IENICA

Interactive European Network for Industrial Crops and their Applications

BACKGROUND SCENARIO
AND
EXECUTIVE SUMMARY
TO EUROPEAN OVERVIEW

FORMING PART OF THE IENICA PROJECT

FINAL

IENICA is a project funded under the FAIR Programme
by DG XII of the European Commission

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PREFACE

This project was funded under the Fourth Framework Programme, FAIR. It has run for 3 years with 14 EU member states as partners, all co-ordinated by Central Science Laboratory in UK.

The 3 key focus areas for the project have been:

- Setting up a crops, products and contacts database (http://www.csl.gov.uk/ienica).
- Assessing markets, opportunities and constraints for non-food products in EU-15.
- Ensuring technology transfer through international conferences, newsheets and direct informal contact and discussion.

Achievements:

All targets in the current IENICA project have been achieved:

- Freely accessible website on the internet which currently receives over 44,000 calls per year.
- 14 individual state reports identifying markets and constraints for non-food crops and an EU overview are completed and awaiting formal printing. Summaries are already available from the website.
- Three major industry focussed conferences have been delivered – Copenhagen (Natural Fibres Performance Forum), Wageningen (Vegetable Oils – Meeting the Needs of Small, Medium and Large Enterprises) and Valbonne (Speciality Chemicals for the 21st Century).
- Over 12,000 technical newsheets have been distributed.

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This summary is prepared from a European overview document by the same author. It is formatted in this style in response to EC request.

Individual state reports and data collected independently by the author formed the basis of the European overview document. Contributions from industry are gratefully acknowledged.

All are available on the IENICA website – http://www.csl.gov.uk/ienica

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INTRODUCTION

Agriculture in the widest definition includes grazing land of all descriptions, including upland, traditional cropping areas, horticulture and farm woodland as energy coppice. Forestry embraces all wood production outwith that definition, both naturally developed and commercially afforested and harvested.

Agriculture in EU-15 is primarily focussed upon the production and provision, either directly, or via processors, of crops for food and animal feedstuffs. Total utilised agricultural area is 137.3 million ha. Of this, approximately 75 million ha is in arable production and 50.4 million ha in permanent grassland. Approximately 33% of total EU land area is afforested. This amounts to 118 million ha.

Areas of mainstream arable crops and non-food crops by EU State are shown in Tables 1.1a and 1.1b.

Main Arable Crops in the EU based upon IENICA Project Estimates

Table 1.1a : Crop areas in EU15 by Country (000's ha)

PLANT SPECIES BY COUNTRY	Total EU	Austria 97	Belgium 96	Denmark 97	Finland 97	France 97	Germany 97	Greece 95	Ireland 97	Italy 95	Netherlands 97	Portugal 90	Spain	Sweden 97	UK 97
CARBOHYDRATE CROPS															
Wheat Total	21359.9	259.8	196.4	684.0	124.0	4843.7	6654.0*	860.8	93.9	2481.0	189.3*	457.0*	2126.9	344.0	2045.
Wheat – Set aside (Industrial use)	10.7					10.4									0.3
Barley	9139.8	260.6	50.4	739.0	533.4	1690.3	*		190.7	381.0	*	*	3558.4	483.0	1253.
Maize	3945.0	188.3	6.1			1857.6	268.0			942.0	12.7	215.0	455.3		
Sorghum	103.4	0.7				68.7				34.0					
Sugar beet Total	2136.5	51.6	98.0	68.0	31.7	461.7	504.0	40.1	34.0	283.0	114.1		201.8	60.0	188.5
Sugar beet Set aside (Industrial use)	12.4					12.4									
Potato Total	1415.4	23.5	61.4	40.0	40.9		300.0	50.6	18.0	180.0	179.9	117.0	204.0	36.0	164.1
Potato – Starch	94.5			30.8							62.4			1.3	
Chicory	16.4		12.0								4.2		0.2		
OILSEED CROPS															
Oilseed rape Total	2744.8	54.9	4.9	103.5	55.3	974.9	862.0		5.0	46.0	0.6		58.2	73.0	506.5
Oilseeed rape – Set aside (Industrial use)	315.0	3.0		10.2		162.0	107.0			4.7					28.1
Sunflower	2007.9	20.0				894.9	23.1	22.8		230.0		105.0	712.1		
Sunflower – Set aside (Industrial use)	44.1					41.0	3.1								
Linseed	225.9		11.3	2.0	2.2	5.4	96.7		8.0				0.5		99.8
Soybean	308.1	15.2				97.9				195.0					

