Kenaf:
a non food multi-purpose crop for Southern Europe

E. Alexopoulou and M. Christou
CRES
Kenaf
Hibiscus cannabinus L. (Malvaceae)

- Kenaf is a short-day annual herbaceous crop cultivated mainly for its fibrous stem.
- It has been cultivated long, as early as 4000 BC in western Africa.
- Its area of cultivation is estimated to about 200,000 ha (FAO) and the main producers are Thailand, China, India and Mexico.
- Recent research has demonstrated numerous potential uses for each of the two stem materials (bark or core), which often must been separated.
Reasons for considering kenaf as a high productivity multi-purpose non-food crop for Europe:

- It can provide raw material for both industrial and energy applications.
- The high biomass potential (up to 26 t/ha) and the low inputs of the crop.
- It offers alternative land use and can be used in a crop rotation.
- It is an annual non-food crop with quite similar cultivation and harvest to other conventional field crops.
- It has high farmers perception as an annual crop.
Uses of the crop

• **Core uses** (paper pulp, oil/chemical absorbents, insulation panels, horticultural mixes, bedding materials for animals, etc.). Apart from the industrial uses the core material can be used for thermochemical process (combustion, gasification and pyrolysis).

• **Bark uses** (paper pulp production)

• The **whole plant** has high protein and good digestibility and may be pelletized).
State-of-the-art of the crop in Europe

• The sustainable yielding potential of the crop as well as the limitations that certain cultivation techniques (irrigation, fertilization, sowing date and planting density) place of the crop growth have not been defined.

• In the framework of the two previous EU projects the using for kenaf and pulp have been tested by several industries. Hardly any publication has been published to report the results and the exploitation plans of these projects.
Kenaf yields in southern EU

✓ In southern Europe it has been reported production of **20 t/ha dry stem** (Mambelli and Grandi, 1995; Manzanares *et al*., 1993).

✓ In other research works it has been reported up to **26 t/ha dry matter yields** (Alexopoulou *et al*. 1999; Alexopoulou *et al*. 2000a, 2000b, Petrini *et al*. 1994 and Quaranta *et al*. 1998).

✓ It should be mentioned that a lot of research work on kenaf have been carried out in Italy the last decade but most of the publications are in Italian.
Biokenaf project
QLK5 CT2001 01729

• The overall objective of the project is to introduce and evaluate kenaf as a non-food crop through an integrated approach for alternative land use in South EU that will provide diversified opportunities for farmers for biological materials for the “bio-based industries” of the future.
Specific objectives

* Determination of the sustainable yielding potential of kenaf
* Development of a dynamic growth simulation model
* Evaluation of the effect of harvesting time and storage methods to the quantity and quality of harvested material.
* Evaluation of the suitability of kenaf for both selected industrial and thermochemical energy applications
* Environmental assessment and LCA to make scenarios for alternative land use in South EU
* Economic evaluation of kenaf for alternative land use
* Preparation of a handbook and booklet for kenaf
* Link establishment between Biokenaf and AKS
## Consortium

<table>
<thead>
<tr>
<th>Partners</th>
<th>Country</th>
<th>Main involvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRES</td>
<td>Greece</td>
<td>WP1, WP2, WP4, WP8</td>
</tr>
<tr>
<td>University of Catania</td>
<td>Italy</td>
<td>WP2</td>
</tr>
<tr>
<td>University of Thessaly</td>
<td>Greece</td>
<td>WP2, WP3</td>
</tr>
<tr>
<td>BTG</td>
<td>The Netherlands</td>
<td>WP5</td>
</tr>
<tr>
<td>CETA</td>
<td>Italy</td>
<td>WP2, WP4</td>
</tr>
<tr>
<td>INIA</td>
<td>Spain</td>
<td>WP2</td>
</tr>
<tr>
<td>FCT/UNL</td>
<td>Portugal</td>
<td>WP2</td>
</tr>
<tr>
<td>ATO</td>
<td>The Netherlands</td>
<td>WP6</td>
</tr>
<tr>
<td>UNIBO</td>
<td>Italy</td>
<td>WP2</td>
</tr>
<tr>
<td>INRA</td>
<td>France</td>
<td>WP2, WP6</td>
</tr>
<tr>
<td>ADAS</td>
<td>UK</td>
<td>WP7</td>
</tr>
</tbody>
</table>
Geographical presentation of the projects' components

- **UK**
  - ADAS (Partner 12)
  - Economic analysis for the crop production chain

- **Portugal**
  - UniNOVA (Partner 7)
  - Kenaf Field Trials (WP2)
  - Environmental impact assessment and LCA (WP6)

- **Spain**
  - CIT-INIA (Partner 6)
  - Kenaf Field Trials (WP2)

