# Hållbara biomaterial – en tulipanaros?

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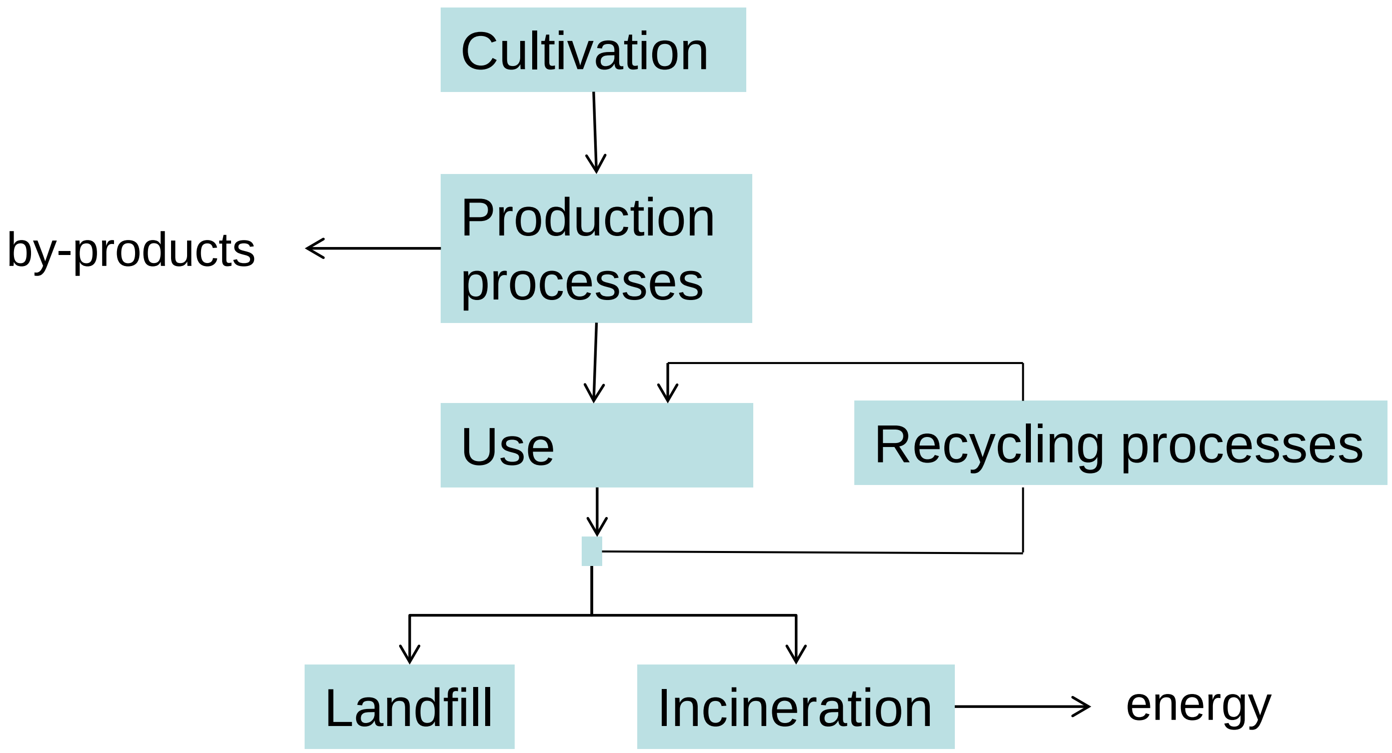
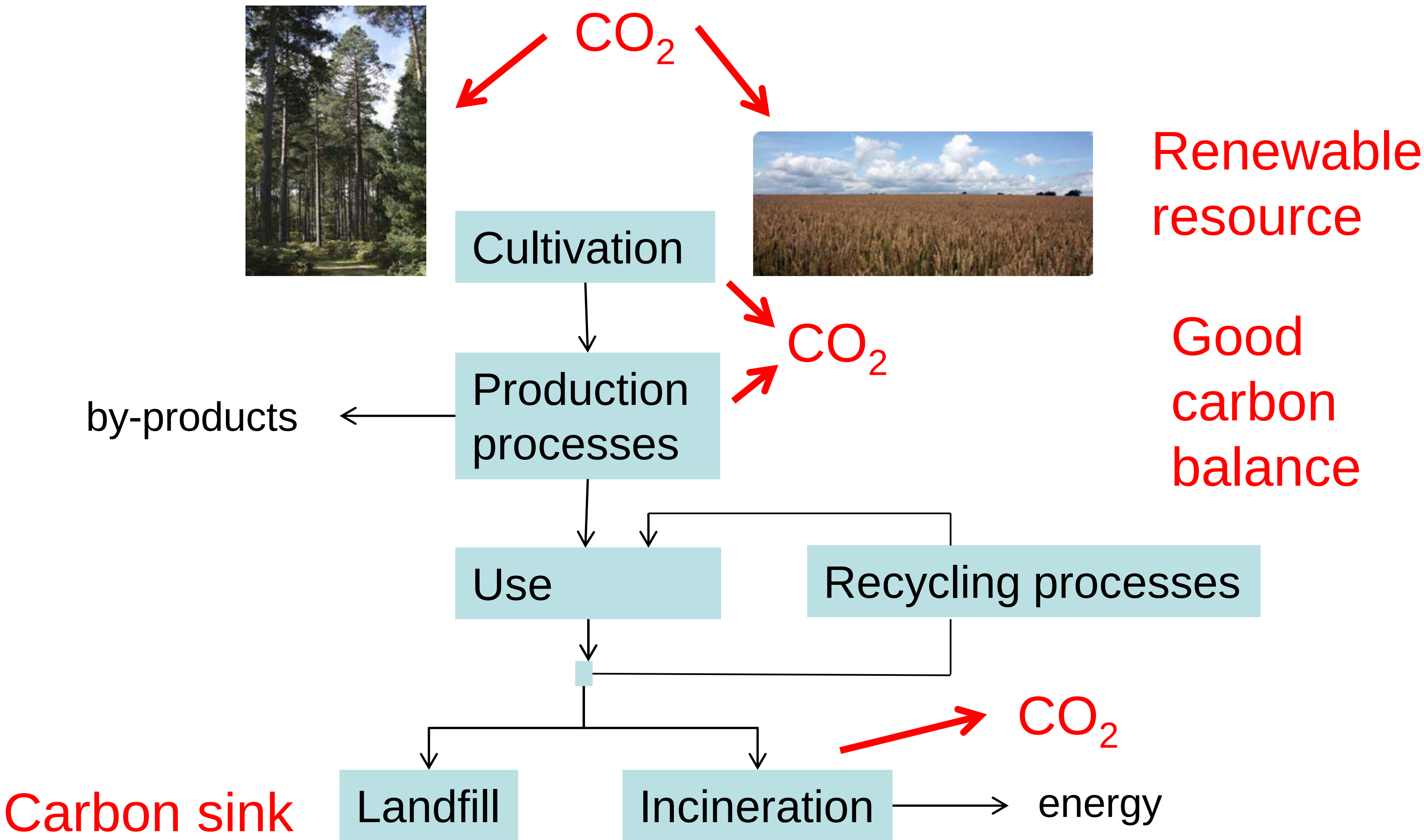