* Total cereal area

Table 1.1b : Crop areas in EU15 by Country (000's ha)

PLANT SPECIES BY COUNTRY	Total EU	Austria 97	Belgium 96	Denmark 97	Finland 97	France 97	Germany 97	Greece 95	Ireland 97	Italy 95	Netherlands 97	Portugal 90	Spain	Sweden 97	UK 98
Hemp	17.27	1.1			0.07	10.6	0.4				1.2		1.3		2.6
Flax	111.9	0.8	11.0	3.5	1.0	45.0	3.6			3.0	4.3		7.9	15.0	16.8
Cotton	446.6							441.2					5.4		
Miscanthus	0.23			0.03			0.2								
Short Rotation Coppice	2.3			0.6		1.0	0.1								0.6
Fibre sorghum	1.0							1.0							
SPECIALITY CROPS															
Total area	41.8	1.1			1.9	29.1	4.0				2.0		3.3		0.4
Lavandin						14.3									
Lavender						2.5							2.1		
Oil Poppy	7.0	0.9				5.5					0.6				
Clary	1.0					1.0									
Chamomile	0.7						0.7								
Borage	0.5														0.5
Saffron	1.2												1.2		
Caraway	0.2										0.2				
Oil pumpkin	14	14.0													
Grand Total/Country	**44544.4**	895.5	451.5	1618.63	790.47	11229.9	8826.9	1416.5	349.6	4779.7	571.5	894	7338.6	1012.3	4306.

Tables 1.1a and b summarise the areas of relevant crops, as supplied in the 14 state reports. They indicate that industrial carbohydrate and oil products are largely derived from food crops (cereals, potatoes, sugar beet, oilseed rape, sunflower and soyabean). Apart from crops grown on set-aside and starch potatoes, it is therefore difficult to identify the specific areas devoted to industrial carbohydrate and oil crop production. The area of fibre crops is relatively small and readily identifiable. The area of speciality crops is very small and is composed of many species, which differ considerably between countries.

Currently, the majority of consumer goods purchased in EU-15 are derived from fossil resources, a significant proportion being oil derived through the petrochemical industry.

In addition, Eurostat data shows considerable areas of perennial crops from which secondary products could be derived, eg vine, hop, citrus and olives.

Whilst set-aside arrangements have been a partial driver for the establishment of the non-food crops sector, it has to be recognised that set-aside is fundamentally a market management mechanism for cereals and oilseeds. In terms of non-food crops it is no more than an opportunist niche, which because of the uncertainty of its size, does not create the conditions required for significant industrial investment.

The realisation that petrochemicals in particular could become prohibitively expensive or cease to be available as oil resources decline has been recognised for many years. Estimates vary and the provision of 'true' estimates is highly complex. Nonetheless, something between 40 and 50 years from 2000 seems to be a key milestone by which reserves will have become critically low. Hence, there is an impetus to move the balance of production from the finite to the renewable industry generally and to move some agricultural resources to non-food production.

Political systems, like Common Agricultural Policy, along with changes in world markets and improvements in agricultural production have caused surpluses to be stockpiled, for example in EU Intervention stores. This has been recognised for about 20 years, yet it is surprising that little progress has been made in reducing them. Rexen and Munck (1984) assessed potential outlets to obviate high levels of cereals building up in EU stores by 2000.