- **France**
  - INRA (Partner 11)
  - Kenaf Field Trials (WP2)
  - Environmental impact assessment and LCA (WP6)
  - Growth Model (WP3)

- **The Netherlands**
  - ATO.DLO (Partner 9)
  - Utilization of kenaf for Industrial Products (WP5)
  - BTG (Partner 4)
  - Utilization of kenaf for Energy (WP5)

- **Italy**
  - UNI, CT (Partner 2)
  - Kenaf Field Trials (WP2)
  - UNIBO (Partner 10)
  - Kenaf fields with size 2 ha (WP2)
  - CETA (Partner 5)
  - Kenaf Field Trials (WP2)
  - Harvesting and Storage Trials (WP4)

- **Greece**
  - CRES (Coordinator)
  - Kenaf Field Trials (WP2)
  - Harvesting and Storage Trials (WP4)
  - Thermochemical energy applications (WP4)
  - Handbook and Booklet (WP5)
  - UTH (Partner 3)
  - Kenaf Field Trials (WP2)
  - Growth Simulation Model (WP3)
# Details of the experimental trials

<table>
<thead>
<tr>
<th>Experimental field trials</th>
<th>Countries</th>
<th>Factors under study</th>
<th>Experimental design</th>
<th>Plot size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screening trial</td>
<td>Greece</td>
<td>Six kenaf varieties</td>
<td>Randomized complete block design in three blocks</td>
<td>6x6 m²</td>
</tr>
<tr>
<td>Sowing times and plant populations</td>
<td>Greece, Italy, Spain, Portugal and France</td>
<td>2 varieties 2 sowing times 2 plant populations</td>
<td>A factorial in three blocks</td>
<td>6x8 m²</td>
</tr>
<tr>
<td>Irrigation and nitrogen fertilization effects</td>
<td>Greece, Italy, Spain, Portugal and France</td>
<td>4 irrigation rates 3 nitrogen fertilisation rates</td>
<td>A split-split split plot design in three blocks</td>
<td>6x8 m²</td>
</tr>
<tr>
<td>2 ha kenaf field trial</td>
<td>Greece, Italy</td>
<td>The best-performed variety will be sown under the best plant population and will be irrigated and fertilized according to the results from the previous trials</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Varieties

**Everglades 41** (late variety that produce reasonable fiber production and a cotton-like leaf shape)

**Tainung 2** (late variety, with superior raw fiber production and palmate leaf shape)

**Gregg** (is a new variety with slightly longer growing period that may contributes to greater fiber production and palmate leaf shape)

**Dowling** (new variety, that may prove to be a very high fiber producer with non-palmate leaf shape)

**SF 459** (new variety that is favored for soils with nematode problem and palmate leaf shape)

**G4** (it is considered as a photoperiod-insensitive variety that combines a short maturity cycle (100-130 days between emergence and flowering) and high productivity when grown in the Mediterranean region)
Expected results

Adaptability and Productivity Trials (WP2)
- Evaluation of the adaptability and productivity of several kenaf varieties in South Europe.
- Selection of the appropriate kenaf varieties in the pedoclimatic conditions of Southern EU.
- Determination of the appropriate combination of irrigation and fertilization inputs that will result in the maximum biomass yields and under minimum production cost.

Development of the crop growth model (WP3)
- Energy balance of the crop under different cultivation and harvesting and storage methods, which can lead to management improvement of the crop.
- The dynamic growth and biomass production model that will be a useful tool for yields and energy production prediction of kenaf.
Harvesting and Storage Trials (WP4)
✓ Determination of the appropriate harvesting time to ensure higher yields.
✓ Information on the application of various harvesting machines commonly used in the agricultural practice.
✓ Information on the application of various storage to ensure minimum losses in quantity and quality of feedstock.

Utilization of kenaf (WP5)
✓ Establishment of a market-driven demand for kenaf as alternative source for energy production.
✓ Increased demand for annual fibre based renewable and sustainable products.
✓ Increased European market potential for kenaf based industrial products.
Environmental impact assessment and LCA (WP6)

✓ Environmental impact assessment covering the whole production chain of kenaf.
✓ LCA considering the potential of kenaf as a biofuel for thermochemical conversion processes (combustion, gasification, pyrolysis).
✓ Scenarios for alternative land use in agriculture regions of south EU.

Economic analysis for the crop production chain (WP7)

✓ Cost of kenaf at farm and at plant gate (including harvesting, storage and transportation).
✓ Economic comparison of kenaf with other annual conventional crops.
Preparation of Handbook and Booklet for kenaf (WP8)

☑ Evaluation of the collected data of the project as well as of all the relevant bibliography that will be recorded in the Handbook and the Booklet.

☑ Handbook can be used as a pilot for the future development of the crop