Some Aspects of the Environmental Impact Assessment and Life Cycle Analysis of Kenaf production and use

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⇨ *To what extend is cultivation and use of a certain energy crop in a certain European region sustainable?*

Environmental Impact Assessment:

Evaluation method to explore the possible environmental effects of a proposed project

Life Cycle Assessment:

Environmental effects of the production of a certain product during the whole life cycle or process chain (from the beginning to the end)

Energy crops

- \+ Renewable Sources of Energy
- \+ Use of set aside land or derelict land
  - Limiting erosion risks
- \+ Positive Carbon Balance
  - Reduction of greenhouse gas emissions
- \+ Low sulphur content
  - Reduction of acidifying gas emissions

Land intensive (monoculture)

- Water pollution (NO_3^-, PO_4^{3-}, pesticides)
- Danger of reducing the Biodiversity

Aim of the Work:

To compare the ecological sustainability of production and use of kenaf in southern European regions

To compare the ecological sustainability of kenaf in southern European regions with the sustainability of other crops and of other energy sources

Milestones:

★ Environmental impact assessment covering the whole production chain of kenaf

★ Life cycle analysis considering the potential of kenaf as a biofuel for thermochemical conversion processes (combustion, gasification, pyrolisis)

LFA considering other uses, will also be studied

★ Scenarios for alternative land use in agriculture regions of south EU

Ecological criteria to be considered

- Energy budget
- Emission of greenhouse gases
- Emission of acidifying gases
- Emission of ozone depleting gases
- Emission of minerals to soil and water
- Emission of pesticides
- Erosion
- Groundwater depletion
- Use of resources
- Waste production and utilization
- Contribution to biodiversity
- Contribution to landscape values
- Other criteria

Socio-economic criteria to be considered

- Costs of energy produced or costs of the product produced
- Costs of abated CO_2 emission
- Employment creation

Net avoided use of fossil energy

Net Energy Gain = Energy Output - Energy Input

Productivity
x
Heat of Combustion

Production phase
Pre-conversion phase
Conversion phase

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

Production phase:

