Marieke J.G. Meeusen-van Onna
George-Jan Boers

Mededeling 553

FIBRES IN THE EUROPEAN UNION

Availability and prices of fibrous raw material for packaging in the EU-12

February 1996

Agricultural Economics Research Institute (LEI-DLO)

ABSTRACT

FIBRES IN THE EUROPEAN UNION; AVAILABILITY AND PRICES OF FIBROUS RAW MATERIAL FOR PACKAGING IN THE EU-12
Meeusen-van Onna, M.J.G. and G.J. Boers
The Hague, Agricultural Economics Research Institute (LEI-DLO), 1996
Mededeling 553
ISBN 90-5242-332-6
61 p., tab., appendices

This report has been written within the framework of RENEWPACK (AIR2 CT94 1796). RENEWPACK is an EU sponsored and financed research project, that aims to improve packaging products manufactured from renewable resources as agricultural fibres. Many agricultural fibres can be used for some application. However, first technical, marketing, environmental and agro-economic issues have to be considered. This report considers the price and availability of agricultural fibres in the EU-12; two items that have a decisive importance for the industry in selecting fibrous raw material. The report discussed the price and availability of (cereal, rapeseed and linseed) straw, miscanthus, flax, hemp, kenaf, poplar, eucalyptus and short rotation coppice.

Renewable resources/Fibres/Straw/Miscanthus/Flax/Hemp/Kenaf/Poplar/Eucalyptus/ Short rotation coppice

CIP-DATA KONINKLIJKE BIBLIOTHEEK, DEN HAAG

Meeusen-van Onna, M.J.G.

Fibres in the European Union : availability and prices of fibrous raw material for packaging in the EU-12 / M.J.G. Meeusen-van Onna and G.J. Boers. - The Hague : Agricultural Economics Research Institute (LEI-DLO). - Tab. - (Mededeling / Landbouw-Economisch Instituut (LEI-DLO) ; 553)
ISBN 90-5242-332-6
NUGI 835
Subject headings: fibres / packaging products / renewable resources.

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Legenda in tables:
-: Nil or no data available;
*: Estimates;
F: Forecasts

PREFACE

This report has been written as part of the project 'Renewpack', which aims to improve paper-based and paperboard-based packaging products manufactured from renewable resources.

A contribution is made to the first selection of fibres that will be subject of further (technical) research. This first selection is based on several factors, of which technical, marketing and (agro-)economic factors are the most important. These three criteria will be the base for the first selection. Other participants of the project 'Renewpack' will consider the technical and marketing issues and this report will focus on the (agro-)economic issues, like availability and price.

A series of reports, of which this is the first, will describe the availability and production of the selected fibre groups more in detail. An issue to be considered in a following report is (among others) to distinguish between fibre availabilities within countries and fibre supply on micro-economic level. Furthermore, following reports will pay attention to future developments and their impact on the availability, production and price of fibre. Also, more attention will be paid to the situation in countries that will accede to the European Union. These considerations will provide the basis for case-by-base comparisons of alternative projects for packaging production.

The director,

The Hague, February 1996 L.C. Zachariasse

SUMMARY

This report has been written within the EU project 'Renewpack' (AIR2 CT94 1796), which aims to improve paper-based and paperboard based packaging products manufactured from renewable resources.

In this report, a contribution is provided to the first selection of fibres that will be subject of further (technical) research. This first selection is based on several factors, of which technical, marketing and (agro-)economic factors are the most important. The technical and marketing issues will be considered by other participants of the project 'Renewpack'. This report only considers the (agro-)economic factors.

In this report four groups of fibres are considered that differ in technical quality:

1) non-wood fibres: cereal straw and rapeseed straw;
2) non-wood fibres from miscanthus;
3) non-wood fibrous raw material with long fibres: flax, hemp, linseed straw and kenaf;
4) wood: poplar, eucalyptus and short rotation coppice.

The (agro-)economic assessment of the fibres is based on a few arguments:

a) *Availability*. In the case of an abundant source of fibres, the pulp and paper industry is assured of supply and a large group of farmers might profit from the research project, which means an abundant source is to be preferred to a scarce one;
b) In relation to [a]: the *extent of concentration* of the availability of the fibre source. A concentrated production of the fibrous raw material is preferable to a situation where production is more spread;
c) *Price*. Fibres that are available at comparatively low costs are economically more interesting to the industry than expensive fibres;
d) *Necessity of new applications* for the fibres.

All these arguments are more or less influenced by policy, on EU-, national- or regional level. The influence of the EU policy seems to be limited. It is not expected that a dramatic re-orientation of the EU policy will take place and therefore it is not expected that dramatical shifts in the agricultural production will occur. However, an exception has to be made for crops that strongly depend on direct EU subsidies, for example set-aside subsidies. The EU is reconsidering those measures and it is not expected that these subsidies will exist 'for ever'. That means that the supply of those crops is less guaranteed than others.

The extent of concentration of availability does not seem a distinguishable factor; all fibres are more or less available at regional level. Therefore,

only the availability, price and necessity of finding other applications are given in table 1.

Table 1 Mean annual production (x 1,000 ODMT) and average market price (ECU per ODMT) of fibres and the need for finding new applications for fibres in the EU in the period 1990-1995

	Production	Market price	Need for finding other applications a)
Non-wood: straw			
- cereal straw	92,650	47	++
- rapeseed straw	8,500	47 b)	++
Non-wood: miscanthus	0 c)	55-100	0
Non-wood with long fibres			
- flax	21-25	175-235	+
- hemp whole stalk	38	70	+
- hemp bast fibre	13	320	+
- kenaf whole stalk	0	53-106	0
- kenaf bast fibre	0	235-470	0
- linseed straw	255	82	++
Wood			
- eucalyptus	2,600,000	107	0
- poplar	1,728,000	175	0
- short rot. copp.	0	70-90 b)	0

Notes:

a) ++: Two arguments have been found: (1) In several countries there is a surplus of straw that is considered a problem. Due to the fact that it is forbidden to burn straw, farmers are looking for solutions to address the problem; (2) Prices of cereal and oil are decreasing, which makes it economically more interesting to find useful applications for by-products, like straw.

+: One argument has been found (Market prices are relatively low at the moment).

0: No specific argument has been found;

b) There is no market for this product at the moment, therefore the price is estimated, based on the expected cost price;

c) There is no commercial production, yet.

As table 1 shows, in terms of price combined with availability, (cereal) straw and eucalyptus are preferable. They are the most abundant source of fibres: about one million ODMT of straw and about 2.6 million ODMT of eucalyptus available at relatively low cost (47 ECU per ODMT straw and about 100 ECU per ODMT eucalyptus.

When one only considers the price as a decisive factor, one can add hemp whole stalk, kenaf whole stalk and linseed as interesting fibres sources. However, the options 'whole stalk' for hemp and kenaf are not commercial practice, at this moment. It does not seem to be economical viable for the pulp and paper maker. The hughe amount of very short fibres seem to cause additional costs in the processing step. However, the technical partners in the RENEWPACK project have to assess this item. Furthermore, one has to consider the less guaranteed medium or long-term supply of those fibres. Hemp and linseed strongly depend on subsidies, which are subject of reconsideration within the EU.

When one wants to select a 'new' crop, one can choose kenaf, miscanthus or short rotation coppice. The costs of each 'new' crop varies between 50 to 100 ECU per tonne.

1. INTRODUCTION

1.1 Framework of the study

This report has been written within the framework of RENEWPACK (AIR2 CT94 1796). RENEWPACK is an EU-sponsored and financed research project, in which several EU organizations participate (see appendix 1). The project aims to improve packaging products manufactured from paper-based and paperboard-based sheet material and forms, starting from renewable resources as agricultural fibres.

The item of new packaging products will be assessed from several points of view such as marketing, technology, costs, environmental. In this report the costs item will be discussed. Other participants will consider the other issues.

The project takes three years (1995-1998) and is split up in tasks and phases. The first phase is the 'identification phase'. This phase explores and delineates the field of research and identifies the experimental targets in process and application technologies. It focuses on fibrous raw material, on process and manufacturing technology, on cost profiles and market acceptance of alternative and novel products in the paper and paperboard-based packaging sector. This report has been written within the framework of the identification phase.

1.2 Objective

The question to be answered in this report is: 'Which fibres have to be selected for further (technical) research in the project 'Renewpack, from an agro-economical point of view'?'

To answer this question, a few arguments will be considered:

a) *availability*. In the case of an abundant source of fibres, the pulp and paper industry is assured of supply and a large group of farmers might profit from the research project, which means an abundant source is to be preferred to a scarce one;
b) in relation to a): the *extent of concentration* of the availability of the fibre source. One can understand that a concentrated production of the fibrous raw material is preferable to the situation where the production is more spread;
c) *price*. Fibres that are available at a comparatively low cost are economically more interesting to the industry than expensive fibres;
d) the *necessity of new applications* for the fibres.

All these arguments are more or less influenced by policy, on EU, national or regional level. When relevant and possible, the effects of these policies will be considered.

1.3 A further definition of the objective

Fibrous raw material

The fibrous raw material (FRM) for pulp and paper can come from traditional, 'established' crops, timber, 'new' crops or from underutilized by-products. A number of different characteristics of plant fibres determine their (technical) quality and their application range. The following groups of fibres have been distinguished:

1) non-wood fibres: cereal straw and rapeseed straw;
2) non-wood fibres from miscanthus;
3) non-wood with long fibres: flax, hemp, linseed straw and kenaf;
4) wood: poplar, eucalyptus and short rotation coppice.

Availability of data on market prices and production

This analysis cannot be exhaustive and it cannot cover all EU countries separately for several reasons, for example the availability of data. Statistics on market prices and production are available for 'established' fibre crops; however, for by-products and for 'new' crops there are no statistics available. For that reason, a questionnaire was sent to the Offices of the Agricultural Council of the Netherlands in all Member States. In addition experts from organizations and industries involved and research institutes in the EU Member States have been consulted by telephone. Unfortunately, not all the questions have been answered, since some data are not available or have not yet been found.

Which EU countries?

In 1994 the EU consisted of twelve countries. Since January 1, 1995, three countries have acceded to the EU: Austria, Finland and Sweden, resulting in the EU 15. Since several countries are still 'knocking on Brussels' door', the EU 15 may well change into the EU 27 by 2010.

