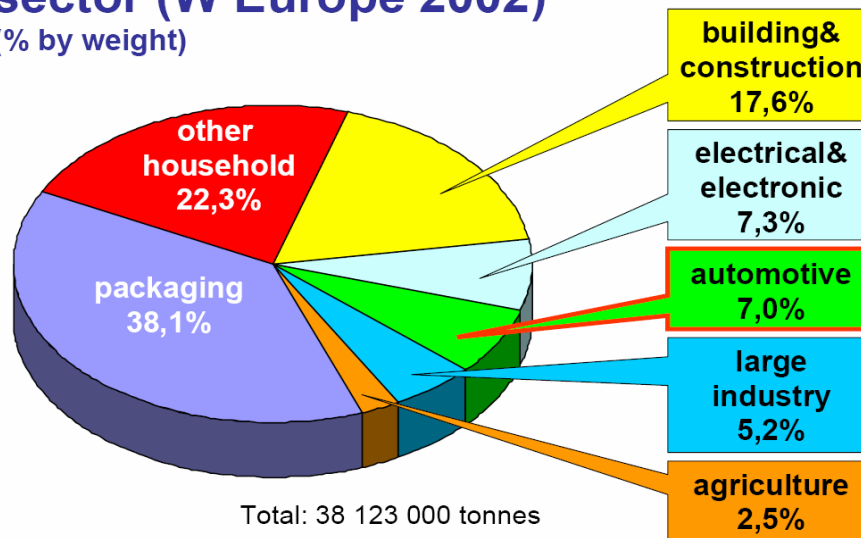


- ❖ Whole crop utilisation
- ❖ Diverse products/markets
- ❖ Economies of scale (large market driver)
- ❖ Diverse processing: Biochemical & Chemical (syngas)
- ❖ Lignin provides energy
- ❖ Analogy with oil refinery
- ❖ Difference: Diverse feedstock, biochemical processing

Plastics

Plastics consumption by industry sector (W Europe 2002)

(% by weight)

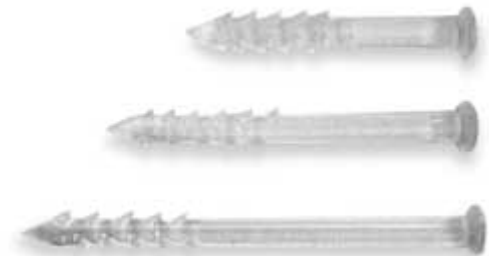


UK Market ~ 5.0MT

- ❖ W. Europe plastic waste 2000 = 19.5MT
- ❖ Critical to divert waste from landfill
- ❖ Waste Recovery (mechanical recycling, feedstock, energy) = 7MT
- ❖ UK very low recovery rates
- ❖ Biodegradable Polymers

Synthetic Biopolymers: Polylactic Acid

- ❖ Fully biodegradable new polymer (since 1932!)
- ❖ Based on lactic acid produced from starch
- ❖ 20-50% less fossil fuel resources than conventional plastics
- ❖ Dow Cargill “NatureWorks” Polymer
- ❖ 140,000 tonne pa plant in Nebraska





NNFCC

National Non-Food Crops Centre

Biopolymers

Biologically produced polymers with unique properties

- Sustainable materials
- CO₂ neutral monomer source
- Reduced processing
- Burn cleanly
- New functionalities
- Biodegradable, compostable

Natural Biopolymers: Starch Based

Synthetic Biopolymers: polylactic acid, polycaprolactone....

Growth rates – up to 30% of market by 2010



NNFCC

National Non-Food Crops Centre

Starch Based Biodegradable Polymers

- ❖ Feedstock: Corn, potato, maize, food waste....
- ❖ Starch blended with other polymers)
- ❖ Novamont: Mater-Bi Family
- ❖ 35,000 t/y production capacity
- ❖ Rodenburg (Netherlands): Solanyl polymer
- ❖ Made from potato peels 40,000 t/y capacity





NNFCC

National Non-Food Crops Centre

Industry views

- A common view within the commodity polymers sector is that biodegradable polymer technology is currently limited by
 1. High price and process temperatures
 2. Poor tensile properties at higher temps
 3. Poor solvent resistance
 4. Hydrolytic instability
 5. Insufficient mechanical properties





