Kenaf breeding and techniques in China

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Outline

- Introduction of kenaf
- Brief history of kenaf in China
- Progress of Hybrid Kenaf Breeding
- Characteristic in Tropics (MY)
- Multiple applications of Kenaf & potential markets
- Conclusion

From IBFC kenaf team, 2008
Introduction of kenaf

* Kenaf, Malvaceae, *Hibiscus cannabinus* L, an annual fiber crop, wide adaptability, photosensitive to shortday, 2n=36

* Hybrid kenaf, a high heterosis, Fast growing

* Leaves, a high-protein animal food
  The bark, long bast fibers
  The core, short woody fibers.

* The kenaf stem, an ideal blend of long and short fibers for paper and paperboard products

In winter of Sanya

From IBFC kenaf team, 2007
Brief history of Kenaf in China

History, Area, Production

* History: started in 1908
* About 100,000 ha in the early 1950’s.
* From 1970's to 1990, area fluctuated around 400,000 ha, peak, > 900,000 ha in 1985
* Since 1990, affected by cheaper synthetical fibers

Fortunately, larger in recent years for kenaf multi-uses.
The changes of fiber yield:

1.5T/ha

2.5--3.0T/ha

4.5—5.2T/ha
Major agro-ecological kenaf growing regions in China

* (1) The South China Kenaf Belt

* (2) The Yangtze River Kenaf Belt

* (3) The Yellow and Huaihe River Kenaf Belt

* (4) The North China Kenaf Belt (Northwest and Northeast)

From IBFC, 2003
Over 30 kenaf varieties and hybrids were bred and approved in recent 30 years in China
Procedure of breeding

1. Original material garden
2. Seed selection
3. Variety comparative test
4. Regional trial
5. Production testing
6. New variety approval and extension
crossbreeding

- sexual crossbreeding
  - inbreeding cross
  - distant hybridization
pattern of sexual cross

* 单交（single cross）
* 回交(back cross)
* 多亲杂交(multiple cross)
Single cross

A × B → F₁

B × A → F₁

reciprocal cross
回交 back cross

A × B

F₁ × B

F₁ × B
多亲杂交multiple cross

A × B

F₁ × C

添加杂交
多亲杂交

\[(A \times B) \times (C \times D)\]

\[F_1\]
Principle of parent match

1. Complementary principle of parent character
   - Complementary of different character
   - Complementary of different unit character

2. Using genetic relationship distant parents matching

3. Female parent with more merit character
Selection of crossing offspring

- pedigree method
- mixing individual plant selection method
- bulk selection method
The hybrid kenaf research started in 1978 in China.

A commercial herbicide, “Dalapon”, as a selective spermicide for hybrid seed production.

Led to the development of a commercial scale hybrid seed production in 1980’s.

From IBFC kenaf team, 1996
The discovery of kenaf male sterility in China


A series of improved kenaf male sterile lines (Cytoplasmic male sterility, CMS) and maintainer line and restorer were used for breeding hybrid kenaf

From IBFC kenaf team, 2006
The comparison between kenaf male sterility line and maintainer line (A、C、E maintainer line flower; B、D、F male sterility flower)
The comparison on pollens between kenaf male sterility line and maintainer line. (A,B: male sterility line; C,D: maintainer line)
Pollen cytological observation shows that the mutant was cytoplasmic-nuclear male sterile line (right: male sterility line; left: maintainer line)
Photoins. Kenaf male sterile
Characteristic in Tropics (MY)

* Near equator
* Stable and suitable temperature
* Similar short day length (12 hours)
* Enough rainfall
* Many insects
Kenaf in the first month grow slowly
Then grow fast
But after flowering, growing speeds decreased greatly
Varieties: photoinsensitive (flower later, 3-4 months), but most varieties sensitive to shortdaylight

Fast growing, good resistance to disease and insects, salt, high bark percentage, high plants

Natural condition: Suitable soil, water (irrigation), fertilizer, rotation, cultivation
Main Factors on Fiber yield

* Biomass yield
  final available plants, plant height, stem diameter, growth period…….

* Fiber Percentage (Fiber rate to Fresh stem, to dry stem, bast )
  Fiber rate to Fresh stem from low 4.5% to high 6—7%
Reaching Aim of 22—25 Ton dry stem/ha.