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

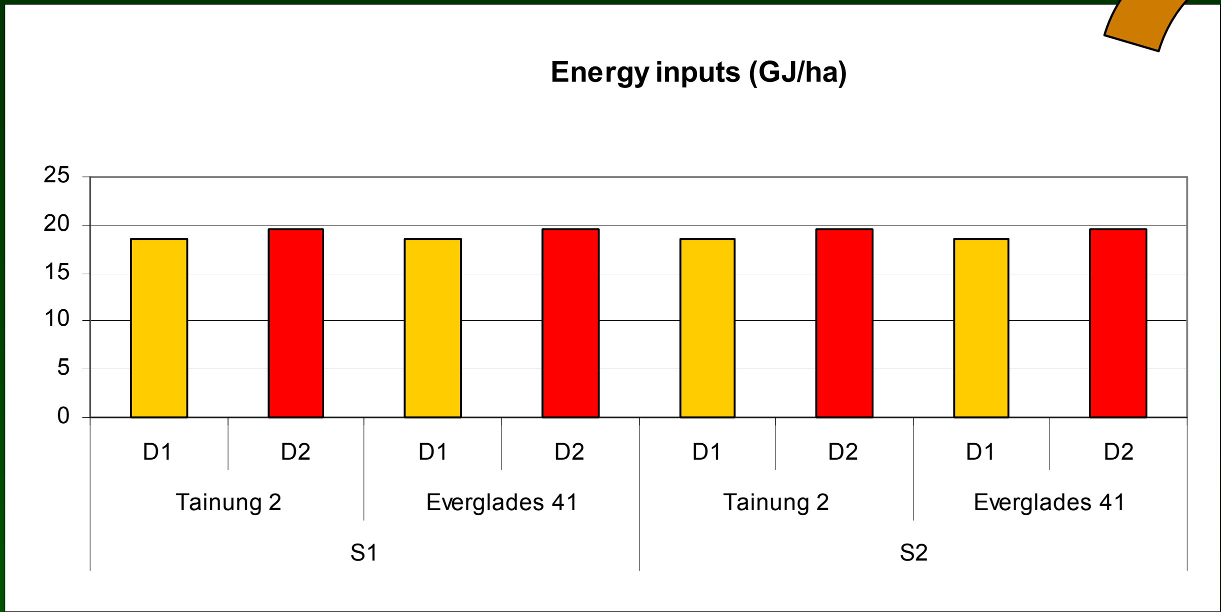
Pre-conversion phase

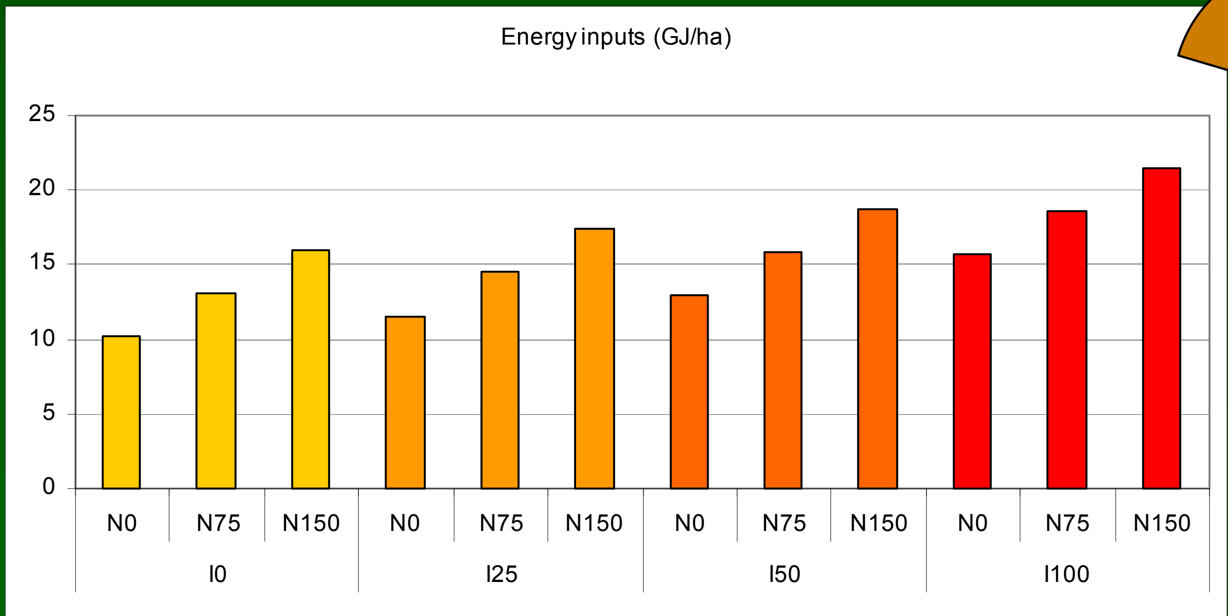
- transport of biomass
- drying and storage of biomass at the plant