Their recommendations were:

1. That the EEC stimulates co-operation between agriculture and industry, starting by establishing agricultural refineries as demonstration units in various EEC countries.

2. That the EEC revises its present tariff system regarding cereals and cereal products and changes it to a coherent, simplified set of rules designed to stimulate efficiency in cereal production and in the industrial use of cereals, thus creating the basis for an internationally competitive biotechnology industry in the EEC.

3. That the use of straw as a fibre source should be stimulated by supporting a modernisation of the present industrial process to obtain competitiveness with the wood based industries.

4. That the production of agricultural commodities in which the EEC is deficient - maize for starch, feed protein, vegetable oil, and cellulose fibres – should be stimulated by quality related premium prices of present commodities and development of new crops.

5. That significant basic research programmes should be established in the industrial manufacture of cereal based products, including genetic engineering of plants and micro-organisms, purification of cereal components and their processing and modification into final products.

Clearly, many policy changes have occurred since these primary recommendations were laid and certainly much research has been undertaken in the cereals area. Equally, change in world prices and increasing deregulation of markets through GATT/WTO negotiation have made agricultural crops more economically competitive as non-food feedstocks than in the past. However, the IENICA project has confirmed that much of this potential has yet to be exploited.

Moreover, recent expert projections indicate that surpluses of cereals in EU-15, especially wheat, will be significant (see table 1.2), unless major action is initiated to prevent their accumulation. Current export regulations would prevent export aids for these surpluses but non-food uses provide an ideal opportunity for them, within EU-15. Recent commercial initiatives to process wheat for non-food uses in Spain could be repeated elsewhere, subject to assessments confirming market acceptability. Also, such projected surpluses of food crops suggest that significant land areas could easily be diverted to non-food crop production.

Table 1. 2 : Projected EU Cereal Intervention Stocks under Agenda 2000 (million tonnes)

	97/ 98	*98/ 99*	*99/ 00*	*00/ 01*	*01/ 02*	*02/ 03*	*03/ 04*	*04/ 05*	*05/ 06*	*06/ 07*
Wheat	3	7	12	16	20	25	31	40	50	61
Coarse Grains	11	13	26	15	11	8	6	6	7	9
Total	14	20	38	31	30	37	38	46	57	70

Source: Timms (1999)

The IENICA project has indicated that for development of renewables to occur, a number of key processes need to be put in place.

- Establish systems that integrate the supply, manufacturing and distribution activities through supporting infrastructure; this enhances economic viability.

- Improve the understanding of plant metabolism, via functional genomics, to optimise the design or use for specific value-added processes; in addition to the use of current inherent components, exploring novel polymer production and use.

- Ensure that the development of new processes with very high efficiency accompanies secondary processes that use all components as co-products and therefore eliminate wastes, this provides economic and environmental benefits.