Require:

* Under the suitable condition of cultivation (soil, fertilizer, water, control insects & disease)
* Improved Ins. kenaf varieties & hybrids
* 5—6 months growing period, plant height 4--6m, final available effective plants 120,000—150,000pl/ha,
* Good resistance & suitability to disease&envir.
Super hybrid kenaf

* Two high yield crosses, 1980's: H005
   1990's: H116
* Super hybrid kenaf, 2005: H305

2007: H316 and H318,
2011: H368, H328 (Photoinsensitive)

over 20% higher than CK in yield
**Fibre yields of kenaf lines & hybrids in national regional trial**  
*(2004—2006, retted dry fiber, kg/ha)*

<table>
<thead>
<tr>
<th>Place</th>
<th>H318</th>
<th>H316</th>
<th>LC 0301</th>
<th>Fuhong 992</th>
<th>Fuhong g9913</th>
<th>ZH-01</th>
<th>K03-2</th>
<th>CK (KB2)</th>
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<tbody>
<tr>
<td>PuTian FJ</td>
<td>5114.10</td>
<td>5015.83</td>
<td>4473.33</td>
<td>5226.67</td>
<td>5075.83</td>
<td>3425.83</td>
<td>5120.00</td>
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<td>Nanning GX</td>
<td>3874.20</td>
<td>3401.67</td>
<td>3476.67</td>
<td>3045.83</td>
<td>2792.50</td>
<td>1963.33</td>
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<td>YingTan JX</td>
<td>5242.50</td>
<td>5030.81</td>
<td>5316.67</td>
<td>4874.17</td>
<td>4741.67</td>
<td>4342.50</td>
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<td>Changsha HN</td>
<td>5050.05</td>
<td>4805.50</td>
<td>4928.33</td>
<td>4287.50</td>
<td>4200.83</td>
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<td>4184.17</td>
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<td>XiaoSha JZ</td>
<td>3447.45</td>
<td>3395.83</td>
<td>3445.00</td>
<td>3250.00</td>
<td>3285.83</td>
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<td>3146.67</td>
<td>3016.67</td>
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<td>LiuAn AH</td>
<td>3830.85</td>
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<td>3198.33</td>
<td>2998.33</td>
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<td>3064.17</td>
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<td>XinYang Henan</td>
<td>4322.55</td>
<td>3978.33</td>
<td>4150.83</td>
<td>3705.83</td>
<td>3599.17</td>
<td>3165.83</td>
<td>3582.00</td>
<td>3620.00</td>
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<tr>
<td>Average</td>
<td>4411.65</td>
<td>4171.31</td>
<td>4251.31</td>
<td>3968.21</td>
<td>3867.38</td>
<td>3262.74</td>
<td>3939.88</td>
<td>3653.33</td>
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<td>Over CK(%)</td>
<td>20.75**</td>
<td>14.18**</td>
<td>16.37**</td>
<td>8.62</td>
<td>5.86</td>
<td>-10.69</td>
<td>7.84</td>
<td>0</td>
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Production of kenaf seeds
quality standard of good seeds

净度 Clarity

纯度 purity

饱满度 Plumness

水份 Moisture
Modern Agriculture on hybrid kenaf
Sown by large machinery in Xinjiang (Northwest of China)
The raw bast were separated from fresh stem with small machinery in field.
Bast fibre bioretting and processing
Super hybrid kenaf yield record:
7500kg fiber/ha (30 ton dry stalk /ha)
in Honghu county of Hubei province, 2009

From IBFC kenaf team, 2009
Photoinsensitive Super Kenaf H328,
Near 7m,  9, November 2012
Photoinsensitive Super kenaf, over 6 m, 9 November 2012, China.

Suitable planting in Malaysia
Multiple applications of Kenaf and potential markets

* Automotive industry
* Green Building
* Furniture
* Forage—leaves (22% protein) and top young stem as cattle and sheep etc. foods
* **Paper** – substitute of wood for pulp
  largest potential market

(World--415 million tons paper, in 2011.
  China--100 m tons , at the rate 4.6% each y ↑, Imported 40 million tons pulp etc.,)
35 million ha saline and alkaline land
Multi-uses of kenaf

From IBFC kenaf team
Conclusions

- Hybrid kenaf, high heterosis, wide adaptability
- Photoinsensitive super hybrid kenaf suitable to zone near equator (including Malaysia)
- Fast growing, leaves as a high-protein animal food
- Friendly to environment, its multi-use products biodegradable
- A best non-wood fiber crop -- substitute of wood for pulp

For protecting the forest and earth, and meeting the increasing demand for pulp and paper, kenaf has a huge potential market in pulp and bio-composite in future years

To save trees, turn kenaf to better paper…
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