Conversion phase

- process energy needed for conversion

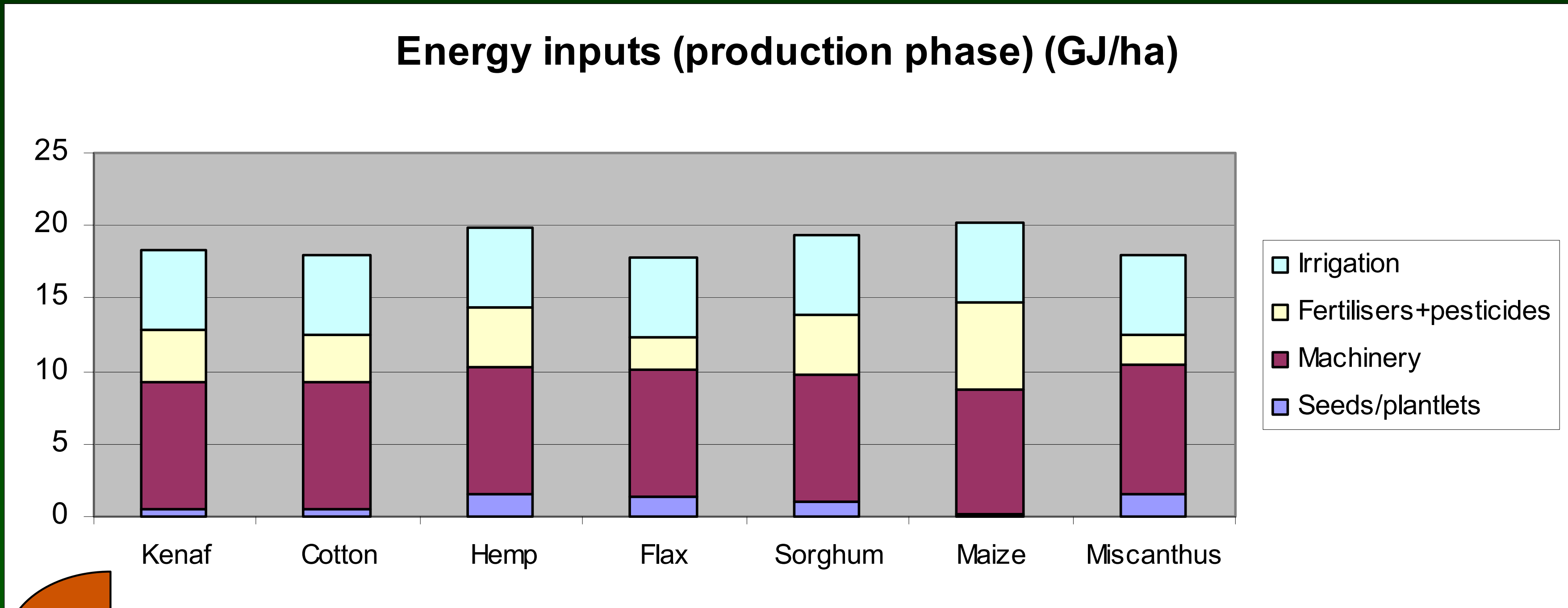
Energy inputs – Production phase (Biokenaf project)





- ⇨ Varieties (no ≠)
- ⇨ Sowing dates (no ≠)
  - ⇨ If Irrigation is the same
- ⇨ Sowing densities
  - ⇨ Higher nºseeds/m^2
  - ⇨ Higher E_{input}
- ⇨ $N_{fertiliser}$
  - ⇨ Higher N
  - ⇨ Higher E_{input}
- ⇨ Irrigation level
  - ⇨ Higher I
  - ⇨ Higher E_{input}