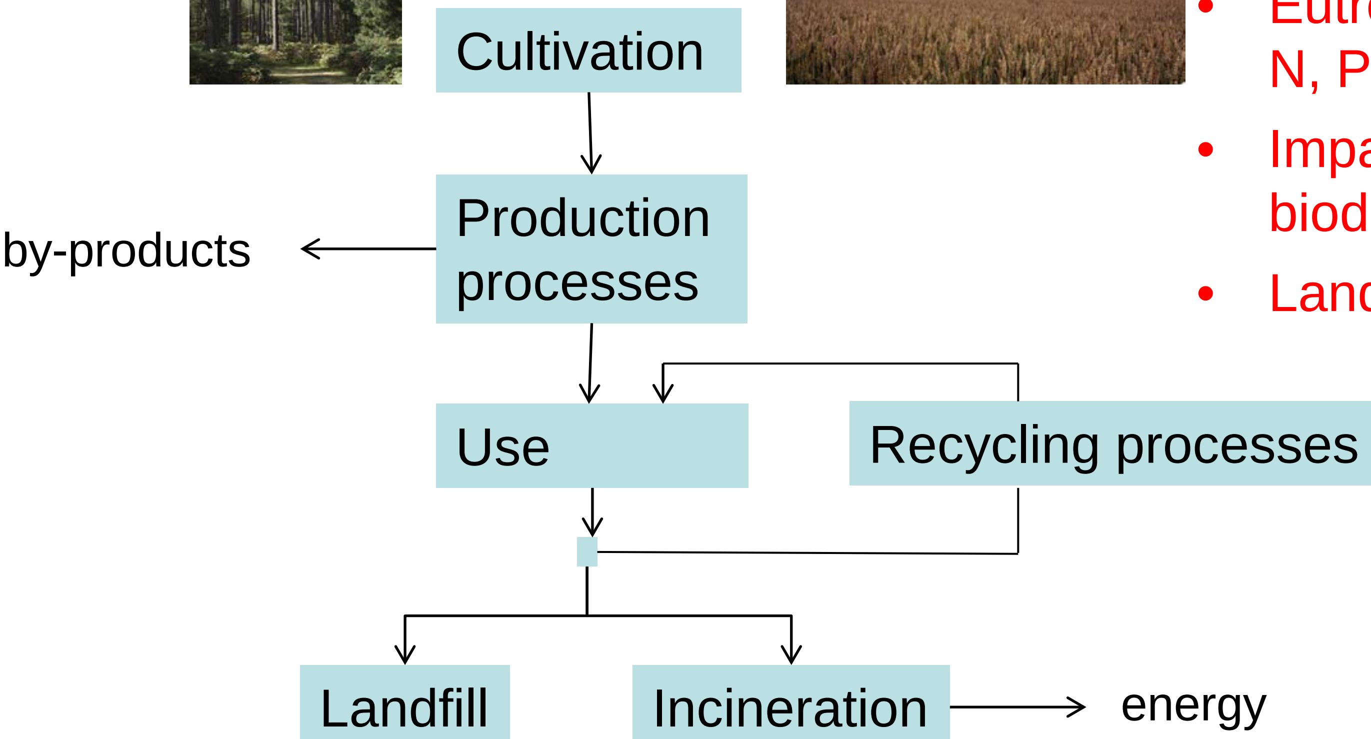
# Life cycle of a bio-material