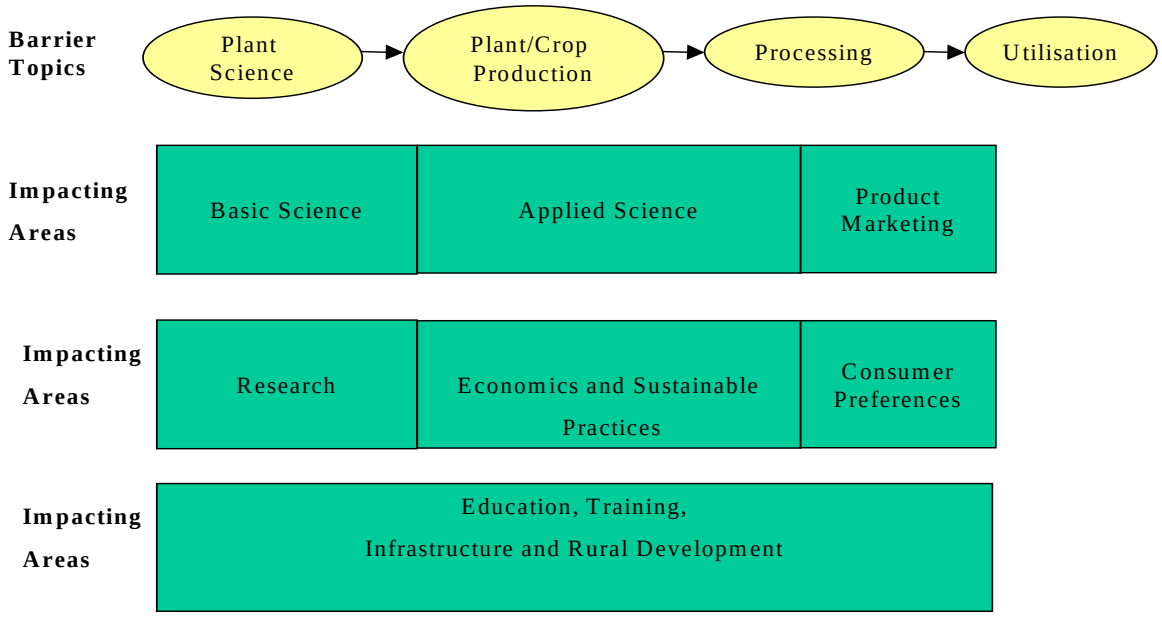
- Cross-check that specific goals and research targets are consistent with those of non-food market needs and specifications.

- Develop approaches to ensure a consistency in supply and demand; keeping factors such as price/volume, performance, geographical location, quality, etc within defined limits on an annual production basis; developing standards for these factors.

- Establish formal vertically integrated partnerships where producer and user of non-food products act in unison.

A recent report published in the United States of America by Vision 2020 Executive Steering Group summarised the pathway for progress and development of non-food crops and products in the form of figure 1.1.

Figure 1.1 Pathway for progress and development of non-food crops and products



These pathways apply equally in EU-15 but the IENICA project has concentrated on identifying plants/crops or co-products with non-food use; markets and constraints. It recognises that huge amounts of research had been funded at the basic and strategic applied levels.

There appears to have been little demand from industry for non-food biorenewables (excluding energy which is not part of the IENICA project specification). The causes identified for this are:

- Lack of awareness of opportunities.

- Lack of financial need or incentive to change.

- Investment in current technologies and lack of capital to re-tool.

- Lack of clarity in the development of non-food renewables market in political and environmental sectors.

- Lack of market organisation and guaranteed supply of primary products.

In essence, there has been much 'technology push' but in many non-food product sectors, little 'market pull'. The fundamental concepts behind the IENICA project are to facilitate the correction of that imbalance in a systematic and sustainable manner through identification of crops, markets, products and industry contacts.

References:

Timms K. 1999. Changes in support systems and the effect on arable crop production in EU. *Proceedings BCPC-Weeds-1999.*

Rexen & Munch. 1984. Cereal Crops for Industrial Use in Europe. *EU Commission EUR 9617 EN*

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS FROM THE IENICA PROJECT

This summary and the EU overview have been prepared from data submitted to the co-ordinator in 14 state reports, supplemented by further input by industry and the co-ordinator. It is divided into 3 component parts:

- EU/EC wide issues.

- Market opportunities:
  - oils
  - fibres
  - carbohydrates
  - speciality products
  - protein crops

- Constraints and opportunities
  - technical
  - legislative
  - economic
  - environment
  - communications
  - other issues

EU/EC Wide Issues

1. EC regulation is not well focussed in terms of non-food crops. There is a need to develop and promulgate a clear concise long-term strategy for non-food crops and products. This requires co-ordination and pro-activity between DGs Agriculture, Environment, Energy, Industry and Research.

