IENICA

FIBRE FACTS

A Framework for buyers and sellers of flax and hemp fibres within the EU

August 2004

Acknowledgements

We would like to thank all IENICA partners for their input into this document, in particular colleagues at the Institute of Natural Fibres in Poznań, Poland and Harry Gilbertson

This work was funded under the IENICA workstream of the IENICA-INFORRM project. IENICA is the Interactive European Network for Industrial Crops and Applications. The overall project is funded by the Fifth Framework Programme of the European Commission under the Quality of Life Programme. This project is a development of the FAIR Programme (FP4)-funded IENICA project.

INTRODUCTION

This market information booklet is one of several that have been written as part of the current IENICA workstream of the IENICA-INFO*RRM* project.

These booklets are the first to try to characterise the specifications that a farm feedstock must achieve to be acceptable in the non-food products sector. The lack of specifications has been highlighted as a bottleneck in development of such products. Whilst it has been quite difficult to produce these booklets and there is not doubt they will be superseded in time, they will certainly form the first step in assisting growers match market requirements with their agricultural feedstocks.

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One feature common to all natural fibres used by any industry is that the fibres can literally pass through many hands between being a growing crop in the field and becoming a finished saleable item, whether as bed-sheet or shirt; car-part or carpets; plastics or paper.

At every stage of being passed along the supply-chain it is vital that each party can communicate precisely what they are passing-on or receiving. Whether it is a farmer with straw bales for decorticating or a processor with rolls of non-woven fabric for moulding - there needs to be an agreed list of criteria against which each party can establish whether they have completed their task correctly or not. Whilst these specification sheets will differ slightly in every case, this booklet seeks to lay-out a draft form of headings for consideration. Buyers and sellers can go on to build and tailor their own unique commercial agreements.

The booklet is intended only to provide an objective basis, it favours neither buyer nor seller, but merely outlines the main headings that experience has shown should be considered and is neither exhaustive nor definitive. Each process and application will have its own unique set of criteria, accepted methods of measurement and different priorities.

By definition, natural fibres will always contain a certain degree of 'natural' variation. This will evidence itself in many ways - as differences in size, shape, length, strength, fineness, colour and so on. Variation can never be eliminated; the question is - can it be understood and quantified to a sufficient extent for the immediate purpose of creating marketable products?

Specifications are therefore all about stating clearly what is important to have measured, and then agreeing a method and scale of measurement and, finally, the setting of acceptable and agreed maximum and minimum values along this scale.

The booklet applies to flax (*Linum usitatissimum*) and hemp (*Cannabis sativa*) jointly except where stated, as these are the major European fibres which are currently traded. Other bast fibres, such as nettle fibre thanks to pioneering work in Austria and Germany, may become important in the future and similar specifications will need to be developed for these.

It is hoped this booklet will be useful to everyone in the supply-chain, that it will encourage more prospective users and suppliers of natural fibres to approach their business and co-operation in a rational and informed manner, to their mutual benefit.

SPECIFICATIONS

There are a number of different points in the supply chain of natural fibres where there needs to be a written specification - mostly these will be between separate legal entities trading with one another, but sometimes they may be internal documents between departments or divisions within a single large company. In the case of the automotive industry there may be two or more sub-processors in the supply-line each adding a stage until the final component is ready for the assembly line.

- Crop specification - what is being grown and how (see IENICA's Agronomy Booklet, which gives generic agronomic guidelines for flax and hemp; see **www.ienica.net**)
- Straw specification - how is it harvested, stored, graded and presented (bale form)
- Fibre specification i.e. length, fineness, strength, colour, impurities/presentation (bale form)
- End-use specification i.e. yarn, fabric, component (performance testing which controls the limits for the previous specifications)

Each country has developed its own methods, terminology and standards for natural fibres. In addition, several testing methods exist to determine properties such as strength, fineness, length etc. Depending on the method, the results are quite different and so it is important to always be aware of the method used. Much of the information provided in this document is from the Institute of Natural Fibres (INF) in Poznań, Poland (**http://iwn.inf.poznan.pl/**) and relates to Polish standards.

Sources of information on standards include:

- The European Committee for Standardisation (this also gives links to Members' National Catalogues): **www.cenorm.be/catweb/cwen.htm**
- The International Organisation for Standardisation (ISO): **www.iso.org**
- ASTM International Standards: **www.astm.org**

In addition, quality characteristics for flax fibres have been defined through the TES4TEX project (www.tes4tex.com), and the data introduced on a virtual market (buyer-seller); the approach is mainly based on west European flax. The general aim of the project was to define the most important characteristics of flax fibres for spinning by objective quality assessment (simulation technology, fineness, strength) and organoleptic or visual quality assessment (length, colour, homogeneity), indicating classes of materials and evaluation methods for each characteristic. For more information see www.tes4tex.com.