$CO_2$
Renewable resource
Cultivation
$CO_2$
Production processes
by-products
Good carbon balance
Use
Recycling processes
$CO_2$
Carbon sink
Landfill
Incineration
energy

## But…

- other GHG, $N_2O$, $CH_4$
- Pesticides
- Eutrophication, N, P
- Impact on biodiversity
- Land use change



# What does LCA catch?

- Other GHG, $N_2O$, $CH_4$ – possible, not always included
- Pesticides – possible, not always included
- Eutrophication, N, P – possible, often included
- Impact on biodiversity – we do not even know how to begin….
- Land use change – sometimes done, results highly uncertain and controversial

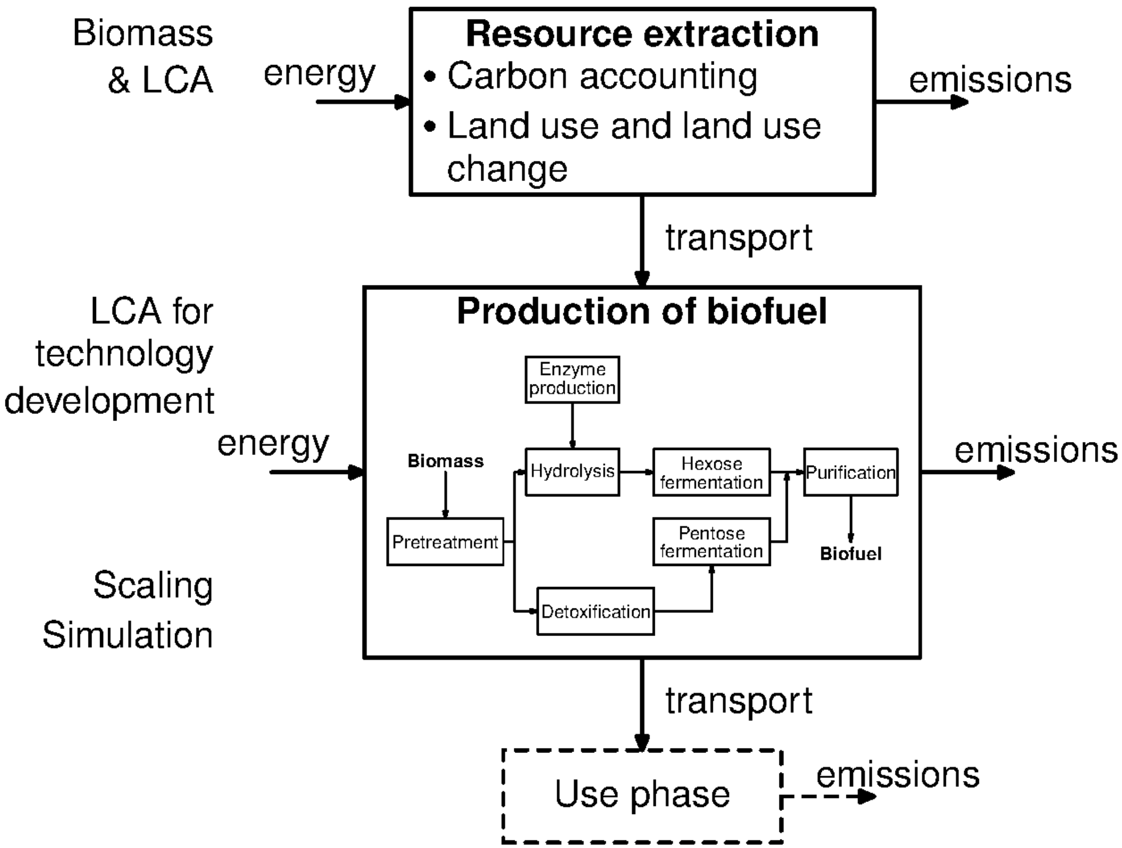
# Bio-materials projects at ESA

- Bio-ethanol production using high-gravity fermentation
- LCA of bio-polyethylene (bio-PE) production (via bio-ethanol)
- Environmental evaluation of bio-composites
- Development of a process to produce bio-acrylate polymers
- Biodiversity in LCA (project under formulation)