   - There must be a requirement laid upon EC/EU administration to develop a coherent strategy for non-food products from plants and act in concert with it when regulations are revised or proposed.

   - Anomalies in EC regulations should be removed:

   - Flax and hemp regime and non-food but non-traditional markets.
   - Impact of EINECS[1] and ELINCS[2] on non-food products (see section 'Legislation', page 14).
   - Plant derived crop protection products (see section 'Legislation', page 14).

2. The needs of industry and the potential of agriculture need to be better understood and more clearly addressed. This should be undertaken by exploiting the data provided in this project and extending contacts with EC. Presentations to officials in various interested Directorates General of EC should be considered.

[1] European Inventory of Existing Commercial Chemical Substances.
[2] European List of Notified Chemical Substances Regulations.

3. EC policy makers should consider the total benefits of crop derived non-food products through standardised life cycle analysis procedures. Benefits should be positively promoted through the inclusion of such bio-renewables in EC tender documents for contracts. Support should be considered for the development of bio-renewable product specifications and labels to educate and identify for consumers.

4. CAP has a market distorting effect in the oilseeds (food v non-food) and fibres (clothing textiles v novel uses of fibres) sector. This needs to be examined and corrected when regimes or CAP are revised and during WTO activities.

5. The whole issue of non-food crops and products should form a coherent package within Framework 6 Programme of EC. That package should be part of the structured EC strategy on non-food crops and must be focussed on industry needs and development of the rural economy.

6. Blairhouse Agreement/EC-US oilseeds agreement. Definitive statements on the long-term standing and precise meaning of this agreement are needed.

Market Opportunities

1. Oils

Overall usage of vegetable oils and animal fats in the non-food sector of EU-15 is approximately 3 million tonnes per annum. This excludes biodiesel fuels. Key market sectors are lubricants, paints and surface coatings, surfactants and oleochemicals. Considerable potential for expansion exists, including import substitution of both vegetable oils and tallow.

- Bio-lubricants - the potential EU market is approximately 370,000 tonnes/annum but currently less than 10% of that potential is exploited. There are significant environmental benefits for the use of bio-lubricants where high environmental contamination occurs.

- Bio-printing inks - the EU market is in excess of 120,000 tonnes/annum. Belgium has made considerable progress in using vegetable based printing inks, but elsewhere, particularly outside of Scandinavia, Netherlands and Germany, usage is very small. There are no technical reasons for this lag in uptake.

- Bio-solvents – the EU solvent market is approximately 4 million tonnes/annum of which 1.9 million tonnes/annum are hydrocarbon solvents. Considerable health, environmental and security benefits would accrue from substituting vegetable derived solvents for current fossil derived materials. At least 12.5% of total market could be vegetable derived but to date less than 1.5% has been achieved.

- Linoleum. - the EC demand for linoleum is likely to rise to 56 million m^2 by 2003. This will generate a 64% increase in linseed oil requirement, which could be produced in the EU. Total linseed oil usage in the linoleum market in Europe will therefore be 56,000 metric tonnes per annum.

- Surfactants – the EU market is currently in excess of 2 million tonnes tonnes/annum and increasing. By 2005, domestic household use of surfactants alone is likely to be 1.5 million tonnes/annum. However, expansion of surfactant production from EU grown bio-renewable sources is limited by the inability of EU to produce vegetable derived short chain fatty acids, eg lauric acid. Alternative feedstocks for surfactants must therefore be sought from other EU crop plants, since lauric acid derived from transgenic plants appears uneconomic in cool temperate regions.

- Polymers - the majority of polymers are derived from petroleum but certain products are based upon, or incorporate vegetable oil-based derivatives. There appears to be considerable scope for an expansion in the use of vegetable oils in polymer production. The most widely used polymer is erucamide, derived from HEAR, used as a slip agent in polythene film.

- Paints and surface coatings- increasing use is being made of bio-solvents by the paint industry as well as the use of alkyl resins and varnishes based on vegetable oils.