The enlargement process of the EU is still continuing, but definite accession dates are not yet available to the would-be EU countries. It is still uncertain which countries will accede to the EU, when and in what order of preference. The meeting of the leaders of the fifteen Western European countries on December 9 and 10, 1994, in Essen, made clear that the formal accession talks with the CEECs will begin in 1998, while actual accession will take place in 2001 or in 2002 at the earliest. It is expected that the Visegrad countries (Poland, Hungary, the Czech Republic and Slovakia) will be the first to enter the EU. After that, the Balkans and, finally, the Baltic states.

This report focusses on the EU 12. Consequently, Austria, Finland and Sweden will not be considered. Only when relevant, the situation of these countries will be described. For example, in the chapter 'wood' these countries will be discussed, as these countries are true forest-based countries. Furthermore, when relevant, special attention will be paid to the position of the acceding Visegrad countries. The reason for this approach is that it is not yet known when the enlargement will take place. Another reason for this approach is that the agricultural production and structure of the acceding countries at the time of accession is unclear, as is the influence of accession on the agricultural production and structure. At this moment, agriculture in the CEECs is in bad shape and will remain so for a considerable time, unless the Eastern producers become more competitive. It is still difficult to say how and to what extent the agricultural structure, production and productivity will adjust.

1.4 Outline of the report

The first chapters will consider the availability and prices of fibres. These chapters will describe the availability and market prices in recent years.

In chapter 2 straw will be considered, followed by miscanthus in chapter 3. Chapter 4 deals with non wood with long fibres and in chapter 5 wood will be discussed.

Each chapter ends with a summary, in which the availability and market price are given per unit of '(oven) dry matter' (ODMT). A meaningful comparison of the costs of the different FRMs is only to be made if the costs refer to the same moisture content basis. In this report the unit '(oven) dry matter' is used as the base for comparison. It is difficult to ascribe accurate estimates of moisture content to all FRMs, since they vary quite widely. Therefore, an assumption has been made. For wood the average moisture content is about 40%, based on industrial practice (Jacobs, Toval, Hellinga, Gonzalez) and for the agricultural sources (straw, flax, hemp, kenaf, linseed and miscanthus) a moisture content of 15% is assumed. This is the maximum percentage which makes it possible to store the raw material without any problems, over a period of at least six months.

After the description of the groups of fibres, the future developments of the Common Agricultural Policy and their impacts on the availability and prices of the fibres will be discussed in chapter 6.

The report ends with conclusions, in chapter 7.

2. NON-WOOD: STRAW

2.1 Introduction

The two groups of short fibres that will be considered are: straw from cereals and straw from rapeseed. Within the group of cereal straw a further distinction is made between straw from soft wheat, durum wheat, barley, oats and rye. This distinction is made because of the differences in (technical) quality.

2.2 Cereal straw

Present use

Straw is used as livestock bedding and feed, in mushroom compost, for root-crop storage, mulching, thatching, brickmaking, effluent absorption, and as fuel; some straw is used for paper production in some countries. For most of the straw, markets and applications already exist. However, in countries like Denmark and the UK there is a surplus of straw (see appendix 2). In the past, producers burnt straw in the field, but post-harvest, in-field burning has been banned. Producers are therefore looking for other applications of straw to address the problem of surpluses.

Present use in the pulp and paper industry

At some time, cereal straw has been most important source of raw material for the pulp and paper industry until the wood pulp industry was firmly established in the early twenties.

In more recent years, straw has been used for quite some time, especially in the pulp and paper industry (for example in France and in the Netherlands). Due to environmental problems many manufacturers using straw as a fibrous source have been shut down. At this moment 2-3% of the straw is processed in the industry (Dam et al., 1994: 75). The straw is being used commercially in Spain, Italy, and the UK, while in Denmark and (again) in East England initiatives are being taken to set up a pulp and paper industry. Besides this, there are a few ongoing EU projects on using straw in the pulp and paper industry. For example the EU project dealing with extrusion, in which St. Regis participates.

In Spain, the Sociedad Anonima Industrieas Celulosa Aragones (Saica) uses straw as a source for corrugating materials. Saica is the world's largest straw pulp and paper manufacturer with a capacity of 550,000 tonnes of paper per year. On average, Saica processes 600 tonnes of straw per day (and 1,100 tonnes of waste paper). Saica usually obtains straw supplies from within a 130-km radius of the mill. The crops are harvested during a three-monthly period and are stored in 800-1,000 tonne piles. The straw contractors deliver the straw daily to the feeding area (the straw feeding area at the mill can store two days' production), where it is separated according to species before specific treatments are applied (Marcus, 1994).

In Denmark, until 1990 a cellulose industry based on straw was running in Fredericia, with a capacity of up to 90,000 tonnes per year. However, because of the low worldwide market prices and due to (environmental) technological problems, the plant shut down in 1990. Since then several unsuccessful attempts have been made to start up production again. Now there are plans to use capital from the electricity companies that are forced to use straw, for processing of straw in Fredericia.

In the UK, too, several attempts have been made, mainly by British Sugar and Electra Innvotek, to build a straw-pulping facility in East England; so far, nothing has emerged.

Production

The production of cereal straw is not monitored by the EU Statistical Office (Eurostat). For that reason, another procedure has been followed. The available estimates on the production of straw are based on different approaches. First, Eurostat provides the data on the area per crop. The average production of straw per hectare is derived from national statistics or it is estimated (see appendix 3). Multiplication of both data results in the straw production, which is given in tables 2.1 and 2.2. In addition to this, for some countries other sources were available. They have been compared with the estimations mentioned before.

With regard to the yield per hectare, a distinction can be made between high and low-yielding countries. In the northern part of the EU (Belgium, Denmark, Germany, France, the Netherlands and the UK), the yield of straw ranges from four to five tonnes per hectare, while in the southern part it is assumed to be 20 to 25% lower, due to climatic conditions and other production techniques (see for example note a), below table 2.1).

The production of cereal straw is estimated to be in excess of 100 million tonnes, as tables 2.1 and 2.2 show. This estimation agrees more or less with that of Chisholm (1994) and Dam et al. (1994); the latter estimates an average production of about 140 million tonnes cereal straw per year. Appendix 4 gives more detailed information on the production per crop per country.

The country with the highest production level is France, followed by Germany and the UK. These countries account for nearly 70% of the total production in the EU. Within these countries the following production regions can be identified: Centre de France, Île-de-France and Picardie (France), Nieder-Sachsen and Bavaria (Germany) and East Anglia (UK). In Italy, Basilicata and Molise are important production regions of cereal straw and in Spain the main production regions are Aragon and Castilla-La Mancha. See appendix 5.

Table 2.1 Mean annual production of cereal straw in the EU and the EU countries, subdivided into crop, in the period 1991-1994 (x 1,000 tonnes)

	S. wheat	D. wheat	Barley	Oats	Rye	Total
Belgium-Luxemburg	1,115	0	63	11	0	1,189
Denmark	2,985	0	140	361	407	3,893
France	23,481	1,115	6,257	944	216	32,013
Germany	12,787	57	9,088	1,740	2,870	26,542
Greece	1,023	2,047	491	110	56	3,727
Ireland	423	0	85	.	.	508
Italy	3,026	4,785	1,277	363	23	9,474
Netherlands	638	0	17	28	25	708
Portugal	799	78	197	230	226	1,530
Spain a)	2,175	805	5,153	259	158	8,550
UK b)	9,913	4	4,723	272	32	14,944
Total	58,365	8,891	27,491	4,318	4,013	103,078

a) For Spain the straw yield of wheat (in tonnes per hectare) is 1.4; barley straw 1.3; oats straw 0.8; rye straw 0.9; b) For the UK other sources provide other data. The production of straw in the UK has been calculated to be around 13.5 million tonnes annually. Of this about 5.2 million tonnes is wheat straw, 7.2 million tonnes barley straw, 0.5 million tonnes oat straw and 0.6 million tonnes is rape straw.
Source: Eurostat, 1994 (b).

Table 2.2 EU production of cereal straw by crop, in the period 1991-1994 (x 1,000 tonnes)

	S. wheat	D. wheat	Barley	Oats	Rye	Total
1991	59,686	10,197	34,728	4,361	4,256	113,228
1992	61,028	8,821	33,162	3,701	3,899	110,611
1993	56,417	8,179	29,749	3,803	4,192	102,340
1994	56,335	8,374	27,886	4,169	4,447	101,211

Source: Eurostat, 1994 (b).

The country with the highest production of barley, rye and oats is Germany. The most important production regions of barley are Bayern (20%) and Niedersachen (14%). Niedersachen is also one of the most important producers of rye (20%), together with Brandenburg (25%), while Bayern accounts for 25% of the area of oats.

With respect to the accession of the Visegrad countries the production of cereal straw in these countries has also been estimated, based on an average annual production of three tonnes of straw per hectare. The production of straw in the Visegrad countries is estimated by relating cereal production in these countries to the production of cereal and cereal straw in the EU.

Table 2.3 Mean annual production of cereal straw by crop in the Visegrad countries, in 1993 and 1994 (x 1,000 tonnes)

		Wheat	Barley	Oats	Rye	Total
Hungary	1993	3,204	202	1,264	135	4,805
	1994	3,458	260	1,237	140	5,095
Poland	1993	10,819	6,470	3,416	1,605	22,307
	1994	10,312	6,529	1,901	1,628	21,885
Czech Republic	1993	2,567	202	1,989	170	4,840
	1994	2,765	234	724	200	5,188
Slovakia	1993	1,290	74	724	35	2,213
	1994	1,436	101	701	34	2,272
Total	1993	17,889	7,302	1,945	6,948	34,075
	1994	17,971	7,343	2,002	7,124	34,440

Source: OECD, 1995 (a), (b), (c), (d).

As table 2.3 shows, the total production of cereal straw in the Visegrad countries is more than 34 million tonnes: about one third of the production in the EU. In the group of cereal straw, wheat straw prevails with more than 50%, followed by barley straw with more than 20%.

Market prices

Eurostat provides the average market prices on users level for straw. These are compared to the market prices provided by other, national sources, if available. Consequently, data sources refer both to national and EU sources. As the notes suggest, the interpretation of these data is difficult, because it is not clear whether the data only represent the straw that is sold or whether they include the unused straw (at a price of zero), which leads to a lower average price.

