



# FROM GROWING KENAF TO ITS INDUSTRIAL USE

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EU Project – Crops2Industry



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## What's Kenaf?

Kenaf (*Hibiscus cannabinus* L.) is a short day annual crop native to southern Asia. It is grown mainly for bast fibre in China (44%), India (39%), Indonesia, Malaysia, Bangladesh, USA, South Africa, Vietnam, Thailand and parts of Africa.



Next to cotton, it is probably the most cultivated plant for fibre worldwide.

## Morphology



- Stem: round, 1-2 cm diameter, generally single unbranched, 2-4 m tall;
- Leaves: lobed or unlobed depending on variety and position
- Flowers: monoecious;
- Fruit: capsule 2 cm diameter containing several seeds that take 45 days for ripening;
- Root: tap root system;
- Fibre: two kinds, the long fibres are mainly in the thin bark (cortical layer), whereas the short fibres are in the ligneous core, namely pith (short fibre)

bark

pith



## Growth & environmental conditions

Parameter	Average range
Base T – emergence (°C)	9 -10
Base T - growth (°C)	12 -14
Optimum T (°C)	20 - 27
Cycle length (d)	75 -105 (short-cycle); 105 – 120 (mid cycle); 120 - 140 (long cycle)
Photoperiod	Flowering occurs when day-length is < 12.5 h
Transpiration efficiency (L Kg <sup>-1</sup> )	400 – 600
RUE (g MJ <sup>-1</sup> )	2.4
Needed rainfall (mm)	500 – 600 (in 5 months)
Soil	Drained sandy-loam soil

## Agronomy

SOIL TILLAGE & SOWING	
Seedbed preparation	Fine and firm seedbed. Improperly prepared bed and dry soils during the early stages generally cause irregular growth and not uniform stems
Variety choice	240 potentially available varieties but only 10 are commercially grown
Seed (kg ha <sup>-1</sup> )	30 – 40
Seed cost (euro kg <sup>-1</sup> )	4 – 5
Sowing depth (cm)	1 – 4
Sowing time	Late April - early May (15 °C soil)
Plant population (plants m <sup>-2</sup> )	60 – 80*
Dist. between the row (cm)	25 – 35
Dist. within the row (cm)	2 – 5
Time of emergence (days)	4 – 5

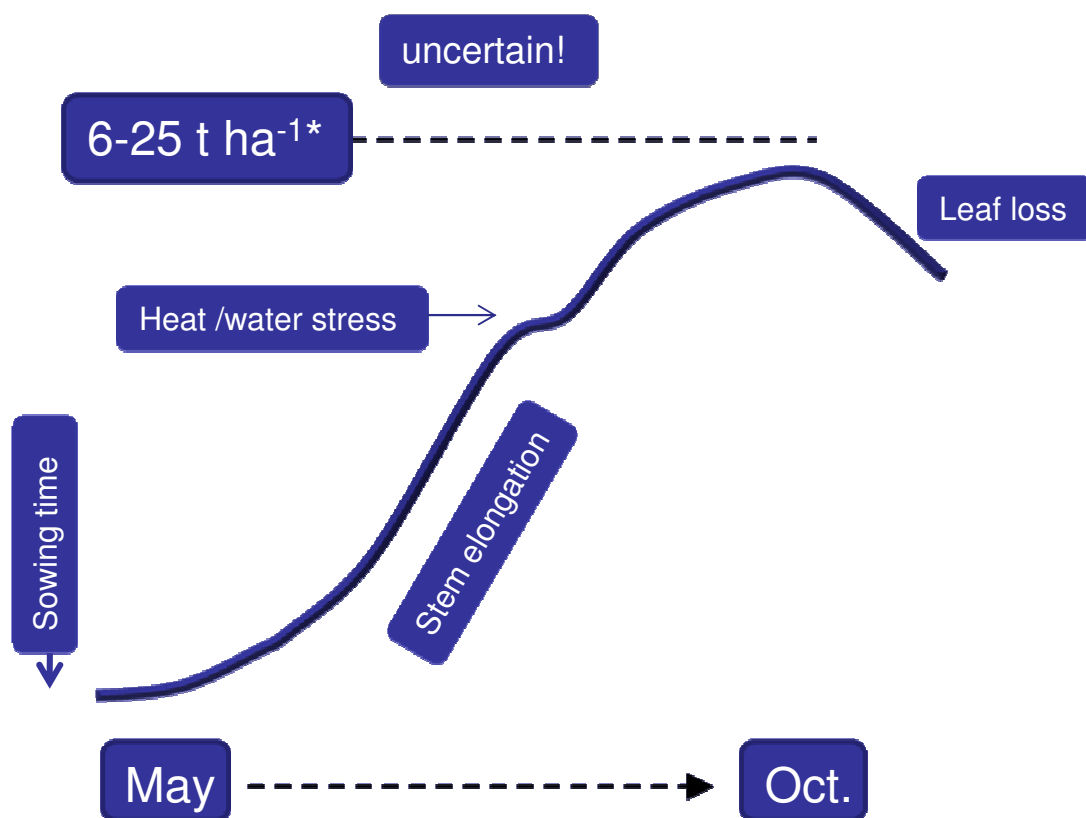
\* Low plant population causes branching and thus decrease the fibre quality (Fahmy et al., 1985)