2. Fibres

EU industry uses both home grown and imported fibres (eg jute). There would be considerable benefit to industry, in terms of quality and reliability of supply, if they were able to substitute imported fibre with home-produced material.

In terms of specific sectors within the fibres market, clothing textiles form the traditional component and novel uses, (eg automotive parts), the new and developing component.

The total clothing textiles market in Western Europe is projected as 7.9 million tonnes for 2001 with a 10% increase expected by 2006. Of the textiles market, approximately 40% is supplied by natural fibres, of which wool and cotton are dominant. Undoubtedly, small and perhaps valuable niche markets existing for hemp, flax and silk derived textiles. In the case of the former two crops, progress in development will be enhanced by technological development, although cost and fashion trends will limit potential. It should be noted that small amounts of non-traditional short fibre flax are currently spun with wool. The future of this market requires examination.

The new fibres market sector includes matting based products (eg simple filters, growth media, geo-textiles), which tends to be lower value and composites (eg automobile parts, building composites) which tend to be higher value. The automotive sector should be considered as a primary market driver for the short to medium term future with Europe, producing about 18 million cars and light vans annually. Proven uses amount to 10kg fibre per vehicle and potential likely uses in the same vehicles up to 10kg fibre per vehicle more. Current estimate of maximum market, based upon existing automobile production, is 350,000 tonnes/annum of fibre, amounting to about 1 million tonnes of primary product.

In insulation products plant fibre is being used to replace glass fibre, giving health, energy and environmental benefits.

While the wood-based panel industry, producing particleboard, medium density fibreboard etc, is based on small roundwood and wood residues, there is some potential for substitution with annual fibres. However these will have to be price competitive to obtain a market share.

Paper and pulp provide options for utilisation of agricultural wastes (eg straw) or specially produced crops (eg reed canary grass, Miscanthus). Market potential is virtually infinite but costs, processing scale and market instability limit progress. Similarly, to reduce costs and allow sustainable economic production, scientific and technological developments are essential in terms of cellulose content, impurities and exploitation of secondary metabolites.

3. Carbohydrates

Starch markets in EU and elsewhere are well developed and organised.

Estimates of total EU starch market for the year 2000/2001 are 7.3 million tonnes/annum of which 3.7 million tonnes is in the non-food sector, 1.4 million tonnes in paper and cardboard making, 1.1 million tonnes in plastics and detergents and 1.2 million tonnes in fermentation and other technical uses. Additionally, smaller markets exist in water purification, cosmetics, toiletries, pharmaceuticals, paints and agrochemicals. Several of these latter offer high potential for added value, but limited tonnage. The development of biodegradable plastics is currently very limited.

4. Speciality Products

The speciality products sector offers considerable potential for bio-renewables, often at high value (eg personal care products), but at relatively low volume. However the market is volatile, reacting rapidly to supply and demand changes. Specifications are frequently ill defined and processing/formulation details severely restricted because of commercial pressures.

Market segments include:

- Essential oils
- Pharmaceuticals
- Popular health products
- Colourants and dyes
- Perfumes
- Personal care/beauty products
- Novel plant protection products
- Intermediates for processing

Essential oils markets worldwide are approximately 45,000 tonnes/annum and rising. However, that estimate includes an uncharacterised tonnage that could not be produced in EU. Aromatic plants have a world market in excess of 50,000 tonnes/annum. Estimates of medicinal plant markets suggest 70,000 tonnes/annum. European collection of aromatic and medicinal plants amounts to 20-30,000 tonnes/annum. Approximately 200 species, which are native to Europe, are involved. The European herbal supplements market is valued in excess of €7 billion/annum and demand is rising.

The Global dyes market for textiles is in excess of 700,000 tonnes/annum, with an estimated market value in 2000 of more than €4.5 billion. It seems unlikely in the extreme that plant derived dyes could supply anything more than a minor part of this market. However, that minor part could be a valuable niche market.