The market price of cereal straw in the EU in the period 1989-1992 is given in table 2.4, which shows the differences in prices per country. In Spain prices are highest, about 100 ECU per tonne, followed by a group of EU countries where the price is about 40 ECU per tonne; in the UK the price of straw is the lowest: nearly 30 ECU per tonne. It is amazing that just in the country where industrial use of straw takes place, the prices of straw is the highest.

The market price of 40 ECU per tonne agrees with the cost price calculated by Boon: 41.7 to 42.8 ECU per tonne (see appendix 6). Furthermore, the table shows that prices were relatively stable during the past couple of years.

Table 2.4 Market price of cereal straw in the EU on users level, in the period 1989-1992 (ECU per tonne, exclusive VAT)

	1989	1990	1991	1992	1989-1992
Belgium	40.4	32.5	38.7	47.2	39.7
Denmark	.	.	.	.	47 a)
France	34.2	35.1	42.6	40.5	38.1
Germany	.	.	.	.	.
Greece	42.4	45.0	44.6	40.9	43.2
Ireland	.	.	.	.	.
Italy	48.0	65.4	50.1	60.8	55.8
Luxemburg	.	.	.	.	.
Netherlands	69.4	65.3	77.5	80.9	73.2
Portugal	.	.	.	.	.
Spain	92.3	100.5	110.4	109.1	103.0 b)
UK	29.4	31.9	28.1	21.4	27.7

a) The average price for straw (15% moisture content), delivered at the industry, is 47 ECU per tonne (440 DKK per tonne). The lowest price is 37 ECU per tonne (350 DKK per tonne) and the highest recorded price is 56 ECU per tonne (528 DKK per tonne), all excluding VAT (Elsam and Elkraft, 1994); b) At this moment the market price for straw is relatively high, due to drought and a shortage of straw.
Source: Eurostat, 1994 (a).

2.3 Rapeseed straw

Rapeseed has been grown as an industrial crop for many years. Today, the market is growing, especially for 'biodiesel', a renewable fuel. Because of possible benefits to producers, the environment, the reduction of agricultural surpluses and to the dependence on foreign supplies of energy, the EU and several member states promote the use of biofuels. The European Commission has targeted supplying 5% of motor vehicle fuel consumption with biofuels by 2005 and some member states promote the use of these fuels through tax relief aimed at making biofuels competitive with cheaper fossil fuels. In 1993, France and Italy offered supplementary set-aside payments to producers of the required oilseeds for biodiesel production (Normile, 1994: 57-58). Aided by the EU set-aside premium and the national payments, the increase of rapeseed took place on set-aside land in particular, as shown in table 2.5. This encouragement of the cultivation of rapeseed might lead to a decrease of the production of rapeseed straw.

Present use

At this moment rapeseed straw is not used commercially. The straw is used as fertilizer.

Production

The production of rapeseed straw can be divided into the production on set-aside land and 'other' production.

The following table shows the area rapeseed planted on set-aside land and the production of rapeseed straw, based on a production of four tonnes per hectare (Carruthers, 1994).

Table 2.5 Area of rapeseed planted for industrial use (x 1,000 ha) and production of rapeseed straw (x 1,000 tonnes) on set-aside land in the EU and the EU countries, in 1993 and 1994

	1993	1994
Belgium	5	10
Denmark	18	35
France	49	192
Germany	70	80
Italy	0	4
Spain	6	25
UK	40	83
Total area EU (x 1,000 ha)	188	429
Total production (x 1,000 tonnes)	752	1,716

a) Including sunflower.
Source: Normile, 1994: 58.

Table 2.6 Production of rapeseed straw in the EU and EU countries, in the period 1989-1994 (x 1,000 tonnes)

	1990	1991	1992	1993	1994
Belgium	28	44	28	16	24
Denmark	1,084	1,120	764	648	724
France	2,756	2,956	2,748	2,236	2,704
Germany	.	3,800	4,004	4,028	4,264
Ireland	20	20	24	.	.
Italy	68	56	32	16	16
Netherlands	32	28	16	8	8
Spain	96	41	32	40	268
UK	1,560	1,760	1,688	1,508	1,960
Total	5,644	9,825	9,336	8,500	9,968

Source: Eurostat, 1994 (b).

As can be concluded from this table the area of rapeseed has been increasing rapidly over the last two years. Particularly the UK and France can be identified as 'growing' countries.

The 'other' production of rapeseed straw, given in table 2.6, is based on Eurostat statistics (area) and the estimated straw production of four tonnes per hectare.

As table 2.6 shows, the agricultural area of rapeseed is largely located in Germany (41%), France (30%), the UK (18%) and Denmark (10%). Total production in 1993 was nearly 9 million tonnes and in 1994 nearly 10 million tonnes.

Market price

Since rapeseed straw has not yet been used commercially, no market price can be given. However, a prognosis for rapeseed straw can be made, based on the assumption that the (costs of) harvesting rapeseed straw is comparable with the (costs of) harvesting cereal straw. Taking into account that the production of straw per hectare is nearly the same, namely about four tonnes per hectare, the price of rapeseed straw is assumed to be maximal 40 ECU per tonne.

2.4 Summary

Table 2.7 gives an overview of the availability and market prices of short fibres in ODMT.

Table 2.7 Production and market price of short fibres, in tonnes and ODMT and ECU per tonne and per ODMT

	Production		Market price	
	tonne	ODMT	ECU/tonne	ECU/ODMT
Cereal straw	109,000	92,650	40	47
Rapeseed straw	10,000	8,500	40 a)	47

a) There is no market for this product at the moment, therefore the price is estimated, based on the expected cost price.

3. NON-WOOD: MISCANTHUS

Miscanthus is not yet commercially grown. At this moment, miscanthus is only cultivated for research, demonstrations and pilot plants. The reason for the hightened interest in miscanthus is that the crop appears to be suitable for fibre production. The results are promising, although large-scale agricultural cultivation has not been conceived yet: first results are encouraging, but the first experiments will not reach full yield potential until 1996 (Speller, 1994).

As mentioned before, research of miscanthus is ongoing and involves several institutes in Europe. One of the international projects is the European Miscanthus Network, funded by the EU. This network consists of eighteen European research organizations and the project aims to investigate the possibilities of miscanthus cultivation in the EU. To be more precise, the project aims are:

- to determine the sustainable yield and quality of miscanthus at different locations in the EU, with particular emphasis on Northern Europe;
- to evaluate and test different technologies for harvesting, storage and drying of miscanthus; and
- to identify, evaluate and test selected industrial end uses of the crop.

To determine the potential yield of miscanthus, each network participant has established one or more testing fields.

Experiments show that the yield of miscanthus ranges from fifteen to twenty ODMT stems per hectare per year. The reported European yield ranges from 11.7 to 25.3 ODMT per hectare per year. More recent work in Germany has shown that the potential for yields from the third year of a plantation is

Table 3.1 Yield at harvest of miscanthus in the third year of production in several EU countries (ODMT per hectare)

	Year of establishment	Yield	Comments
Belgium	1991	20	None
Germany	1990	20	None
Greece	1990	12	Irrigation problems
Ireland	1990	10	None
Italy	1991	23	With irrigation
Portugal	1990	24	With irrigation

Source: Miscanthus Network, 1994.

about 18 ODMT per hectare per year and yields in the fourth year were said to be in excess of 25 ODMT per hectare (Speller, 1994). Besides these results, there are those from the European Miscanthus Network. Table 3.1 shows the miscanthus yield of trials that were held in 1990/1991.

It is difficult to assess economic performance; cost prices cannot be estimated due to the lack of good yield data. Furthermore, research on the cultivation techniques are still ongoing. The planting of miscanthus in particular is an item that requires special attention when one tries to reduce the costs of miscanthus. Table 3.2 shows the cost price of miscanthus in case planting costs are 430 and 4,300 ECU per hectare respectively. It is clear what the impact on the cost price is.

Table 3.2 Cost price of miscanthus according to planting costs (ECU per hectare) and production life cycle (years) (ECU per ODMT a))

	10 years	15 years
430	60	55
4,300	100	86

a) Based on a yield of 20 tonne per hectare.
Source: Van Onna, 1994.

Table 3.2 shows that the cost price of miscanthus varies from 55 to 100 ECU per tonne, depending on the length of the production life cycle and the planting costs. This cost price includes the costs of land use and building.

4. NON-WOOD: LONG FIBRES

4.1 Introduction

In this chapter the non-wood fibre crops flax, hemp and kenaf will be considered, as well straw from linseed. The fibre crops that will be considered in this chapter are grown primarily for their fibre yield, while linseed is primarily grown for its seed. As mentioned before, only the non-wood species will be considered in this chapter; in the next chapter wood will be considered.

Flax, hemp, linseed and kenaf have been grown for decades, although kenaf has not been grown in the EU until now. Kenaf is particularly suited to subtropical climates. However, in the EU work is progressing on developing kenaf as a domestic crop, which can therefore be classified as a 'new crop'.

Each of the four crops is composed of two components: bast fibres and woody core fibres ('shive' or 'shiv'). Furthermore, flax consist of two bast fibres fractions: the long bast fibre fraction and the short bast fibre fraction. Theoretically, one can consider two options of utilization. The first option refers to the whole stalk and the second option only considers the extracted bast fibre. In this report, only for hemp and kenaf the two options will be considered. For flax and linseed the two options are not relevant. In case of linseed the option of the extracted long fibre is not realistic. The plant is 'constructed' to maximise the oil production and not to maximise the fibre production; the 'construction' of the plant, with its short and fine seed-bearing stalks, is not specialized in producing fibres. Therefore, the extraction of bast fibre is not seen as a realistic option.

Regarding flax, the long bast fibre fraction is used in the textile sector, which generates much higher prices than the paper industry. So, in this case it is not realistic to consider the option of the whole stalk. The same applies for hemp and kenaf. For these two crops, the current practice is only one option: to use the extracted long bast fibre. However, in this report the other option will be considered also. The reason for doing this, is that the extracted long bast fibre is used to advantage for specialty papers only, where relatively high FRM prices can be paid. The packaging papers considered in this RENEWPACK project can, perhaps, not afford such prices; this sector needs cheap fibrous raw material. The option of using the whole stalk might be interesting if growing and utilizing both components proves to be feasible technically and cost-wise; helped by lower harvesting costs and storage. However, one has to consider that using the whole stalk means that the (very) short core fibres are still present and these fibres might need separate processing, causing higher costs in the processing step. The disadvantage of the higher costs in the processing might exceed the advantage of lower costs of production and result in net higher costs. That is perhaps one reason this option is not current practice in the paper industry. So, the most realistic option is the option of using the extracted bast fibre only. Nevertheless in this report the two options will be presented.