# Bio-ethanol production using high-gravity fermentation

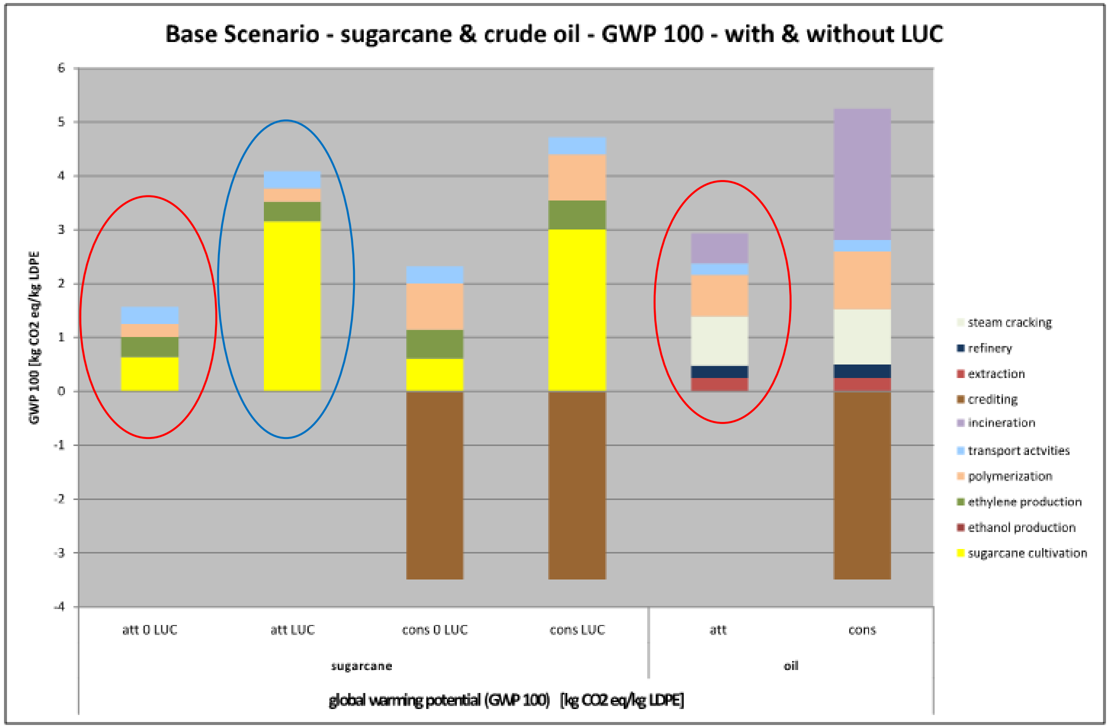
- Bio-ethanol not only used as fuel, but also as a chemical building block for, e.g. production of polyethylene
- Development of new technology to produce bio-ethanol more economically
  - High-gravity fermentation → High solids concentration in the fermentor
- Life cycle assessment (LCA) to determine the environmental performance of high-gravity technology for
  - Yeast-based ethanol production
  - Research steps to make butanol conceivable as a biofuel in addition to ethanol