5. Protein Crops

The use of protein derivatives from plants has not been subjected to the breadth of exploitation as other non-food crop market sectors.

Current production of protein isolates and concentrates is 1 million tonnes/annum. Undoubtedly, this tonnage will increase, although currently the timescale for this is indefinable.

The most promising areas for EU produced non-food proteins use is in packaging and labelling, controlled release of pharmaceuticals or chemicals, adhesives and cosmetics.

However, the likelihood of competition for markets between proteins and other non-food products (eg starch derivatives) must be recognised. Key development will probably occur with proteins from plants as secondary products.

Constraints and Opportunities

1. Legislative

- The requirements of anti-narcotics legislation limits the expansion of the hemp crop and in some countries (eg UK) adds to production costs. Development of nil THC hemp varieties and rapid diagnostics for THC containing hemp should be progressed since demand for hemp feedstocks is well established.

- The European List of Notifiable Chemical Substances Regulations (ELINCS), and European Inventary of Existing Commercial Chemical Substances Regulations (EINECS) both apply to plant products. These are considered by industry to be expensive and constraining (eg in high viscosity esters) and their role and applicability to plant products should be reviewed.

- Legislation on re-use of lubricants could offer good opportunities to expand vegetable oil use. Similarly, regulations on bio-lubricants for sensitive areas would be beneficial to the environment and should be considered EU-wide.

- Demands for enhanced biodiversity are being progressed. The role of non-food crops, especially of novel species, should be considered in this context.

- The regulation of plant protection and plant health products appears to be anomalous for plant derived materials: whole plants are exempt but plant components are not. These regulations should be reviewed and, if appropriate from a risk viewpoint, revised.

- The legislation relating to all aspects of non-food crops or products should be unified across EU, since trade in these products is trans-national.

- An EU series of standards regulating description and quality of bio-renewable materials and products should be developed in partnership with industry. It should be based upon environmental benefits. Such a scheme should be built on the principles of the Blue Angel or White Swan Eco-marks.

- European Union regulation on wastes and waste disposal, including packaging should include aspects of bio-renewables that are beneficial to the environment.

2. Technical and Scientific

- There is a generic need to identify and characterise genotypes and cultivars with particular uses in provision of bio-renewable produce. This will not be easy in sectors like that of essential oils, where chemotaxonomy forms the only realistic taxonomic base. These characteristics should be available on websites like IENICA. Particular emphasis should be laid upon market 'pull'.

- Industry and agriculture need to be linked in a proactive manner to facilitate the production of standards and specifications against which plant produce can be measured and assessed. Short, interactive vertically integrated production chain needs to be stimulated.

- Whilst many extraction and purification techniques for plant products are well proven, there is a need to undertake continued development and refinement in order to keep pace with market needs and to identify higher value products. Equally, there is a pressing need to indulge in lateral thinking to develop novel extraction and purification procedures which also allow the exploitation of desirable secondary metabolites.

- Agronomic and physiological studies need to be linked to sustainable economic production and end products quality parameters. These studies should include understanding of linkages with primary and secondary plant metabolites; modelling approaches should be included since they inter-relate existing research results and highlight areas of poor knowledge. These studies are particularly important for herbs and plants producing essential oils where much dubious data exists in the literature.

- Processing and extraction procedures which are environmentally benign should be considered as high priority and special effort put into their development validation and economic demonstration.

- Studies should be instigated to assess the extent to which initial processing of primary product can be undertaken in the production locality. This could benefit rural employment whilst reducing total production and transport costs.

- The role of transgenic technologies in providing opportunities for novel and especially sophisticated molecules is important. Assessments need to be made of real market opportunities, since not all are economic, (eg lauric acid from rapeseed).