4.2 Flax

Present use

The stem of flax is composed of core and bast fibres, of which the latter is composed of a long and a short fraction. Both bast fibres of flax are used in the textile sector, although the market for short bast fibres in particular was in bad shape during the late eighties. This has resulted in many research programmes into new, other industrial uses for short bast fibres. Only short bast fibres could be of potential interest to the pulp and paper industry because of price reasons. Therefore the focus will now be on short bast fibres. One must have in mind that the short bast fibres of flax are to be considered as 'long' fibres in the context of this report.

Production

Eurostat monitors the production of flax fibres, but these data are not suitable for this report. It seems that Eurostat defines fibres as those produced at farm level. This means that fibres include the woody core, which accounts for over 60%. However, this report only takes the short bast fibre that can be used in the pulp and paper industry into account. Since the Eurostat data cannot be used, another approach is taken: the production of flax fibres, as shown in table 4.2, is based on the area of flax and average yield of short bast fibres per hectare. The average yield of short bast fibres is assumed to be 500 kg per hectare, which is considered 'not very high yielding' compared with other fibres. The estimation is based only on the Dutch yield in previous years

Table 4.1 Yield of flax fibres in the Netherlands in the period 1982-1989 (kg per hectare)

	Straw	Long bast fibre	Short bast fibre
1982	8,300	950	400
1983	6,800	830	500
1984	9,050	1,200	650
1985	8,000	1,000	600
1986	7,900	1,100	400
1987	8,050	700	500
1988	7,150	800	450
1989	6,300	650	375

Source: Riensema et al., 1990.

(see table 4.1), but hardly differs from the yield per hectare in Belgium, while productivity in France could be slightly less.

Table 4.2 Production of short bast fibre of flax in the EU and EU countries, in the period 1989-1992 (x 1,000 tonnes)

	1989	1990	1991	1992
Belgium-Luxemburg	5.5	6.0	5.0	4.0
France	26.0	31.0	21.5	18.5
Italy	0.5	0.5	0.5	0.5
Netherlands	2.5	3.0	2.5	1.5
Total	34.5	40.5	29.5	24.5

Source: FAO, 1993.

Table 4.2 shows that in 1989 and 1990 the EU produced 30,000 to 40,000 tonnes of short bast fibre. However, that period can be considered as a period of low prices and surpluses. In 1991 and 1992 the market established and prices increased (see table 4.4). For that reason, the average production is considered to be 25,000 to 30,000 tonnes.

The four EU countries with the highest production in successive order are: France (74%), Belgium (17%), the Netherlands (7%) and Italy (<1%). However, short bast fibres do not originate at the farm, but at the processing industry (see appendix 7). Consequently, the allocation of the processing industry must be known before anything can be said about the availability in Europe. The processing industry is concentrated in Belgium, which leads to the conclusion that that is also where the flax fibres mainly originate from.

In view of the enlargement of the EU, the production of flax in the East European countries is given in table 4.3. As mentioned before, it should be

Table 4.3 Area of flax in East Europe (x 1,000 ha) and production of flax fibre a) (x 1,000 tonnes)

	1989		1990		1991		1992	
	Area	Prod.	Area	Prod.	Area	Prod.	Area	Prod.
Czechoslovakia	26	25	25	22	17	8	12	6
Poland	34	19	30	16	10	56	6	2
Romania	70	38	85	39	85	40	86	42
Total	139	82	140	77	112	77	104	50

a) 'Fibres' refers to 'straw', which includes the woody core, the long fibre and the short fibre.
Source: FAO, 1993.

pointed out that 'fibres' cover not only the short bast fibre, but also the woody core and the long bast fibre. Production of fibres as shown in table 4.2, then, cannot be compared with the figures in table 4.3. From table 4.3 it can be learned that the area of production in the East European countries is about twice the size of the area in the EU. However, due to the fact that productivity is much less, this does not mean there is twice as much short fibre available. As can be seen from table 4.3, the production of fibres, including short bast fibres, long fibres and the woody core is about 500 kg per hectare, while in the EU the production of short bast fibres alone is 500 kg per hectare.

Market price

Table 4.4 shows the market price of short bast fibre in the years 1990 till 1994. As mentioned before, the market prices vary considerably depending on supply and demand. In the years 1989 and 1990 the oversupply of flax resulted in low prices; in recent years the market has established and prices have increased to 150 to 200 ECU per tonne.

Table 4.4 Market price of short bast fibres of flax, in the period 1990- 1994 (ECU per tonne)

	1991	1992	1993	1994
Middle	51-82	51-82	127	154
Better	82-124	82-124	185	203-304
Best	.	.	304-365	.

Source: Vlasberichten, 1990-1994.

4.3 Hemp

Cultivation of hemp has been forbidden because of the contents of narcotic components. However, in recent years, in some EU countries it is permitted to grow hemp, providing that only specified varieties with negligible drug content are used. In countries like Germany where the hemp cultivation still is prohibited, it is to be expected that this will change due to EU policy: the EU has permitted the cultivation of low-THC varieties (0.3% THC content in the upper one third of the leaves) (Karus and Leson, 1994).

Present use

The bast fibre in hemp fibrous tissue represents 30-35% of the stalk, on mass basis; the core (0.5 to 0.6 mm long) is the remaining part. The two fibres are distinctly different and complement each other. The long bast fibres provide strength, while the short core fibres with their large surface area contribute to the opacity of the paper sheet.

As mentioned earlier, an important issue is related to whether only bast fibres or both bast and core material are utilized. Two options are available: the separation of components and the separate processing, or the production of a mix containing both types of fibre. At this moment, the first option is taken. In France and the United Kingdom the bast fibres are used for the production of high-quality products, like cigarette paper, while shives are used in entirely different applications such as fuel. In 1993, in Germany, Schneidersöhne introduced its first hemp-based paper products. At this moment, the paper manufacturer markets a complete line of hemp paper. The papers are based on mixtures of bleached hemp pulp and de-inked recycled paper, most commonly 50/50 blends. However, since the fall of 1994, paper based on 100% hemp pulp is also available. Although the second option (the use of the mix of both types of fibres) is not currently in practice, this option also will be considered (Karus and Leson, 1994).

Production

Table 4.5 shows the area and production of hemp in the EU during the period 1980-1993. Until 1987 the EU produced approximately 30,000 tonnes of hemp; after that production declined to nearly 20,000 tonnes of hemp. During the last years, though, production of hemp has increased again. Financial encouragement (a higher EU premium) might be the cause of this increase. The average production of long-fibre hemp is estimated to be 10,000 to 15,000 tonnes.

Almost all the hemp is produced in north France, near Paris.

With the decided enlargement of the EU by the Visegrad countries it is worth mentioning their situation. Enlargement of the EU with the Visegrad

Table 4.5 Area (x 1,000 ha) and production (x 1,000 tonnes) of hemp and hemp bast fibre (x 1,000 tonnes) a) in the EU in the period 1980-1993 b)

	Area	Whole stalk	Bast fibre
1980	6.7	43	14
1985	6*	36	12
1986	6*	33*	11
1987	5	34	11
1988	3	18	6
1989	3	18	6
1990	3	.	.
1991	3	22	7
1992	5	36	12
1993	.	45	15

a) The long, bast fibre represents 30-35% of the stalk; b) The period 1980-1986 refers to the EU 10 and the period 1986-1989 refers to the EU 12.
Source: Eurostat Crop Production 1981(4), 1983(4), 1986(4), 1990(4), 1991(4), 1994(4).

states could lead to an increase of hemp production in the EU, as can be seen from table 4.6.

Table 4.6 Area (x 1,000 ha) and production (x 1,000 tonnes) of whole-stalk hemp in East Europe in the period 1988-1992

	1989		1990		1991		1992	
	Area	Prod.	Area	Prod.	Area	Prod.	Area	Prod.
Hungary	2	4	2	2	1	1	1	1
Romania	46	35	46	38	46	40	46	41
Bulgaria	1	0	1	0	1	0	1	0
Poland	2	2	1	1	0	0	0	0
Yugoslavia	2	2	1	2	1	2	1	1

Source: FAO, 1994.

Table 4.6 shows that in the East European countries the area planted with hemp is about ten times that of the EU. However, the East European countries produce about the same quantity of hemp as the EU, due to the (very) low productivity in those countries.

Market price

There is only limited useful information on the market price of hemp. Eurostat statistics provide the market price of hemp, but they show a wide range of prices per year and per country. This range can be explained by the diversity of hemp products that are considered as a single group: hemp. This group covers unprocessed hemp, shives and long bast fibres, and hemp products, like rope. The heterogeneity of products in this group hampers the interpretation of the data. Consequently, producers organizations of hemp had to be consulted: the Fédération National des Producteurs de Chanvre in France and Hemp Core in the UK. However, these organizations could not give the market prices of long-fibre hemp. Only the French organization could provide the market price of hemp straw (both long bast fibre and shives): see table 4.7.

Table 4.7 Market price of hemp straw (bast fibre and shives) in the period 1990-1994 (ECU per tonne)

1990	1991	1992	1993	1994
66	64	60	56	50

Source: Fédération National des Producteurs de Chanvre, 1994.

The market prices given in table 4.7 refer to hemp straw, including the bast fibre and the shives. Table 4.7 shows that the average market price in this period is 60 ECU per tonne hemp straw.

For the option 'extracted long bast fibre', additional calculations have to be made. Based on the following assumptions:

- an average market price of 60 ECU per tonne of hemp straw (see table 4.7);
- the bast fibre covers 35% of the fibres; and
- separation of both components (bast fibre and shives) costs about 1,000 NLG per hectare (Van Onna and Van den Ent, 1994), the average price of hemp bast fibre is about 270 ECU per tonne of bast fibre.

