WP6
Environmental Impact Assessment
and
Life Cycle Analysis of kenaf production and use

Partners

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INRA, France (11)

Start month: 12th – 1st March 2004

End month: 39th – 31st May 2006

Ecological criteria to be considered

- Net avoided use of fossil energy
- Net avoided emission of greenhouse gases
- Net emission of acidifying gases
- Emission of ozone depleting gases
- Emission of nitrogen and other nutrients/minerals to soil and water
- Emission of pesticides
- Erosion
- Groundwater depletion
- Use of resources
- Waste production and utilisation

Net avoided use of fossil energy

Net Energy Gain = **Energy Output** - **Energy Input**

Energy Output

- **Productivity x Heat of Combustion**
  - **When Kenaf is used for energy purposes**
- **Energy needed to produce a substitute of a possible Kenaf product**
  - **When Kenaf is used for other purposes**

Energy Input

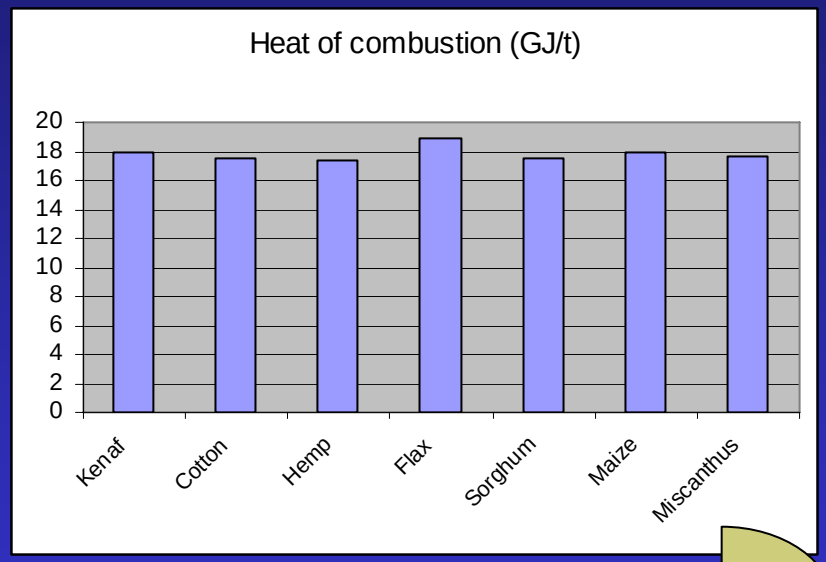
- **Production of Seeds**
  Fertilisers
  Pesticides
- **Machinery**

Energy production

Energy output

Heat of Combustion

Kenaf	17.3 – 18.6 GJ.t^{-1}
Cotton	15.8 – 19.1 GJ.t^{-1}
Hemp	16.8 – 17.9 GJ.t^{-1}
Flax	18.2 – 19.5 GJ.t^{-1}
Sorghum	16.9 – 18.0 GJ.t^{-1}
Maize	17.3 – 18.5 GJ.t^{-1}
Miscanthus	16.4 – 18.9 GJ.t^{-1}



No significative differences

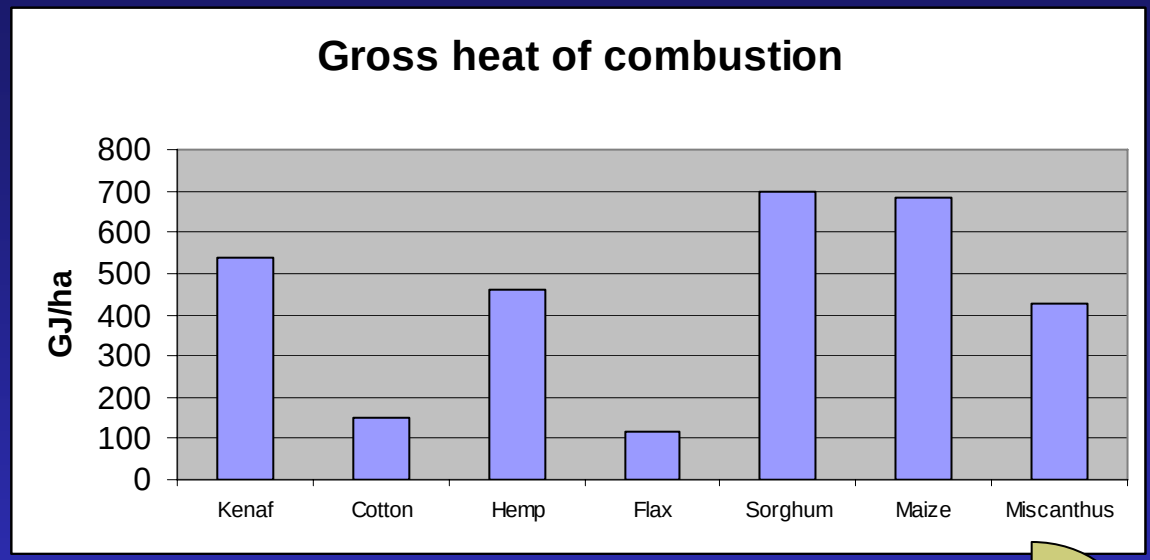
20 t:

Kenaf	**- 7800 l gasoline; 8600 l diesel oil; 12.6 t coal**
Cotton	**- 7600 l gasoline; 8300 l diesel oil; 12.3 t coal**
Hemp	**- 7600 l gasoline; 8300 l diesel oil; 12.2 t coal**
Flax	**- 8200 l gasoline; 9000 l diesel oil; 13.3 t coal**
Sorghum	**- 7600 l gasoline; 8300 l diesel oil; 12.3 t coal**
Maize	**- 7800 l gasoline; 8500 l diesel oil; 12.6 t coal**
Miscanthus	**- 7700 l gasoline; 8400 l diesel oil; 12.4 t coal**

Flax > Kenaf = Maize > Miscanthus > Cotton = Hemp = Sorghum

Productivity in Southern Europe

Kenaf	- 30.0 t.ha^{-1}
Cotton	- 8.7 t.ha^{-1}
Hemp	- 26.4 t.ha^{-1}
Flax	- 6.2 t.ha^{-1}
Sorghum	- 40.0 t.ha^{-1}
Maize	- 38.2 t.ha^{-1}
Miscanthus	- 24.0 t.ha^{-1}



Per region there are differences in crop yields, which lead to differences in energy output, but we do not assume differences in conversion efficiences

Sorghum > Maize > Kenaf > Hemp > Miscanthus > Cotton > Flax

Energy Inputs

Production phase:

- production of seed and plant-cuttings
- production of chemical fertilizer
- production of pesticides
- production and use of machinery in crop cultivation
- chipping of biomass
- drying and storage of biomass at the farm

Pre-conversion phase

- transport of biomass
- drying and storage of biomass at the plant

Conversion phase

- process energy needed for conversion

	- production of seed and plant-cuttings	- machine use
Kenaf	- 0.5 GJ.ha^{-1}	8.7 GJ.ha^{-1}
Cotton	- 0.5 GJ.ha^{-1}	8.7 GJ.ha^{-1}
Hemp	- 1.6 GJ.ha^{-1}	8.7 GJ.ha^{-1}
Flax	- 1.4 GJ.ha^{-1}	8.7 GJ.ha^{-1}
Sorghum	- 1.0 GJ.ha^{-1}	8.7 GJ.ha^{-1}
Maize	- 0.1 GJ.ha^{-1}	8.7 GJ.ha^{-1}
Miscanthus	- 1.6 GJ.ha^{-1}	8.8 GJ.ha^{-1}