## Agronomy

PARAMETER	
N uptake (Kg (N) t <sup>-1</sup> DM)*	2 – 3
P uptake (Kg (P <sub>2</sub> O <sub>5</sub> ) t <sup>-1</sup> DM)	1 – 2
K uptake (Kg (K <sub>2</sub> O) t <sup>-1</sup> DM)	3 – 4
Ca uptake (Kg (CaO) t <sup>-1</sup> DM)	4 – 5
Irrigation (m <sup>3</sup> ha <sup>-1</sup> )*	0 – 3000. Necessary under durable drought periods and T > 30 °C
Weed control	Very important in the first 5 weeks. Post-emergence herbicides or hoeing can fight quite easily the weeds
Pests & disease	Root knot nematodes, anthracnose, <i>Rhizoctonia solany</i> , <i>Botrytis spp.</i> and <i>aphids</i> are common attacks to kenaf.

•Overall, 70-80 kg ha<sup>-1</sup> of N fit the crop demand. Higher doses can be significant when organic matter is <1%. Irrigation, conversely, hugely increase the biomass productivity, especially under Mediterranean conditions.

## Growth and Productivity



Parameters	Range
Fresh Biomass ( $t\ ha^{-1}$ )	20 – 50
Dry Biomass ( $t\ ha^{-1}$ )	6 – 25
Fresh Stems ( $t\ ha^{-1}$ )	10 – 40
Dry Stems ( $t\ ha^{-1}$ )	5 – 22
Dry Fibre ( $t\ ha^{-1}$ )	1 – 2.5
Moisture content (%)	70 – 80
Plant Height (cm)	100 – 400
Base Stem Diameter (mm)	10 – 20

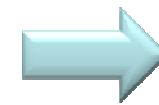
\* BioKenaf Project

1st Workshop  
Poznań, 18 Nov. 2009

# Harvesting

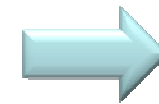
Two methodologies:

1. Cutting – chipping and transport



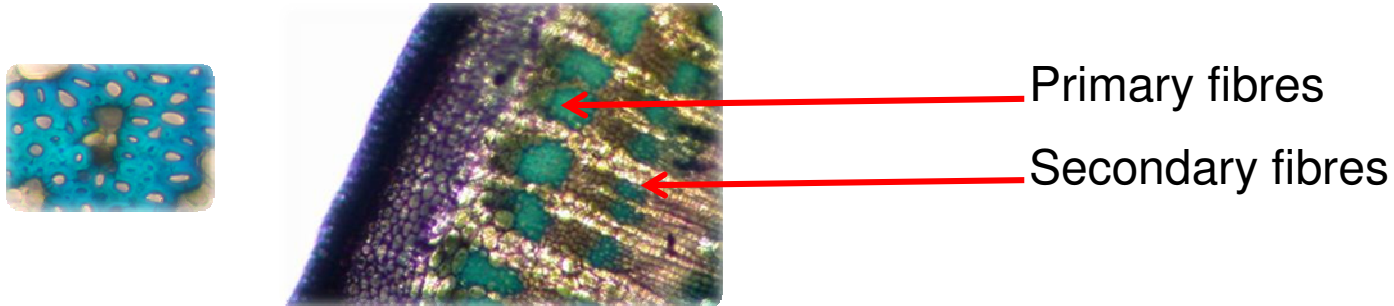
Economic but lower quality

2. Cutting – drying - baling and transport



higher costs but higher quality

## Fibre quality for paper and biofuel industries



Stem component	Kenaf	Hemp	Poplar
Bark (%)	30-38	30 - 35	10 - 20
Core (%)	70-62	65 - 70	80 - 90
Bast fibre (t/ha)	1 - 2.5	1 - 2.5	
Fibre fineness (mm)	20 - 35	20 - 30	25 - 35
Fibre length (mm)	8 - 18	16 - 40	1 - 3

\* Bast fibres = coarser fibres in the outer layer, whereas core part contains finer fibres.

Crop	cellulose (%)			emicellulose + pectin (%)			lignin (%)		
	stem	bark	core	stem	bark	core	stem	bark	core
kenaf	50 - 55	55 - 65	50 - 55	22 - 33	12 - 18	20 - 25	8 - 19	3 - 4	8 - 12
hemp	60 - 70	60 - 70	50 - 60	5 - 15	7 - 12	15 - 20	3 - 14	1 - 2	7 - 10
poplar	45 - 50	25 - 30	50 - 55	30 - 35	10 - 12	14 - 16	18 - 20	18 - 20	18 - 20

## Possible applications

- Rope, twine, ...cordage;
- Engineered wood;
- Bags and fabrics, hamburger wrappers, fast food containers, wallpaper;
- Sails;
- Coarse cloth (similar to that made from jute);
- Energy (both electricity/heat and II generation biofuels);
- Animal bedding, poultry and cat litter;
- Feeds for its high protein and good digestibility (even 3 cuts/year);
- Insulated panels;
- Oil and liquid absorbent materials;
- Materials for blending with resins for bioplastic composites;
- Black liquor, a by-product of making paper from kenaf, is burned for fuel or chemical recovery in USA.
- Seed oil (20% of seed DM) is edible and high in omega polyunsaturated fatty acids, well known compounds for reducing cholesterol and heart diseases.
- Substrate for mushroom production,
- **and several others ...**





## Some remarks

- In Europe kenaf could likely be an option for fibre production in Mediterranean zones. Hence, not for North due to low cold tolerance;
- Selecting new genotypes cold and drought resistant is imperative to promote kenaf in Europe;
- Kenaf is an annual crop very suitable to common farm machineries. As such, it's easy to put in rotation;
- Fibre quality is relevant with good air permeability, capability of giving up moisture; no release of substances harmful to health; biodegradability; no allergic effects;
- Environmental sustainability of kenaf is apparently good if compared to other conventional annual crops such as maize and sugar beet (e.g. kenaf needs lower fertilizers);
- Over 20 years, kenaf can produce approximately 10 - 30 times the amount of fibre of a pine forest (USDA Report on Kenaf No.0800, Fried, 1999);
- Seed production in Europe is practically inexistent. Mediterranean regions seem more appropriate to produce it.



## Kenaf or Hemp in EU?

### Hemp advantages:

- Higher productivity, especially under low input practices;
- Higher fibre quality;
- It is more familiar to farmers;
- Wide growing area, from Finland to Sicily;
- Well known genotypes in term of productivity - environment relationships;
- Seed production is in Europe;
- Less spongy core and then shorter drying period in the field;

### Kenaf advantages:

???

- norm and regulation... It is not known as a drug plant.
- dew retting in a standing crop (post winter rainfall) seems to perform better in kenaf than in hemp (KEFI, personal communication).



**Thank you for the attention!**



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