Table 4.7 shows that the price of hemp straw is decreasing during the nineties. When the market price (about 60 ECU per tonne) is related to the cost price, one can conclude that growing hemp is not economically interesting for unsubsidized farmers. In France, the cost price of hemp straw varies from 71 to 83 ECU per tonne, depending on the yield per hectare (six to ten tonnes per hectare). This 'cost price' only covers direct costs: costs of fertilizer, seed, harvesting and 'levies'. Other costs, like labour, rent and land use have not been considered (French Office of the Agricultural Council of the Netherlands, 1991). For a feasibility study in the Netherlands, the direct costs have also been calculated, which means they are not based on real practice. Compared to the French situation, the direct costs of growing hemp are lower: they are estimated at about 60 ECU per tonne. However, storage costs will be higher in the Dutch region due to climatic conditions (Van Onna and Van den Ent, 1994). This comparison shows that only the direct costs are compensated by the market price. As mentioned before, then, growing hemp is only interesting when it is promoted by subsidies. Regarding decreasing market prices, this (EU) premium covers a progressive part of the total price for the farmer; in 1990 it already covered 50 to 60%.

The price of hemp straw is decreasing. Because of this decrease, the French hemp sector started research into new applications and outlets for hemp. Hemp was (and still is) used for just one application: cigarette paper, in which hemp can be substituted by flax (short fibre). A reason for the price decrease of hemp has been the surpluses of flax and the comparatively low prices for flax. The pulp and paper industry, then, preferred flax, which caused the price-cutting for hemp.

4.4 Linseed straw

The quality of linseed straw is comparable with that of the by-products of flax processing that are used in the pulp and paper industry and with the bast fibre of hemp.

Present use

For linseed, only the option 'whole stalk' will be considered; only this option is a realistic one and currently practised.

In Canada, several attempts have been made to use straw of linseed in the pulp and paper industry for the specialty grades like paper money. The large-scale production of linseed makes it economically viable to develop harvesting equipment for the straw of linseed. Consequently, technically and economically it is no problem to 'harvest' the straw, provided that it is grown on a large scale. However, that does not seem the case in the EU countries. Particularly in the UK, linseed straw used to be considered a problem. It was difficult to dispose of. Although it is not allowed to burn straw (see paragraph 2.2), an exemption was (and still is) made for linseed since the difficulties in utilization. However, in 1996 burning of linseed straw will also be banned; then better harvesting techniques are expected to be used.

Production

As mentioned before, linseed has many industrial applications that make linseed one of the crops that can be sown on set-aside land. This aid by EU policy has lead to an expanded area planted with linseed, mostly within the last years and particularly in the UK, as can be seen in table 4.8.

Table 4.8 is based on Eurostat figures concerning the area planted with linseed and on an estimated production of two tonnes of straw per hectare (Woods, 1994).

Table 4.8 Production of linseed straw in several EU countries, in the period 1989-1992 (x 1,000 tonnes)

	1989	1990	1991	1992
Belgium-Luxemburg	22	24	20	20
France	104	124	86	74
Italy	2	2	2	2
Netherlands	18	14	16	4
UK	34	68	184	278
Total	180	232	308	376

Source: FAO, 1993.

Table 4.8 shows that the UK is by far the most important producer of linseed straw. The UK covers about sixty to more than 70% of total production. As mentioned before, this increase in area has been aided by the EU policy on set-aside.

Market price

Due to this exemption on the ban of burning straw, there is no 'real' market for linseed straw. Only an estimation can be made: about 70 ECU per tonne (personal communication Hague, 1995).

4.5 Kenaf

Kenaf is similar to hemp. It is an annual plant whose stem is composed of a central cylinder with (very) short fibres and by a bark with long fibres. The long bast fibres of the outer bark comprise 30-35% of the stalk by weight and the remaining part are the short fibres of the stalk's interior, or core. Like hemp, then, an issue is related to whether bast fibres alone or bast and core material together are utilized.

Traditionally, kenaf is grown for making twines, fishing nets and textile fibres, but recently, countries in various parts of the world (Australia, US, several European countries) have been investigating the prospects of using kenaf in the pulp and paper industry.

Research on kenaf in Europe is ongoing in the EU project 'KENAF: an agricultural crop for industrial use'. This project investigates optimum uses for this raw material. The objective is to demonstrate the feasibility of the following:

a) kenaf cultivation (seed and straw production) in Europe; and
b) applications in the non-food industries for the various constituents of the stem (long and short fibre), imploying various methods to produce cellulose pulp and paper, or fibre board or particle board.

Another objective is to study new uses of other constituents of the kenaf plant.

Twenty-five firms in six EU member states are participating in the project.

At this moment (spring 1995), cultivation techniques for kenaf are well known. It is also known which factors have a large influence on the yield and, consequently, on the economical variations. However, it is not possible to clearly define every economical aspect.

The EU project on kenaf assumes that the present costs of production are 722.7 ECU per hectare. These are average costs for Spain and Italy, as table 4.9 shows. There are minor differences between the costs of these countries. For Greece, however, costs are considerably higher.

Table 4.9 Average costs of kenaf production (whole stalk) in Spain, Italy and Greece (ECU per hectare)

Spain	702.52
Italy	742.85
Greece	917.83

Source: Oliveros Alba, 1995.

These costs only cover the direct costs: the costs of land preparation (ploughing, harrowing, fertilising, etcetera), input costs (seeds, fertilizer, herbicide, water etc.), labour costs and harvesting costs. Costs of land use and buildings, then, have not been included. Assuming the costs of land use and buildings are about 200 ECU per hectare, the total cost price is about 900 ECU per hectare.

Of the direct costs, input costs prevail (50%), followed by the costs of harvesting (20%), costs of land preparation (20%) and labour costs (10%). Consequently, attempts at cost reduction have to focus on the input costs. To be more specific, the costs of sowing and of of irrigation must be considered.

Kenaf yield varies between ten to twenty tonnes per hectare. The differences in yield can be explained by differences in ecological area, varieties and crop modalities, where the availability of water is a critical issue.

Table 4.10 Average costs of kenaf straw (bast fibre and shives) (ECU per tonne) according to yield (tonne per hectare)

Yield	Costs
10	90
12	75
15	60
20	45

Source: Oliveros Alba, 1995.

As table 4.10 shows the average costs of kenaf straw varies between 45 to 90 ECU per tonne.

For the option 'long bast fibre', one has to make some additional calculations. Assuming that the costs of separation of both components are about 1,000 NLG per hectare (like hemp), the average costs of kenaf long bast fibre is 200-400 ECU per tonne long bast fibre.

4.6 Summary

Table 4.11 gives the overview of availability and market prices of flax, hemp, linseed and kenaf.

Table 4.11 Production and market price of long bast fibres, in tonne and ODMT and ECU per tonne and per ODMT

	Production		Market price	
	tonne	ODMT	ECU/tonne	ECU/ODMT
Flax	25-30	21-25	150-200	175-235
Hemp				
- whole stalk	45	38	60	70
- bast fibre	15	13	270	320
Linseed straw	300	255	70	82
Kenaf				
- whole stalk	0	0	45-90	53-106
- bast fibre	0	0	200-400	235-470

5. WOOD

5.1 Introduction

Timber for pulp production - pulpwood - can be subdivided into coniferous pulpwood and non-coniferous pulpwood. The conifers are omitted from the review because they are outside the scope of the RENEWPACK project; in this project only 'alternative fibre sources' are discussed. The total production of pulpwood and the production of coniferous pulpwood is given in appendix 8.

Table 5.1 shows the production of non-coniferous pulpwood: in 1991 and 1992 nearly 28 million CUM. The six EU countries with the highest production are: France (19%), Sweden (16%), Portugal (16%), Finland (15%), Spain (14%) and Germany (13%).

Table 5.1 Production of non-coniferous pulpwood (x 1,000 CUM, cubic metre)

	1988	1989	1990	1991	1992
Austria	396	430	450	486	542
Belgium-Luxemburg	173	200	300	240	255
Denmark	24	17	4	4	4F
Finland	4,980	5,380	4,707	3,460	4,141
France	4,912	5,374	4,962	5,204	5,358
Germany	.	.	.	3,526	3,618
Greece	62	230	260	265	265F
Italy	772	762	759	769	620
Netherlands	70	75	50	47	47
Portugal	3,925	3,860	3,981	4,557	4,557F
Spain	3,756	3,849	4,000	4,000F	4,072
Sweden	5,179	5,114	4,633	4,800F	4,100
UK	356	391	390	387	387F

'F' refers to 'forecast'.
Source: FAO, 1994:75.

The European Union encourages afforestation financially. One of the measures introduced alongside the Mac Sharry commodity measures is the afforestation aid in the shape of forestry investment and management. The European Union contributes up to 3,000 ECU per hectare for softwoods and 4,000 ECU per hectare for broadleaves and 600 ECU per hectare per year for five years to offset loss of farming income (European Commission, 1994:71).

Two main species of the non-coniferous pulpwood, eucalyptus and poplar, will be discussed more in detail in the following, as will the short rotation coppice. Short rotation coppice differs from the single stem plantation. While in the single stem plantation 'conventional' forest species (hardwoods and conifers) are planted at 1 x 1-meter spacing and clear-felled at 15-20 years, the coppice system primarily uses willows and poplars, planted as unrooted cuttings. They are cut back at the end of the first growing season and then subsequently at cutting cycles of about 3-5 years. It is expected that the stools will remain at a high production level until they are 20-30 years old. Compared with the single- stem plantation, it is envisaged that higher yields can be achieved from coppice.

5.2 Eucalyptus

Eucalyptus may be successful in poor soils, which are marginal for agriculture and unsuitable for other tree species. However, the eucalyptus tree is characterized by an intense productivity response to the improvement of soil fertility and water.

Eucalyptus is cultivated mainly by (small-scale) farmers: in the northwest of Spain the average farm size is 1-5 ha and in the southwestern part about 20-25 ha. Large-scale production is only accounted for by 20-30%.

Production

Eucalyptus is a species particularly suited to the climate of the Mediterranean region, such as the EU countries bordering or close to the Mediterranean: France, Spain and Portugal.

In France, more than 700 ha are planted with eucalyptus and there are plans for large-scale eucalyptus plantations. The average timber production amounts to 20 tonnes per year per hectare at a plantation age of 9 years. The consequent estimation for the coming 10 years is a production 140,000 tonnes per year (Cauvin en Melun, 1994).