Energy inputs – Comparison with other crops

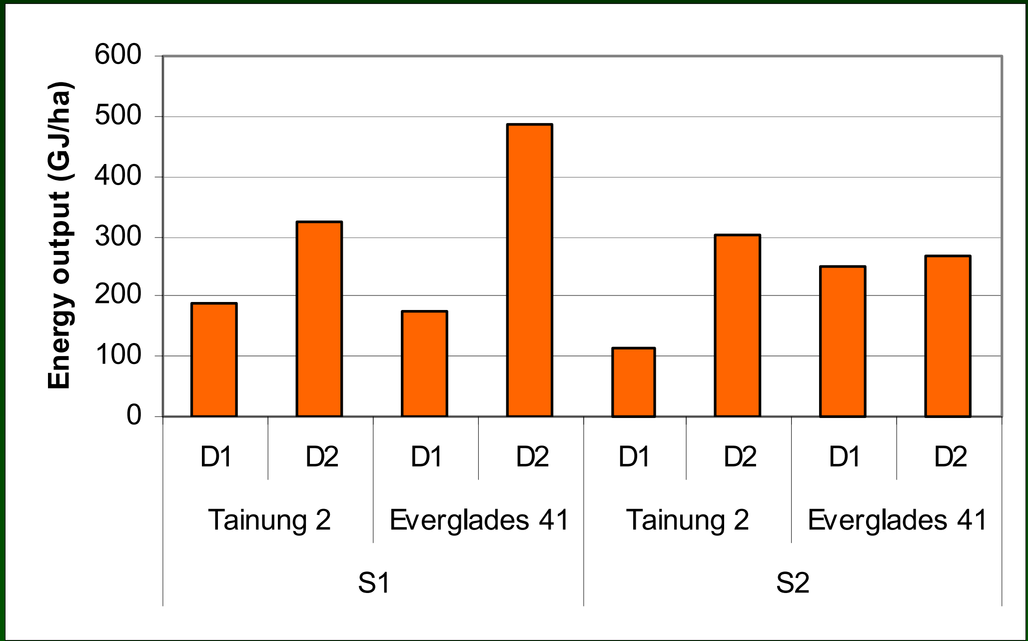


⇨ Hemp and Miscanthus are more costly in terms of seeds/plant cuttings

⇨ No differences among crops in terms of machinery and irrigation

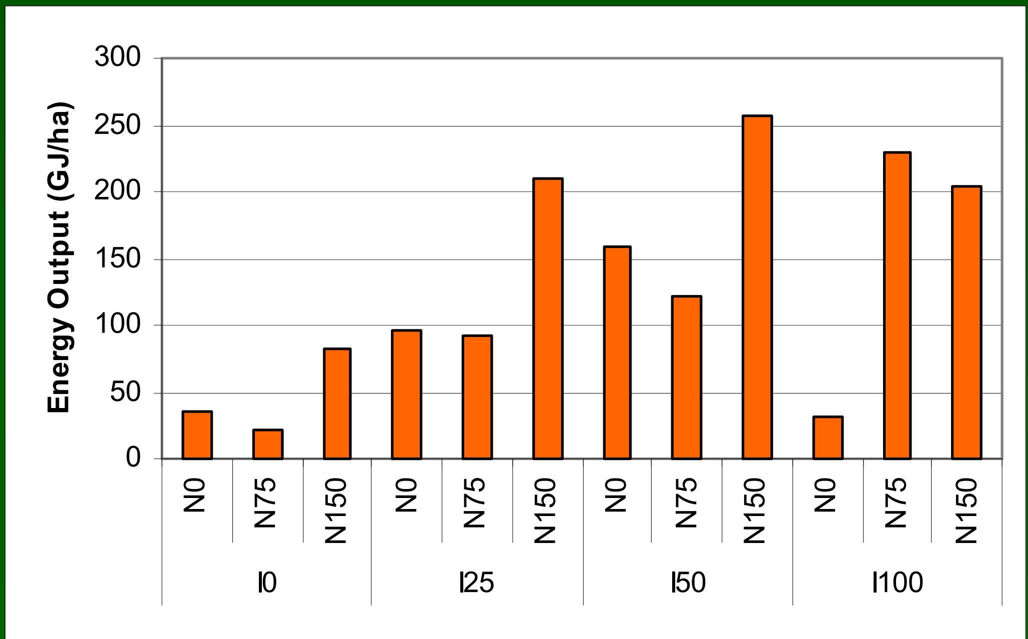
⇨ Maize needs a lot of N fertiliser and cotton a lot of pesticides

Energy outputs – Production phase (Biokenaf project)



The higher the productivity the higher the E_{output}

Early sowing > Late sowing
40 seeds/m^2 > 20 seeds/m^2
Everglades 41 > Tainung 2
(in Portugal)