NNFCC

National Non-Food Crops Centre

Present position

- Two main issues still to be resolved
 1. What is more important from a material properties and market perception standpoint;
 - Polymer is derived from a bio resource – carbon neutrality
 - Polymer is biodegradable
 - Or are both factors crucial to adoption in the market
 2. Disposal
 - Composting
 - Who will be responsible for developing the infrastructure
 - Recycling
 - Energy recovery





National Non-Food Crops Centre

Pharmaceuticals

Nutraceuticals and even

Cosmaceuticals

Markets

*Increasingly
regulated*

From ASA to MHRA

*From “orphan
drugs” to billion-
dollar
pharmaceuticals*

Customers

The general public

*Trained Herbal
Practitioners*

*Pharma,
multi-nationals,*

*Governments,
WHO, etc*

Not an easy market to break into



NNFCC

National Non-Food Crops Centre

Medicinal Plants

Modern drugs from plants; Quinine (Malaria)

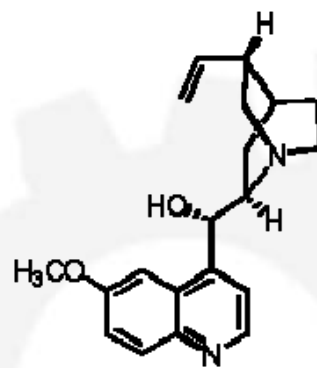
Extracts recorded by Europeans from 1638



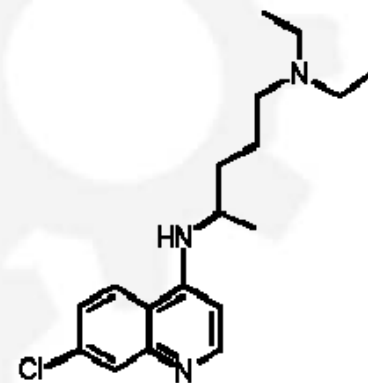
Quinine

Chloroquine

Mefloquine



quinine



chloroquine

Resistance developing; alternatives needed

*Cinchona
Officinalis*





NNFCC

National Non-Food Crops Centre

Medicinal Plants

- *From aromatherapy to recombinant proteins*

Aromatherapy

True Herbal Medicine (including
Traditional Chinese Medicine)

Pure plant-made single compounds

Semi-synthetic pharmaceuticals

Synthetic mimics / third generation
compounds

Recombinant proteins (bio-factories)



*Cinchona
Officinalis*



National Non-Food Crops Centre

Can be a Farm-Based Venture

Essential Oils/ Personal Care

Examples:

Norfolk Lavender, Norfolk Essential Oils

Marketing from premises and on the WWW.

Direct sales to public and to Trade

UK and overseas

Own distinctive brands and lines

Tourist trade; Coffee shops, tours, etc

Direct link to growing, harvesting and processing



Summary

- As demonstrated across the EU and the US non-food crops are already a realistic industrial raw material - therefore technology is not the major issue
- A number of important barriers need to be addressed before large scale commercialisation can commence
 1. Need for commercial scale pilot plant to demonstrate product performance, process viability and market acceptance
 2. Robust feedstock supply at full commercial scale
 3. Need to restructure regulatory framework that addresses the benefit renewables have on waste management and climate change
 4. Need for Government to incentivise industry to adopt renewables as mainstream raw materials – cannot simply rely on market forces as this tends to promote the cheapest and most accessible materials



NNFCC

National Non-Food Crops



Regulatory Requirements

- Chemicals regulations – REACH, dangerous goods/preparations
- Climate change levy
- Materials and Articles in Contact with Food Regulations etc

- WASTE LEGISLATION
- SECTOR SPECIFIC STANDARDS AND AGREEMENTS





National Non-Food Crops Centre

Non-Food Crops

Examples of positive drivers

UK CO₂ Targets

***Energy Crops
Scheme***

***Tax reductions on
liquid biofuels***

***Co-firing
initiatives***

CAP Reform

R&D Funding

***Government
Procurement***

NFC's on set-aside

P&MG Scheme



National Non-Food Crops Centre

- When all factors come together:
 - Performance
 - Environmental profile, LCA
 - Government incentives/legislation
 - Health and Safety at work
 - Cost benefits
 - Availability of raw materials
 - Procurement policies

- We get away from niche markets and into mainstream use
 - Leads to continued development cycle



NNFCC

National Non-Food Crops Centre

Thank You



www.specialc

www.nnfcc.co.uk