In Portugal, an area of more than 400,000 ha is planted with eucalyptus, mainly for pulp and paper. It is estimated that the average yield is approximately 10 m^3 per hectare per year, which gives a total production of nearly four million m^3 or 3.5 million tonnes per year (personal communication Toval, 1995), based on the assumption that 1 m^3 = 0.9 tonne (dry matter content = 40%).

In Spain in 1990, the area of eucalyptus is 460,000 ha, of which 253,000 in Huelva. The other 200,000 ha are located in northwest Spain where eucalyptus is planted together with other species, resulting in a 'net' area for eucalyptus of 130,000 ha. The average yield in Spain amounts to more than seven m^3 per hectare per year: about fifteen m^3 per hectare per year in the northwest and about four m^3 per hectare per year in the southwest region. The yield in the southwest is much less, due to climatic conditions (dry and hot) (personal communication Toval, 1995). This results in an average production of eucalyptus of more than three million m^3 or nearly four million tonnes per year. This estimation agrees with the Spanish statistics: a production of 3,226,000 m^3 in 1990 (Ministerio de Agricultura Pesca y Alimentacion, 1990).

Consequently, the total production of eucalyptus in France, Portugal and Spain amounts to 6.5 million tonnes, which is used mainly for pulp and paper. In connection with table 5.1, eucalyptus can be seen as the main hardwood species produced in those countries.

Market price

In 1995 the market price for eucalyptus in northwest Spain is 9,000 to 10,000 pesetas (55 to 61 ECU) per tonne, delivered costs, free at the factory. The prices have increased during the last two-three years, like all (wood) fibres. Therefore, the price of 55-61 ECU per tonne can be considered a maximum price. The long-term market price is expected to be 60-62 USD per tonne (about 48 ECU per tonne) (personal communication Hellinga, 1995). This price includes the costs of transportation, which is estimated to be 800 pesetas (4.5 ECU) per tonne. Consequently, the 'net price' for the farmer is: 43 ECU per tonne.

The market prices in south Spain and Portugal are about 10% higher, due to the lower productivity (personal communication Hellinga, 1995).

5.3 Poplar

Production

Table 5.2 shows the annual production of poplar (nearly four million tonnes) and its annual removal, subdivided into longwood and stackwood. Both are mainly used as 'industrial wood' (longwood 97% and stackwood 93%), while only 7% of the stackwood is used as fuelwood (Eurostat, 1987).

Table 5.2 Total annual raw wood production and removal of poplars in the period 1980-1984 (x 1,000 tonnes a))

	Production	Removal	Of which	
			longwood	stackwood
Belgium	214.4	214.4	79.9	44.4
Denmark	0	0	0	0
Germany	0	0	0	0
Spain	103.1	88.3	64.8	38.3
France	1,728.4	1,728.4	1,504.9	237.8
Ireland	0	0	0	0
Italy	1,539.2	1,485.0	873.7	665.5
Luxemburg	0	0	0	0
Netherlands	112.5	111.1	79.0	33.5
UK	31.5	31.5	31.5	0
Total	3,729.1	3,658.7	2,633.8	1,019.5

a) Based on the assumption: 1 m^3 = 0.9 tonne (d.m.% = 40).
Source: Eurostat, 1987.
Note that the Italian production of poplar exceeds the production of non-coniferous pulpwood registered by the FAO (see table 5.1).

Market price

Table 5.3 gives an overview of prices in the European Union.

As can be concluded from this table the average market price of poplar in the EU is about 80 ECU per tonne. Assuming the transportation costs to be about 10 ECU per tonne, the market price at 'farm level' is: 70 ECU per tonne.

Table 5.3 Export prices of poplar in the European Union in the period 1988- 1992, in ECU per tonne

	1988	1989	1990	1991	1992	1993
France	73	83	93	89	94	104
Belgium/Luxemburg	63	53	53	55	59	58
Netherlands	48	50	62	38	33	40
Germany	50	54	55	58	60	52
Total EU	69	76	83	81	83	81

Source: Eurostat.

Furthermore, one can conclude that the price of poplar in the Netherlands seems to be rather low. This is in line with the information of the Dutch paper makers. The market price of poplar used for paper and packaging production (delivered costs, free at factory) in the Netherlands was in the first six months of 1995: 73-78 HFL per tonne, increasing to 95 HFL per tonne in August of 1995 (personal communication Algemene Vereniging Inlands Hout, 1995). The price of 73-78 HFL per tonne seems to be rather low, while the price of 95 HFL can be considered rather high. So, the average market price of poplar lies somewhere in between: 85 HFL per tonne. This cost price covers transportation, which varies according to distance: 11.5 HFL (less than 50 km) to 30 HFL (more than 200 km) (personal communication Algemene Vereniging Inlands Hout, 1995). Assuming the transportation cost to be 15 HFL per tonne, the market price at 'farm level' is: 70 HFL (30 ECU) per tonne.

5.4 Short rotation coppice

Research into short rotation coppice (SRC) in the EU has been ongoing since the mid-seventies. The research programmes were instigated primarily as a result of the oil crisis, although the move from research to commercial utilization has been slow. The economic viability of short rotation coppice for fuel is at best marginal. Short rotation coppice is most appropriate for abandoned farm land and marginal for agriculture; it is not economically interesting for farmers without subsidies.

The main interest in short rotation coppice is as an alternative fuel source. In this field, the Scandinavians for some years now have been pioneering short rotation coppice technology. With the recent accession of Sweden to the EU, it is worth mentioning their situation. Sweden has planted approximately 1,000 ha of willows over the past ten years. Most of the production is (commercially) used to supplement the fuel requirements of small-scale heating plants.

Although the research programmes are focused primarily on the use of the fibres as a fuel source, certain short rotation coppice might be considered as a source of fibre for pulp and paper production, too (personal communication Teissier du Cros, Stevens, 1995).

Based on the currently available planting material the best yield estimate lies somewhere between eight to twelve ODT per hectare per year (personal communication Stevens, 1995). Teissier du Cros indicated that a yield of twelve ODT per hectare per year is the best available guess for future commercial production. Using the best clones, cultivation plots and cultivation methods, the yield could increase to seventeen ODT per hectare per year. For average production, however, this is not a realistic assumption (personal communication Teissier du Cros, 1995).

Due to the lack of commercial plantations it is impossible to note a market price. Only estimations of cost prices are available. A delivered cost of between 30-40 ECU per ODT seems to be the best informed guess (Stevens, 1995); this cost price covers the costs of transport. This agrees more or less with the Swedish experiences, where an estimated cost price of 31 ECU per ODT was arrived at. Both cost prices do not include the costs of land and building. When the costs of land and building are included, the cost price is about 63-69 ECU per ODT in the UK (Guilford, 1994) and 89 ECU per ODT in the Netherlands

(Rijk, 1994). Both calculations assume a harvest interval of three years and in both calculations the annualized yield is eleven ODT per hectare. The difference in production cost, nearly twenty ECU per ODT, is mainly caused by the difference in costs of annual management. More specifically: the cost of land rent, which is much higher in the Netherlands than in the UK. Furthermore, the costs of grubbing up are estimated much higher in the Dutch situation than in the case of the UK.

It can be noted that with the improvements in crop productivity through plant breeding programmes, improvements in mechanized planting and harvesting technologies and the use of integrated weed and pest management systems reducing the need for expensive chemical inputs, the cost of short rotation coppice has been greatly reduced over the past few years and is continuing to drop.

5.5 Summary

Table 5.4 gives the overview of availability and market prices of eucalyptus, poplar and short rotation coppice.

Table 5.4 Production and market price of wood, in tonne (ODMT) and ECU per tonne (ODMT)

	Production		Market price	
	tonne	ODMT	ECU/tonne	ECU/ODMT
Eucalyptus	6,500,000	2,600,000	43	107
Poplar	3,729,000	1,728,000	70	175
SRC	0	0	28-36	70-90

Based on the assumption: - 1 m^3 eucalyptus/poplar = 0.9 tonne eucalyptus/poplar (including bark and water) = 0.417 ODT.

6. FIBRES AND THE FUTURE CAP

The selection of the fibres has to be based on the development of market prices and availability on medium term. One might expect that the Common Agricultural Policy (CAP) has a great impact on that. This item has been subject of an expert meeting. Experts of the Dutch Ministry of Agriculture, Nature Management and Fisheries, of the Wageningen Agricultural University, of Stichting Bos en Hout and of the Agricultural Economics Research Institute (LEI-DLO) in the Hague have discussed this item (see appendix 9). The results of the discussion will be presented below.

Straw

There are a few developments that can have great influence on the future of the CAP: the enlargement of the EU by the Central and East European Countries (CEEs) and the Scandinavian countries and the future GATT negotiations. One might expect that these could lead to an adjustment of the CAP. For example, due to the fact that bringing the CEECs under the current CAP without further reforms could lead to prohibitively high costs for the EU budget. On the other hand, it is to be expected that the accession of the CEEs will be accompied with 'transitional arrangements' - as in the eighties with the accession of Spain and Portugal. The experts of the Dutch Ministry of Agriculture, Nature Management and Fisheries and the Agricultural Economics Research Institute (LEI-DLO) in the Hague believe that the impact of the developments mentioned is limited; they do not believe in fundamental changes in the CAP, with great impacts on the supply of agricultural products. So, it is not expected that supply of cereal and rapeseed straw will decline or increase drastically. Only on a regional level there could be a little exchange between those two products.

Wood

Furthermore, the experts do not foresee a shift in the CAP from cereal towards wood. They think that for the support of farmers an EU policy for grain (and milk) is more effective (cheaper) than an EU policy on wood or forest. Therefore, a strong stimulation for and/or re-orientation towards wood production is not to be expected.

At most, the CAP will re-orientate towards more large-scale production. That could lead to more 'marginal' land, which has to be filled up. Extensive wood production could be an option then, but that is not very interesting for our project. Costs are too high and the supply is scattered all over the country; not an ideal base for an agro-industrial complex. Only in certain regions with low costs of labour, low costs of land use and high yields, more intensive wood production is to be expected: Spain, Portugal and Ireland can be mentioned there.