Further Information

Key organisations within the natural fibres sector who can provide further information on various aspects of flax and hemp production can be obtained from the IENICA website: **www.ienica.net**

EC Flax and Hemp Subsidy Regime

The last decade has been a turbulent one for both flax and hemp. Reforms of the subsidy regime have a major impact on the production of these crops. See **http://europa.eu.int** for further information.

1. CROP SPECIFICATION

Flax and hemp are both good break-crops that fit well into most arable rotations. Hemp is particularly good as a cleaning crop as it is such a strong competitor against all weeds. The important stages are timing of sowing and sowing density; after that the growing period usually requires little intervention apart from monitoring for weeds, pests and diseases. The fundamental properties and qualities of vegetable fibres, including flax and hemp, are mostly genetically determined. Hence the strongest influence of the farmer on the fibre quality can be only by selection of varieties offering the best yield parameters. Nevertheless, there are also environmental and agro-technological factors which can improve or worsen the potential offered by that variety. The level of farmer input varies on a country basis. However, the factors which can impact on quality include:

- Selection of the preceding crop and soil type
- Sowing date, fertilisation status
- Post–emergence treatments
- Time and method of harvest

The most important effect on the quality of the straw (and fibre) begins when straw is swathed for dew retting. This must be carried out at the right moment (green-yellow maturity of straw); the process of retting must be monitored and the straw turned if necessary, and retting must be stopped (by drying and taking it from the field) at the proper time.

The farmer can be responsible for harvesting, retting (if any) and baling of the stems, although some larger operations require that these are undertaken by contractors to ensure consistency of the harvested material. Timeliness at harvest is vital for fibre crops if they are to be useful as a homogeneous raw material to any industry

2. STRAW SPECIFICATIONS
TRADITIONAL SPINNING ROUTE

Information from the Institute of Natural Fibres in Poznań, Poland gives the following information for specifications for raw and retted straw, for the traditional spinning route, from Polish standard: PN–P–80103:1996[1]. For industrial applications of fibres, as it particularly seed in western Europe where these markets are rapidly developing, specifications will differ greatly from those given here. Fibre length, particularly, will be much shorter (the IENICA partner for Germany[2] gives a length of 20-40cm, for example).

Flax

The straw must be evened-out at the root end and arranged parallel in bundles of at least 2 kg (retted) or 2.5–4.0 kg (raw)[3]. Bundles should be bound with natural fibre string or flax straw. Retted straw can also be baled but raw straw must not. The most important feature from the farmer's point of view is the colour of the straw as it has a direct effect on the quality of fibre. The light–grey, steel-grey and silver–grey colours of straw (at least for 70% of the stems) are the best as these indicate healthy retting. For raw (unretted) straw the colour must be yellow (at least for 65% of the stems).

Feature of straw	Retted straw	Raw straw
Technical length [cm]	At least 43 cm, but for first class straw it has to be at least 60 cm[4]	At least 43 cm, but for first class straw it has to be at least 60 cm[5]
Stem alignment [%]	At least 70%	At least 70%
Degree of retting [%]	Well–retted stems at least 60%; not less than 90% for first class straw	Not relevant
Health condition	Over 80% of stems have to be healthy	Over 80% of stems have to be healthy
Moisture content[6]	Not more that 16% mcwb[7]	Not more that 18% mcwb
Impurities content[8]	Not more 15, of which weeds not more than 10%	Not more 20, of which weeds not more than 15%

[1] Used here because Poland has a long tradition of natural fibre cultivation and as a world leader in linen production.
[2] Fachagentur Nachwachsende Rohstoffe e.V. – The Agency for Renewable Raw Materials
[3] According to the Lithuanian standard, bundles are measured by diameter – not more than 17cm
[4] In Lithuania (standard LST 1339:2000) - 60cm and 70cm respectively
[5] In Lithuania – 60cm and 70cm respectively
[6] In Lithuania – moisture is expressed in % of absolute dry mass: not more than 25% in sheafs (bundles); not more than 20% in bales; 19% normal.
[7] mcwb = moisture content wet basis
[8] In Lithuania – impurities content is only total and is much lower: not more than 10% in sheaf; not more than 8% in bales; 5% normal

Hemp

For hemp, steel-grey, silver-grey and light-grey colours of straw are preferred, however also brown-grey, dark-grey and green-grey colours are acceptable for lower classes (at least for 70% of stems). For raw straw, light yellow, dark yellow and green–yellow colours of straw are preferred, although light green, light brown, light grey (at least 65% of the stems) and dark green and dark grey are also acceptable for lower classes.