production of chemical fertilizer and pesticides

Kenaf - 3.6 GJ.ha^{-1}

Cotton - 3.2 GJ.ha^{-1}

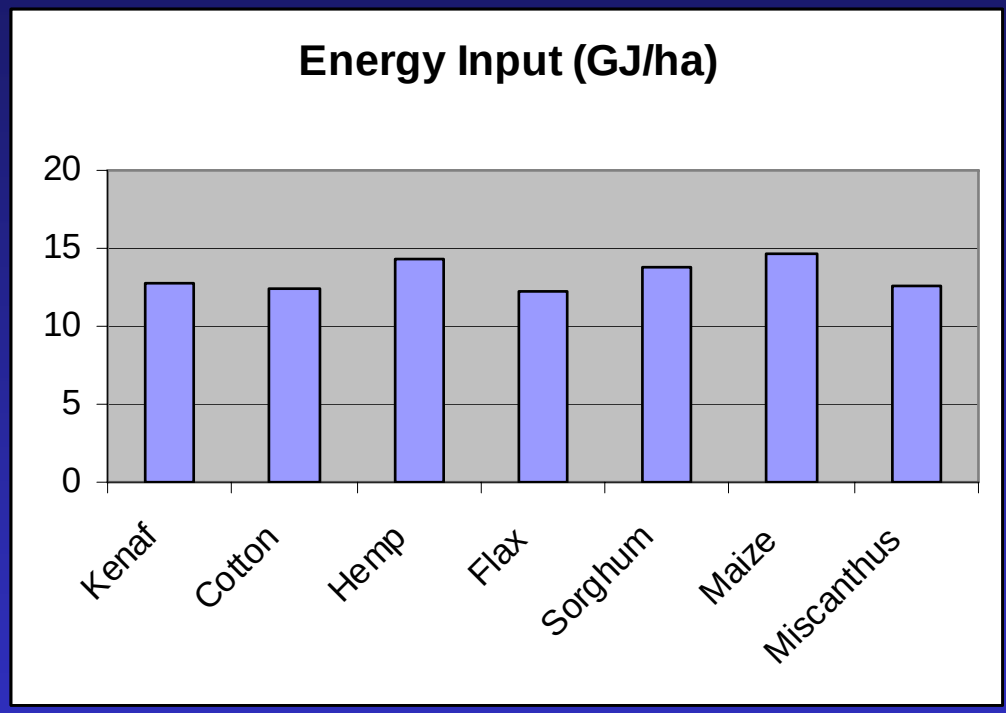
Hemp - 4.1 GJ.ha^{-1}

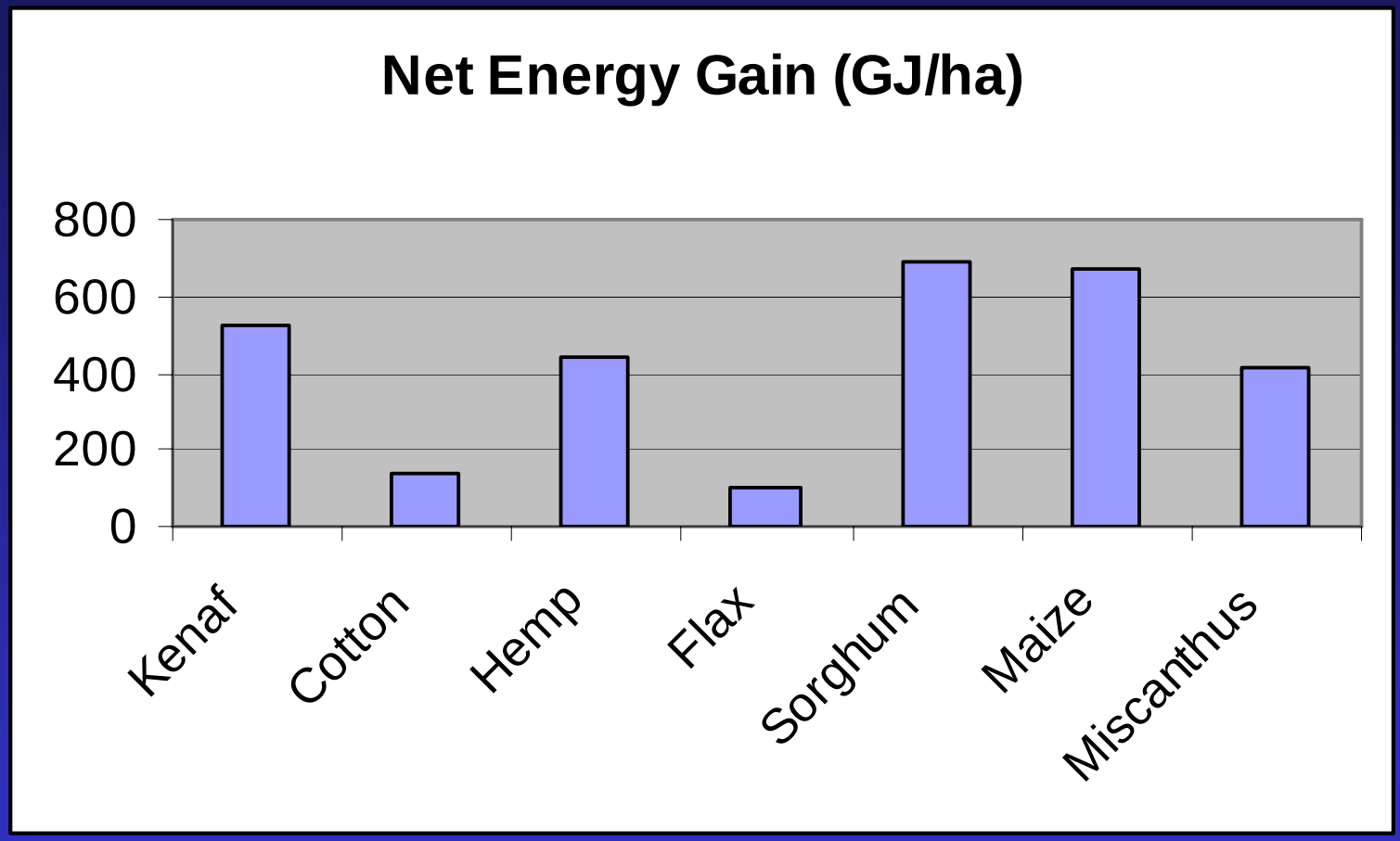
Flax - 2.2 GJ.ha^{-1}

Sorghum - 4.1 GJ.ha^{-1}

Maize - 5.9 GJ.ha^{-1}

Miscanthus - 2.1 GJ.ha^{-1}





Sorghum > Maize > Kenaf > Hemp > Miscanthus > Cotton > Flax

Assuming only the production phase energy inputs, the net energy gain presents the same pattern as the total energy output, because the total energy input, in the production phase, is equivalent to < 5% of the total.