Crops for industrial use

In recent years, EU policymakers have decided to take land out of food production through set-aside schemes. Farmers producing an equivalent of more than 92 tonnes of cereals will only receive the hectare compensations if they set aside the prescribed percentage of their arable land. This set-aside land can be used for non-food uses, which means specific crops for specific applications. There are two ways of meeting this set-aside requirement: rotational and non-rotational set aside. Rotational set aside means the crop does not return to the same area for at least five years. Non-rotational crops require farmers to set a higher percentage of their arable land aside in return for a higher compensation (18% in the UK; 20% in the other EU member states). Recently the Commission discussed the possibility of making no difference between rotational and non-rotational set aside.

This has stimulated the search for non-food crops to utilize set-aside land. Producers are interested because growing industrial crops on set-aside land offers supplemental income by providing revenue from the crop sales in addition to the set-aside premium. However, the extent of the increase will depend on a number of factors, such as: the demand for industrial products, the industrial processing capacity, the producers' profitability, the cost competitiveness, the policies aimed at improving research and development assistance (Normile, 1994). The Dutch Ministry of Agriculture, Nature Management and Fisheries expects an adjustment of the CAP on this point: countries like France, Germany and the United Kingdom push for reconsideration of the set-aside policy. That could lead to a decrease of supply. On the other hand, in several countries an agro-industrial complex around new industrial fibres, grown on set-aside land, has been established. This more or less assures demand and (therefore) supply of the fibre. Which force has the greatest power has to be assessed per case.

Not only the set-aside measurements are subject of critical assessment within the EU, other fibres that ask relatively high direct support are in a similar position. It is not expected that such measurements and subsidies will exist 'for ever'.

Translated to the previous chapters, one can conclude that the supply of linseed straw, flax and hemp is less certain.

To summarize, the medium-term market prices and availability of agricultural fibrous material depend on uncertain factors, such as the impact of the enlargement of the EU, the CAP adjustments and the development of the production of non-food crops on set-aside land. However, the Dutch Ministry of Agriculture does not expect a dramatic re-orientation of the CAP with dramatic decline of increase of fibres. The only thing one can conclude is that fibres that strongly depend on the set-aside measurements or other direct subsidies, like linseed straw, flax and hemp, are the most uncertain sources of supply.

7. CONCLUSION

In this report the selection of fibres is based on agro-economic arguments only: availability, price, necessity of finding new and other applications and extent of concentration of availability. Other arguments, like marketing and technical issues, that have to be considered in the selection processes will be assessed by other participants.

Table 7.1 Mean annual production (x 1,000 ODMT) and average market price (ECU per ODMT) of fibres and the need for finding new applications for fibres in the EU in the period 1990-1995

	Production	Market price	Need for finding other applications a)
Non-wood: straw			
- cereal straw	92,650	47	++
- rapeseed straw	8,500	47 b)	++
Non-wood: miscanthus	0 c)	55-100	0
Non-wood with long fibres			
- flax	21-25	175-235	+
- hemp whole stalk	38	70	+
- hemp bast fibre	13	320	+
- kenaf whole stalk	0	53-106	0
- kenaf bast fibre	0	235-470	0
- linseed straw	255	82	++
Wood			
- eucalyptus	2.600.000	107	0
- poplar	1.728,000	175	0
- short rot. copp.	0	70-90 b)	0

a) ++: Two arguments have been found: (1) In several countries there is a surplus of straw that is considered a problem. Due to the fact that it is forbidden to burn straw, farmers are looking for solutions to address the problem; 2) Prices of cereal and oil are decreasing, which makes it economically more interesting to find useful applications for by-products, like straw).

+: One argument has been found (Market prices are relatively low at the moment).

0: No specific argument has been found

b) There is no market for this product at the moment, therefore the price is estimated, based on the expected cost price.

c) There is no commercial production, yet.

Information about the availability and price has been collected for recent years. However, one must consider developments and their medium-term impact.

The impact of CAP for example is an issue that has to be considered. However, it seems that a re-orientation of the CAP with dramatic shifts in agricultural production is not foreseen. The only thing to take into account is that set-aside and other direct subsidies are subject of reconsideration within the EU, which means that the supply of fibres that strongly depend on those subsidies are less guaranteed.

Table 7.1 shows the score of the (groups of) fibres that are considered. The extent of concentration of availability does not seem a distinguishable factor; all fibres are more or less available at a regional level.

Table 7.1 shows that, concerning price and availability, one has to select (cereal) straw and eucalyptus. Both are available in huge amounts. The straw production is about 1,000,000 ODMT, whilst there is about 2.6 million ODMT of eucalyptus. The price is relatively low: 47 ECU per ODMT for straw and 100 ECU per ODMT for eucalyptus.

Furthermore, one can see from table 7.1 that hemp whole stalk, kenaf whole stalk and linseed are available at relatively low costs: less than 100 ECU per tonne. However, it's doubtful whether the option 'whole stalk' for hemp and kenaf is an interesting option for the pulp and paper industry. Processing costs seem to be relatively high, due to the high amount of very short fibres. The technical partners in the RENEWPACK project will assess this item. Furthermore, one has to take into account that subsidies on those crops are re-considered within the EU and therefore their supply is less guaranteed.

Concerning the 'new' crops, one can choose miscanthus, kenaf or short rotation coppice. They do not differ very much in price.

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Gonzalez, V.
Enso Iberica S.A.; Madrid, Spain

Hellinga, M.
Celulosas de Asturias S.A. (CEASA); Navia, Spain

Jacobs
Parenco; Renkum, the Netherlands

Peeters
Salpa; Belgium

Stevens, E.
Research Assistant of dr. C.P. Mitchell, coordinator of the Joule Poplar Network; Wood Supply Research Group, Department of Forestry, University of Aberdeen, UK

Toval, G.
ENCÉ; Madrid, Spain

Teissier du Cros, E.
INRA; Centre de Recherches d'Avignon, Avignon, France formal coordinator of the Joule Poplar Network

Algemene Vereniging Inlands Hout, Zeist, the Netherlands

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APPENDICES

Appendix 1 Participants and contractors in RENEWPACK

Main contractor and coordinator

Name of participant	Major responsibilities	Scientific team (key scientists)
AERI/ LEI-DLO: Landbouw-Economisch Instituut, The Hague, Nl	coordination, market research, agricultural issues	Dr. J.C. Blom Drs. R.A.C. Koster Ir. M.J.G.Meeusen-Van Onna

Contractors

Name of participant	Major responsibilities	Scientific team (key scientists)
BB: Biocomposites Centre, Bangor, Wales, GB	pulping experiments, research strategy	Dr. J. Bolton Dr. D. Robson Dr. M. Lawther
TA: Triton BV, Haren, Nl	pilot plant runs, industrial partner	Ir. K. Herder J. Hainje
FK: Fraunhofer Institut für Systemtechnik und Innovationsforschung, Karlsruhe, BRD	environmental analyses and issues	Dr. T. Reiss Dr. G. Jaeckel Dr. O. Hohmeyer
FM: Fraunhofer Institut für Lebensmitteltechnologie und Verpackung, München, BRD	barrier technology, testing and properties use and reuse properties and biodegradability	Dr. H-C langowski Dr. M. Menner

Note: the two Fraunhofer institutes are legally one-contractor.

Name of participant	Major responsibilities	Scientific team (key scientists)
WAU-MT: Landbouw Universiteit Wageningen, Wageningen, Nl	process effluent	Prof. dr. Lettinga Dr. J. Field
WAU-PK: Landbouw Universiteit Wageningen, Wageningen, Nl	process technology	Dr. Ir. D. van Zuilichem Ir. J.E. Harsveld van Veen

Note: the two WAU-research groups are legally one-contractor.

Appendix 2 Present use of straw in Denmark and in the UK

Present use of straw in Denmark

Table 2.1 shows the straw yield and the applications of straw in Denmark. It should be mentioned that not only cereal straw is considered in this table; straw of oilseed rape and peas are also included. However, this is only a small percentage of the total production (10%).

Table 2.1 Straw yield and application of straw in Denmark (x 1,000 tonnes)

	Straw	Of which			
		collected	for feed	for heating	other
1989	6,853	4,146			
1990	7,032	3,678			
1991	6,727	3,549	1,797	1,136	616
1992	4,826	3,471	1,761	923	787
1993	5,672	4,812	2,590	1,257	965

Source: Danmarks Statistik, 1994.

For 1993 there was 5.1 million kg straw of cereals, of which 2.5 million kg was used for feed, 1.1 million kg for heating and 919 for 'other'.

Table 2.2 gives another view on straw production and use. Note the differences in production and application: table 2.1 and 2.2 have different sources and are based on different samples.

Table 2.2 Straw production and use (x million tonnes)

Production	6.3	3.8		5.2		5.8
Application						
- feed	1.2	1.2	)			
- bedding	1.1	1.1	)2.5		2.5	
- protection	0.27	0.27	)			
- energy on farm a)	0.45	0.45		0.5		0.5
- CHP a)	0.25	0.45		0.5		0.5
Surplus	3.0	0.3		1.7		2.3

a) It must be mentioned that the use of straw for energy will increase. The 'Energy 2000 Plan' aimes at 1.2 million tonnes of straw used for energy in the year 2000 (Nielsen, 1993).
Source: Elsam and Elkraft, 1994 and Sams, 1993.

Present use of straw in the UK

In the UK, half of the 13.5 million tonnes of straw is baled for use. This is mainly for animal bedding and feed (5.8 million tonnes), crop growing, storage and protection (0.5 million tonnes) and for chemical treatment of feed (0.3 million tonnes). Fuel use accounts for most of the remainder.

The surplus of straw - the other half (6.75 million tonnes) - is either burnt in the field or ploughed in.

Table 2.3 Straw production and use (x million tonnes)

Production	13.5
Application	
- feed and bedding	5.8
- crop growing, storage and protection	0.5
- chemical treatment for feed	0.3
Surplus	6.75

Source: Morrison, 1994.

Most of the wheat straw produced in the UK is available in east England and in the South Midlands, away from livestock areas.