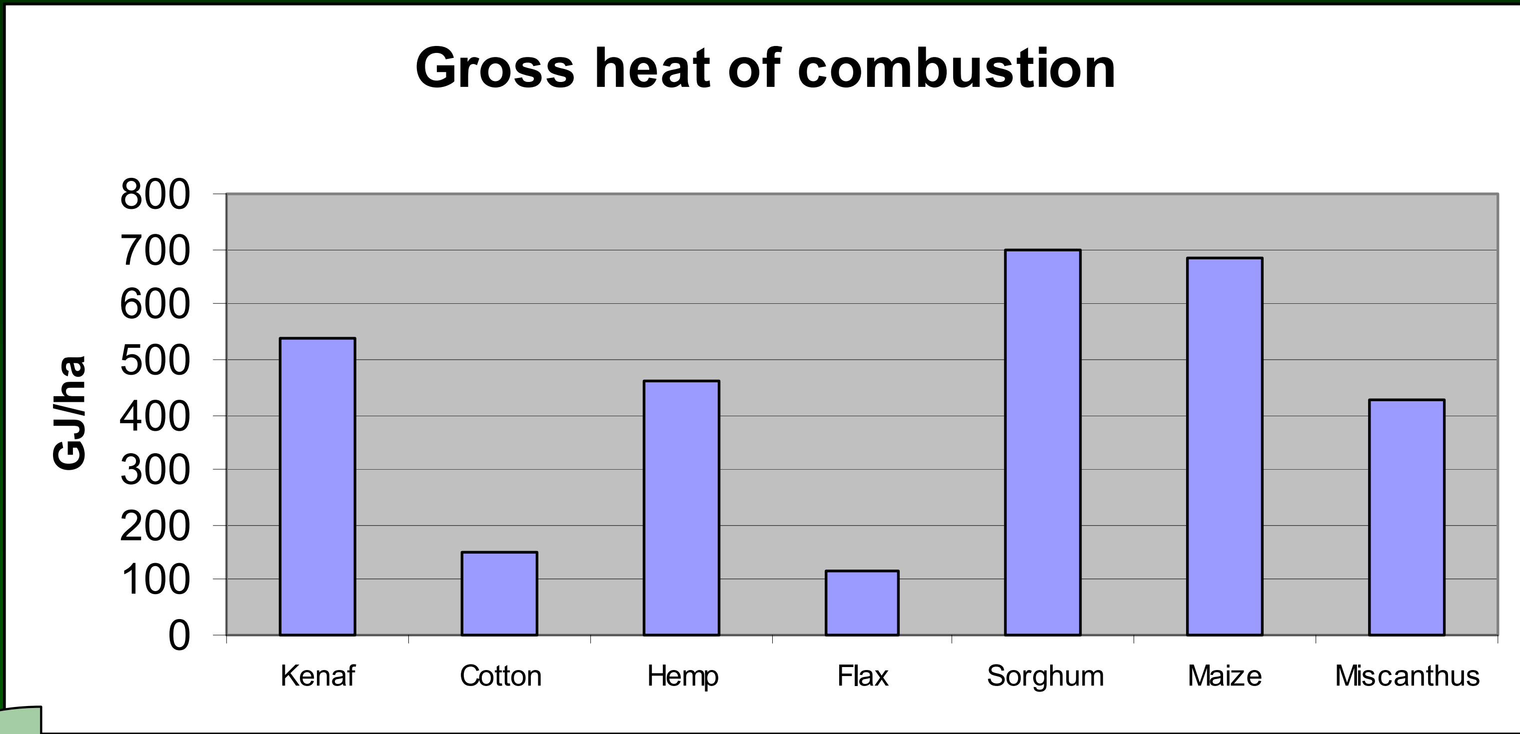


I0 < I25 < I50 < I100

N0 = N75 < N150 kg/ha

(In Portugal)

Energy outputs – Comparison with other crops

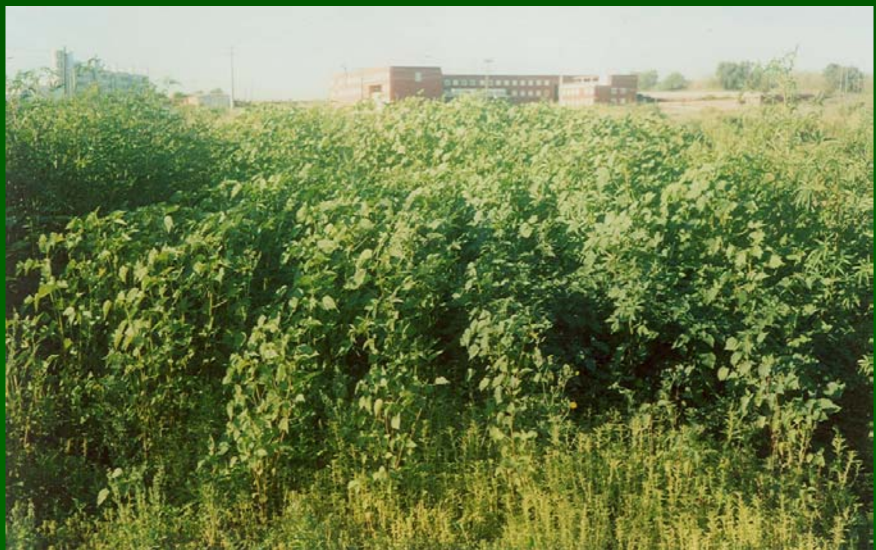


The more productive is the crop the more E_{output}

Emission of Greenhouse Gases

Net Avoided Emissions of Greenhouse Gases = Avoided CO_2 Emissions - N_2O Emissions