3. Environmental Issues

- Comparative life cycle analysis studies of major environmental polluters (eg NO_x, CO_2) should be undertaken and the relative positions of fossil derived and bio-renewable feedstocks confirmed. Priority should be given to the promotion of bio-renewable production where the benefits of the bio-renewable are proven (eg rape oil v. phthalates). Within this requirement standardisation of LCA procedures is essential.

- The direct upstream and downstream impacts of introduction of novel crops and products on bio-diversity should be studied and results promoted as priority.

- Environmentally sensitive but economically sustainable production systems for non-food crops, especially broad-acre crops, need to be developed. Much data for this already exists. Projects like IENICA and the proposed IENICA-Millennium have a major part to play in this.

- The benefits of large scale uptake of diverse bio-renewables in the global warming context should be established and published.

- The impact of EU waste directives and commercial waste directives are not yet elucidated, but need to be assessed in the agriculture and non-food crop/products sectors.

- Genetic modification of some non-food species offers the potential to produce improved products to meet industry specifications but are currently unacceptable to the general public. It will be necessary to devise acceptable environmentally friendly production practices to minimise pollen transfer and public anxiety to enable commercialisation of these types.

4. Economics

- The key issues in successful introduction of bio-renewables are unit cost and comparative performance. These aspects need to be assessed and defined for specific uses of oils, fibres, carbohydrates, protein and speciality products. A total and real cost appraisal is essential for long-term sustainability. EC should facilitate this through projects like IENICA and IENICA-Millennium.

- Industry must be given incentives to change its practices where bio-renewables are shown to have overall benefits.

- Efforts must be made to ensure exploitation of all plant components as primary and co-products. This would enhance economic and environmental sustainability. This means that crops like flax and linseed should be considered as bi-functional.

- New technologies often have a degree of uncertainty in their success. EC should continue to support and promote demonstration projects but these must be linked to realistically appraised market potential.

- It is anticipated that all bio-renewable non-food products will undergo continuous improvement, particularly in terms of market orientation and reduction in true unit cost. This should be encouraged. Findings of the IENICA project should be used actively here.

- Logistical studies, including transport modelling, should be instigated to reduce cost of collection, packaging and transport of bulk primary products like plant fibres in particular.

- Structured contract systems and arrangements between producers, processors and end users of bio-renewables are essential for success. EC should actively promote these relationships and develop 'model structures'.

- The potential for import substitution with home grown bio-renewables in EU should be assessed. This could lead to considerable practical and economic benefits for agriculture, rural economy and industry in EU-15. This is one target for the IENICA MILLENNIUM bid.

5. Communications

- Awareness of proven benefits of bio-renewables should be widely promulgated to industry and consumers. This should occur in a concerted manner throughout EU. IENICA and the proposed IENICA-Millennium project provide the ideal mechanisms.

- The continuation of broad overarching EC networks like IENICA should be encouraged as a means of monitoring and promoting bio-renewables in a non-political way.

- The impact of the IENICA project has been high. This is confirmed by numbers of website hits, demand for newsheets, reports of networking and new products being developed directly as a result of the IENICA project; attendance at and reports back from IENICA seminars and enquiries from industry. It would be beneficial therefore for the project to be funded for a further 3 years after which it could seek world wide funding or be commercialised.

6. Other Issues

- Bio-renewable products are generally viewed as desirable, environmentally beneficial and healthy. Active management of this image must be undertaken to maintain and build upon it where bio-renewables have economic and sustainable markets. Presumably this is an EC DG Environment role?

- It must be noted that bio-renewables could be produced by traditional or organic methods. Both technologies have market places but efforts must be made to maintain and confirm identity of produce from each.

- Those in EU-15 who are issuing tenders for contracts should be obliged to include specifications for inclusion of bio-renewables where performance and true cost have

been shown to be superior to existing materials. Environmental benefits should be included in true cost assessment.

- The potential for competition between bio-renewables should be recognised. Such competition could occur in a number of sectors, eg plastics, adhesives, polymers.

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