Appendix 3 Yield of straw in Europe

Table 3.1 Yield of straw (tonne per hectare)

	North Europe	South Europe a)
Soft wheat	5.2	3.25
Durum wheat	4.3	3.25
Rye	4.2	2,925
Barley	3.8	2,925
Oats	4.0	2.5

Based on: LEI/CBS, 1994 and Darwinkel, 1995.
a) For Spain the straw yield of wheat is 1.4 tonne/ha, barley straw 1.3 tonne/ha, oats straw 0.8 tonne/ha, rye straw 0.9 tonne/ha.

Appendix 4 Production of cereal straw

Table 4.1 Estimation of production of soft wheat straw in the EC (x 1,000 tonnes)

	1991	1992	1993	1994
Belgium-Luxemburg	1,118	1,128	1,097	1,118
Denmark	2,709	3,032	3,229	2,969
France	24,195	24,222	22,844	22,662
Germany	12,672	13,431	12,402	12,646
Bayern	2,522	2,451	.	2,321
Niedersachsen	1,672	1,726	.	1,508
Greece	965	1,079	1,069	978
Ireland	447	473	400	374
Italy	3,260	3,211	2,889	2,745
Netherlands	640	660	614	640
Portugal	919	796	754	728
Spain	2,470	2,258	1,977	1,995
UK	10,291	10,738	9,142	9,480

Personal communication Darwinkel 1995, CBS Oogstraming, Eurostat, ZMP Bilanz.

Table 4.2 Estimation of durum wheat straw production in the EC (x 1,000 tonnes)

	1991	1992	1993	1994
France	1,599	1,378	721	764
Germany	69	69	43	47
Greece	2,321	2,002	1,895	1,973
Italy	5,460	4,388	4,583	4,709
Portugal	101	98	59	55
Spain	643	882	874	822
UK	4	4	4	4

Source: Personal communication Darwinkel 1995, CBS Oogstraming, Eurostat.

Table 4.3 Estimation of production of rye straw in the EC (x 1,000 tonnes)

	1991	1992	1993	1994
Belgium-Luxemburg	17	8	8	13
Denmark	344	370	323	407
France	254	227	189	193
Germany	3,057	2,583	2,780	3,062
Brandburg	684	643	685	.
Niedersachsen	658	538	559	.
Greece	64	50	56	56
Ireland	.	.	.	.
Italy	23	23	23	23
Netherlands	30	25	29	29
Portugal	260	219	214	211
Spain	168	162	156	146
UK	39	32	25	29

Source: Personal communication Darwinkel 1995; CBS Oogstraming; Eurostat; ZMP Bilanz.

Table 4.4 Estimation of production of barley straw in the EC (x 1,000 tonnes)

	1991	1992	1993	1994
Belgium-Luxemburg	350	327	80	72
Denmark	3,777	3,458	2,740	2,675
France	6,650	6,840	6,167	5,373
Germany	9,986	9,402	8,723	8,241
Bayern	1,871	1,794	1,752	.
Niedersachsen	1,409	1,302	1,210	.
Greece	500	500	488	477
Ireland	733	699	673	635
Italy	1,381	1,316	1,243	1,167
Netherlands	119	149	137	151
Portugal	202	196	196	196
Spain	5,737	5,346	4,879	4,651
UK	5,293	4,929	4,423	4,248

Source: Personal communication Darwinkel 1995; CBS Oogstraming; Eurostat; ZMP Bilanz.

Table 4.5 Estimation of production of oats straw in the EU (x 1,000 tonnes)

	1991	1992	1993	1994
Belgium-Luxemburg	66	60	68	60
Denmark	110	112	128	212
France	1,065	912	928	872
Germany	1,927	1,644	1,628	1,760
Bayern	396	356	353	.
Greece	113	108	108	110
Ireland	92	80	80	88
Italy	365	365	360	363
Netherlands	13	16	20	20
Portugal	243	245	230	203
Spain	260	251	262	263
UK	107	106	380	496

Source: Personal communication Darwinkel 1995. CBS Oogstraming. Eurostat.ZMP Bilanz.

Appendix 5 Production in regions of the EU countries

Table 5.1 Percentage of production of wheat and barley straw in the most important regions of the EU countries, in 1991 (x 1,000 tonne)

		Wheat	Barley
Belgium-Luxemburg		1,322	63
Of which ( )	West-Vlaanderen	19	23
	Hainaut	27	15
Denmark		6,147	140
France		24,435	6,257
Of which (%)	Centre	19	11
	Champagne-Ardenne	8	11
	Picardie	10	8
	Bourgogne	7	9
	Poitou-Charentes	7	7
	Midi-Pyrenees	6	9
	Pays de Loire	7	3
Germany		12,844	9,088
Of which (%)	Bayern	20	19
	Baden-Wurttenberg	8	8
	Nordrhein-Westfalen	10	10
	Sachsen-Anhalt	10	8
Greece		3,070	491
Ireland		3,163	85
Italy		7,811	1,277
Of which (%)	Puglia	15	8
	Sicillia	15	3
	Toscane	9	7
	Basilicata	7	9
	Lombardia	2	18
Netherlands		777	17
Of which (%)	Groningen	23	22
	Zeeland	21	22
	Flevoland	12	10
Portugal		877	197
Spain		2,980	5,153
Of which (%)	Andulcia	25	7
	Castilla-Leon	31	36
	Castilla-La Mancha	15	26
	Aragon	10	14
UK		9,917	4,723
Of which (%)	South-East	27	14
	East-Midlands	20	12
	South-East	23	14
	Scotland	6	24

Source: Eurostat, 1994 (c).

Appendix 6 Cost price for straw in Denmark

Table 6.1 Cost price for straw in Denmark (ECU (DKK) per tonne)

Baling, e.g. with Hesstonne baler	16.0	150
Collecting and piling	5.3	50
Storage in open stack	8.5	80
Plastic covering	4.3	40
Insurance	1.0	10
Loading and transport	6.4-7.5	6-70
Total	41.7-42.8	39-400

Source: Boon.

This calculation does not differ very much from the price Nielsen calculates: 49.3 ECU (461 DKK) per tonne of straw (Nielsen, 1993).

Appendix 7 By-products of flax processing

Flax is grown mainly for fibre production for textile use. Only the lower grades are used in various other industries. In contrast with other options, by-products of flax do not arise at the farm, but at the processing industry. Because the processing industry is concentrated in Belgium, this is mainly where flax fibres come from.

There are several by-products which differ in fibre length and cellulose content. Those with the highest fibre length and cellulose content are called 'papierklodden' and 'dechet'. The other by-products are of a lower quality.

The by-products are already mainly used in the pulp and paper industry. They are used for specialty paper, such as cigarette paper and paper money.

There are no statistics available on the production and the availibilty of by-products of flax; there is only an estimation, based on interviews with Belgian dealers in flax: 9,000-10,000 tonnes per year (Van Onna en Van den Ent, 1994).

Market prices for flax by-products vary considerably, depending on demand and supply. In recent years the market was characterized by surpluses and large stocks, resulting in low prices. However, in the last two years there is a better balance of demand and supply, which has lead to an increase of the market prices, as can be seen in table 7.1.

Table 7.1 shows the price of different by-products that have been used in the pulp and paper industry over the last five years.

Table 7.1 Market price of flax by-products in the 1990-1994 (ECU per tonne)

	1990	1991	1992	1993	1994
Papierklodden	42.2-84.4	<51.5	<51.5	72.1	101.4
Dechet	42.2-84.4	<61.8	<61.8	<61.8	<99.8
Chaff ('kaf')	21.1-36.9	10.3-20.6	25.8-36.0	25,7-30.9	25.3-30.4
Flax waste	20.7	20.7	20.7	20.7	20.7
Lemen	30.6-35.9	24.7-29.9	15.4-20.6	15.4-20.6	12.1-17.2

Source: Vlasberichten 1990-1994.

Appendix 8 Production of pulpwood and coniferous pulpwood in the EU

Table 8.1 Production of pulpwood in the EU (x 1,000 CUM)

	1988	1989	1990	1991	1992
Austria	3,013	3,220	2,809	2,674	2,574
Belgium-Luxemburg	968	1,000	1,300	1,050	1,100
Denmark	459	374	500	500	500F
Finland	22,200	22,960	21,242	17,126	19,053
France	9,722	10,812	9,760	10,369	12,108
Germany	.	.	.	12,667	11,359
Greece	220	360	400	410	410F
Ireland	500	550	550F?	550F?	567
Italy	903	878	856	874	712
Netherlands	660	645	670	416	416
Portugal	5,289	5,503	5,765	6,339	6,339F?
Spain	9,056	9,149	9,300	9,300F?	9,467
Sweden	26,669	28,307	24,113	25,088F?	24,300
UK	2,206	2,216	2,270	2,245	2,245F

Source: FAO, 1994:72.

Table 8.2 Production of coniferous pulpwood in the EU (x 1,000 CUM)

	1988	1989	1990	1991	1992
Austria	2,617	2,790	2,359	2,188	2,032
Belgium-Luxemburg	795	800	1,000	810	845
Denmark	435	357	460	460	460F
Finland	17,220	17,580	16,535	13,666	14,912
France	4,810	5,438	4,798	5,165	6,750
Germany				9,141	7,741
Greece	158	130	140	145	145F
Ireland	500	550	550F	550F	567
Italy	131	116	97	105	92
Netherlands	590	570	620	369	369
Portugal	1,364	1,643	1,784	1,782	1,782F
Spain	5,300F	5,300F	5,300F	5,300F	5,395
Sweden	21,490	23,193	19,480	20,288F	20,200
UK	1,850	1,825	1,880	1,858	1,858F

Source: FAO, 1994:74.

Appendix 9 Members of the Expert Meeting

P. Berkhout	Ministery of Agriculture, Nature Management and Fisheries, The Hague
S. van Berkum	Agricultural Economics Research Institute (LEI-DLO), The Hague
J.C. Blom	Agricultural Economics Research Institute (LEI-DLO), The Hague
A.M. Filius	Wageningen Agricultural University, Wageningen
R.A.C. Koster	Agricultural Economics Research Institute (LEI-DLO), The Hague
M.J.G. Meeusen-van Onna	Agricultural Economics Research Institute (LEI-DLO), The Hague
H.J. Riphagen	Ministery of Agriculture, Nature Management and Fisheries, The Hague
J.A.N. Stolp	Stichting Bos en Hout, Wageningen
P.J.J. Veenendaal	Agricultural Economics Research Institute (LEI-DLO), The Hague