CO_2 that would be emitted if fossil fuels would be used to produce the E_{output} - CO_2 emissions caused by agronomic inputs



N_2O (kg $N.ha^{-1}$) = 1 +1.25%*Napplied

Emission of acidifying Gases

Net avoided acidifying Emissions = Avoided Acidifying Emissions - Acidifying Emissions

Avoided emissions that would be emitted if fossil fuels would be used to produce the E_{output}

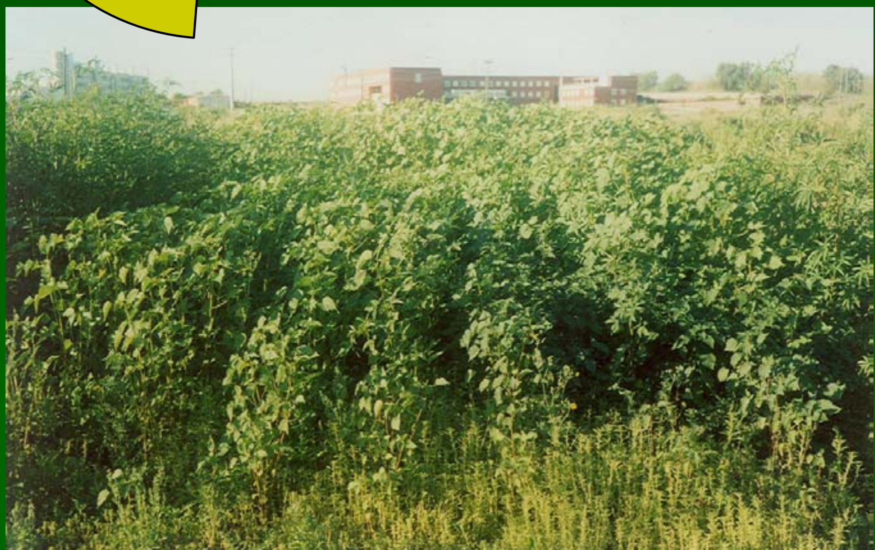
Emissions during use of Fossil Energy (agronomic inputs)
+
Emissions (NH_3 and NO_x), production of $N_{fertiliser}$
+
Volatilization of NH_3 (1% $N_{applied}$)

SO_2, NO_x, NH_3 emissions

Emission of ozone depleting gases

N_2O Emissions

N_2O is the only gas considered



N_2O (kg $N.ha^{-1}$)

=

1 +1.25%*Napplied

Emission of Minerals to Soil and Water

N, P, K Surpluses = N, P, K input - N, P, K output

Fertilisers
Air Deposition
Rain/Irrigation
Water

Productivity
x
Mineral content

NH_3
volatilisation

N_2O
emissions

Mineral content
immobilised
in roots and rhizomes

Emission of pesticides

– amount of pesticides per group (herbicides, fungicides, insecticides and other pesticides) that is used

- scores of harmfulness of the several applications are applied

- total score on pesticides is calculated, indirect effects are analysed

Soil Erosion

- Soil covered by leaves, stems and roots -
  - division of the crop growth into stages
- Rainfall

Harmful Rainfall

Groundwater depletion

- water use of the crop during its growth
- additional water use caused by irrigation

Use of Resources

Information collected concerning

- exhaustion of fossil energy
- exhaustion of fertilizer ores (K and P)

Waste production and utilization

- possible uptake of contaminants
- possible formation of ashes and if they are dumped, particularly when considering the gasification or combustion conversion processes
- reuse of residual materials

- Contribution to biodiversity
- Contribution to landscape values

should also be considered

- Thank you for your attention