Feature of straw	Retted straw	Raw straw
Total length [cm]	At least 80 cm, but for higher classes of straw it has to be 110-130 cm	At least 80 cm, but for the higher classes of straw it has to be 110-130 cm
Degree of retting [%]	Well–retted stems - 90% for first class straw for clothing textiles and 80% for second class. Under-retted stems should be no higher than 70% for cordage	Not relevant
Health condition	Over 90%, 80% and 70% of stems have to be healthy for 1st, 2nd and 3rd class straw respectively	Over 90%, 80% and 70% of stems have to be healthy for 1st, 2nd and 3rd class straw respectively
Stem thickness [mm]	4–6, 4–8 and 3–12 for 1st, 2nd and 3rd class straw (clothing). 3–6, 3–8, 3–12 for cordage	4–6, 4–8 and 3–12
Moisture content	Not more that 20% mcwb	Not more that 20% mcwb
Impurities content	Not more than 15%	Not more than 15%

The baled straw will usually be sold off-farm to a processor. To maximise profit it is important that the farmer has at least some idea of what will happen to his straw, so that it best conforms to the processor's requirements and therefore obtains the highest price. Certain farmers may simply not be in a geographically suitable region to reliably produce the grade of crop needed for a particular process or end-use.

3. FIBRE SPECIFICATION

Markets can be broadly categorised by the processes that the fibres will go through before they become a product or part of a product e.g.

- Classical long-fibre spinning for textiles
- Wet pulping for paper-making
- Fleece-laying for non-wovens
- Carding/spinning for ropes and coarse-woven textiles

Without going into technical detail on each of these processes, the following points are critical for fibre specification purposes[9]: -

Specifications of fibres required for classical spinning purposes

For woven textiles - NO PLASTIC CONTAMINATION. This market is where the degree of retting becomes most critical. Only farmers with a great deal of experience are likely to be able to produce adequate quality regularly. Under-retting will produce a coarse yarn suitable only for ropes. Over-retting will result in fibre (yield) loss during processing and a weak yarn with limited applications. Length and fineness are critical and heavily related to retting. The value of a batch can vary by 100% depending on its quality. High prices can be paid for the fibre but they also fluctuate wildly year on year depending on supply/demand.

The classical methods of wet and dry processing for yarn production (processing of flax and hemp fibres for classic spinning combed yarn) require the following specification of fibres:

Required quality of long fibres

- Flax fibre from 40 to 84[10] – to obtain linen yarns of linear mass 40 tex to 84 tex[11]

[9] Specifications provided from the Polish standards
[10] Lithuanian standard: 15-84
[11] Lithuanian standard: 15-84 tex

- Hemp fibre from 140 to 280 – for spinning to a linear mass 140 to 280 tex, mainly for technical yarn (string and twine)

Length of fibres

The length of scutched flax fibres suitable for hackling operation should be between 40-80cm[12]. The length of hemp fibres should be reduced to fit to the dimensions of scutched flax fibres, prepared for combing.

Fineness

The fineness of flax fibres varies according to the type – from thick to very thin technical fibres. The fineness of hemp fibres also varies according to the type – from thick fibres (low divisible ribbon) to fibres with well divided and very loose ribbon.

Tenacity of fibres

- Tenacity of flax fibres is required between 27–73 cN/tex
- Tenacity of hemp fibres between 27-69 cN/tex

Specification of fibres for carded technical yarns

Short flax fibre

Types 100–500 (e.g. Polish standard PN–P–80105:1998). Short fibre to obtain carded technical yarns of linear mass 100tex – 500tex.

- Fibre length: to this group all tangled flax fibres could be classified, which are in the loose form, known as 'tow'. The length of those fibres is diverse depending on the technology used.
- Fineness of fibres: adequate to the type: from thick, not divisible to very thin technical fibres
- Impurities content: in the range 13%-33%, depending on the type of fibres

Short hemp fibres

Short hemp fibres are classified in types 1000–4000 and allow for processing for technical yarn (e.g. twines)

- Fineness: from ribbon of technical fibres (medium divisible) to the loose and divisible ribbon
- Length: diversified; from short fibres to long, but tangled fibres,

[12] Lithuanian standard: 70-100cm

- Impurities content 3% to 19%.

Specification of fibres for blends with cotton and wool

The new open-end processing systems requires other fibre features.

Blends with cotton and chemical fibres for cotton spinning system (short staple)

Requirements for flax and hemp fibres:

- Length: 25–45 mm
- Fineness: below 1.5 tex
- Impurities content: below 1%.

Blends with wool and man-made fibres

Required for the woollen spinning system. Requirements for flax and hemp fibres:

- Length: 60–120 mm
- Fineness: below 2 tex
- Impurities content: below 2%

Specification of fibres for knitting yarns

The pure, good quality long flax fibre could be processed into knitting yarns on linen spinning systems. The knitted yarns have limited applications, mainly for decorative fabrics, bed cloths and technical uses and in some cases for apparel uses. The later application requires special modification of the fibre with the application of mechanical, chemical and enzymatic finishing treatments. In the mechanical method several treatments are involved: repeated processes of cleaning, loosening, and carding of flax fibres. Modified flax or hemp fibres could then be processed on woollen or cotton-spinning systems, mainly to obtain blended yarn for the production of high-quality textile goods.

4. PRODUCTION OF NON-WOVENS

The application of flax fibres to produce non–wovens is connected with the adaptation to non–linen spinning systems, namely with the need of the following operations: cleaning, dividing and shortening of the fibres. The application of the appropriate blends of fibres would enable their processing as non–wovens with the use of traditional non–woven machinery lines.

The production of non-wovens exclusively of short flax fibres requires the application of specially-modified linen carding machines. It is possible to utilise green decorticated, even uncleaned fibre or the short fibre wastes for the production of geo–textiles e.g. for grass matting and non–wovens applied in the building and furniture industries, as well as for insulation purposes.

Fleece-making generally involves carding and cross-lapping operations which are sensitive to changes in fibre length and fineness. Air-laid non-wovens are generally for geotextiles and horticultural mats and these processes can stand much wider variation and even some contamination ,without affecting adversely the function of the final product (although the processor may not agree!).

An example of a non-woven specification is shown below:

EXAMPLE - FLAX FIBRE SPECIFICATION
AUTO-PANEL NON-WOVEN USE
(names removed for commercial confidentiality)

Raw Materials: Flax fibre noils PP fibres, curled, 100% *Fibre thickness:* *Fibre length:* *Melting point:* Ratio of mixture: *Flax:PP:* *Share of binding agent PP:* *Share of fibres (flax):*	 2.2 – 6.7 dTEX 40–60 mm 160°C 50:50% weight 50–58% weight 50–42% weight
Dry Weight:	MODEL 'X' - 2000g/m^2 +/- 10% MODEL 'Y' - 1800g/m^2 +/- 10%
Thickness:	20 mm +/- 5mm Plate diameter 35mm, loading 24.8g
Colour:	Fair to light grey

Odour:	Neutral, smell slightly of hay
Moisture:	≤ 13% mcwb
Elongation:	90mm +/- 10% as measured with standard tensile equipment
Width of rolls:	As specified, without permissible minimum dimension, +/- 5mm
Diameter of rolls:	+/- 10% according to order
Length of rolls:	+/- 5% according to order 10% of the rolls may have a reduced length, but at least 30 running metres
Wound core:	Inside diameter 75mm

General Indications:

- Products must have a homogenous structure, without accumulations of flax or PP fibres. The share of dust, wood parts and shives combined must be less than 5.5% by weight.
- Each delivery should include a test report according to DIN 500 49 – 3.1 B with the following indications:
  - Name of item/data processing number
  - Batch number/number of consignment
  - Date of production
  - Length of roll
  - Width of roll
  - Dry weight
  - Elongation
  - Moisture
- Each roll should be labelled with the following data:
  - Name of item/data processing number
  - Batch number/number of consignment
  - Date of production
  - Length of roll
  - Width of roll
  - Surface weight (nominal weight)

Definition:	
Dry weight:	Weight of the non-woven product after deduction of the extra weight caused by humidity.
Surface weight:	Weight in grams (g) per surface unit (m^2), dry.
Test Instructions:	
Surface weight:	Cut off 50cm for test purposes at the beginning of the roll. Take off 5 samples of 100cm^2 for weighing. Calculate weight on the basis of dry weight.
Moisture:	Moisture contents can be measured by means of a probe, e.g. type IIM 1 020353 of Messrs. Aquaboy. If measurement is beyond tolerances the moisture test should be carried out in a circulating hot-air cabinet (24 hours, + 105°C).
Elongation:	Test samples 500 x 500mm. Runaways are not allowed. The measuring instrument is to be calibrated every six months.

5. SPECIFICATION FOR THE PRODUCTION OF COMPOSITES

The detailed requirements regarding the features of fibres for composite production are not fully agreed yet. The quality requirements focus mainly on very low impurity content, which should be below 0.2%. Fibres from 1mm up to more than 10cm in length can be used depending on the preparation and resin-impregnation system used. In some cases the special forming of fibres is required, such as in the pultrusion technique.

6. SPECIFICATION FOR THE PRODUCTION OF PAPER

THERE MUST BE NO PLASTIC CONTAMINATION - particularly polypropylene twine - important for fibre baling - which usually uses sisal twine or wire, as dictated by the mill. Fibre length and fineness are less important than shive content. The degree of retting and shive content should be the same throughout the batch of bales presented of sale. Prices paid by the mills for the fibre are low - generally 100-200 Euro/t delivered mill so the transport distance to the nearest mill is important.