# Bio-ethanol production using high-gravity fermentation



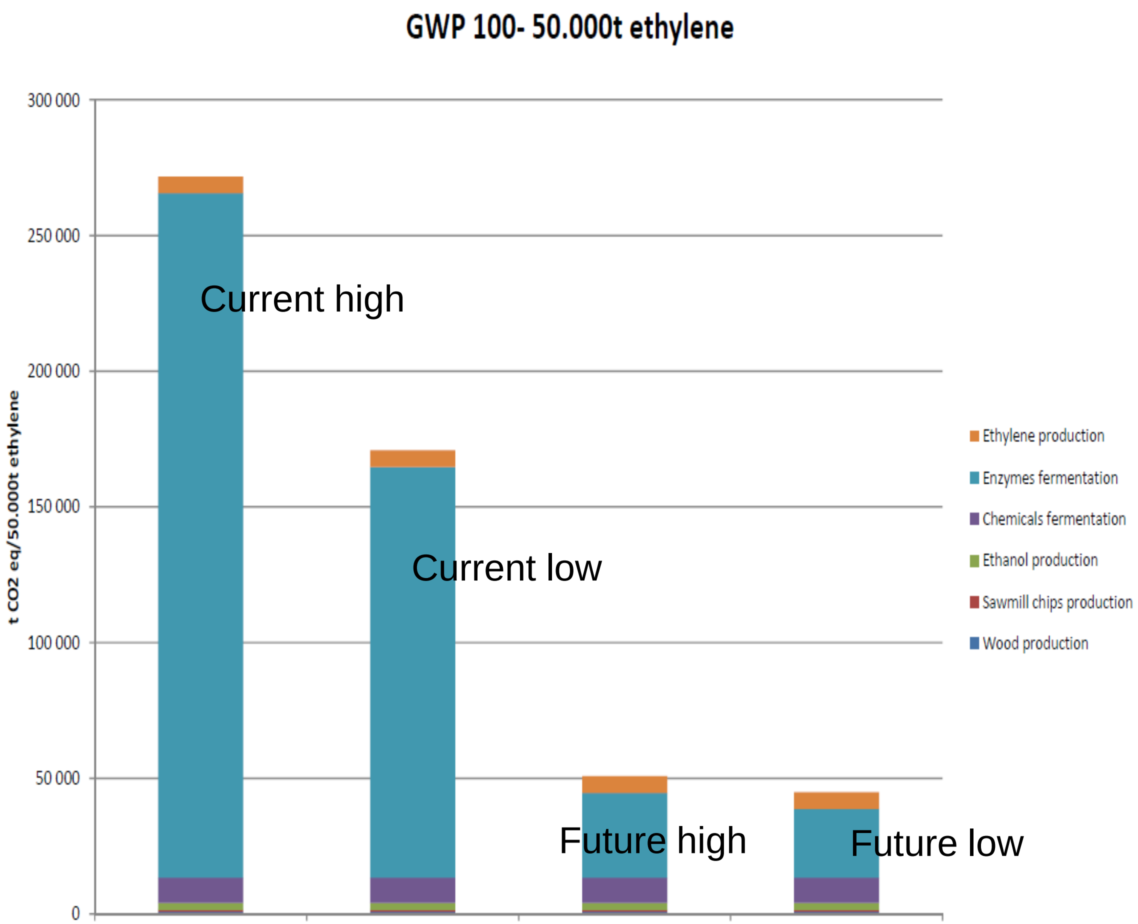

- Biofuels specific issues
- Technology development, scale and LCA
- Simulation
- Use of the analysis results

# LCA of bio-polyethylene production




- Sugarcane PE low iLUC estimate → Lower GWP than fossil
- Sugarcane PE high iLUC estimate → Somewhat bigger GWP than fossil

# LCA of wood based -ethylene production




Production of enzymes decisive for environmental impact

Large improvement potential regarding

- enzyme dosage
- efficency enzyme production

Hydrolysis with dilute acid potentially environmentally preferable (scarce literature, needs confirmation)

Other pretreatment methods exist, environmental assessments scarce

Improvement potential exist also for ethanol production

# Environmental evaluation of bio-composites

- Large market potential → Several biocomposites containing pulp and a polymer have recently been launched
  - Sustainability of biocomposites should be scrutinized over the life cycle in their various applications
- Factors that may negatively impact these materials
  - Contamination of the polymer in the plastic matrix
  - Recyclability of the materials
- LCA as support for a qualitative discussion on the factors driving the environmental impact
- Comparison with fossil-based alternative
  - 40% pulp fibre in biopolymer matrix, e.g. Bio-PE
  - 40% pulp fibre in fossil-based polymer matrix

# Development of a process to produce bio-acrylate polymers

- Application as e.g. superabsorbents
- Bio-based production pathway (forestry-derived raw material stream)
  - Production of 3-hydroxypropionic acid (3-HPA) by yeast
  - Dehydration to acrylic acid
  - Polymerization of acrylic acid
- LCA will be used to assess the environmental impact
- Goals of this study
  - To compare the environmental impact of bio-based poly-acrylate production with its traditional fossil-based production
  - To account for the carbon balance of bio-based poly-acrylate production from a life cycle perspective
  - To explore how LCA is able to guide the process/technology development for bio-based poly-acrylate production

# Conclusions

- Consequences of large-scale production of bio-materials are still unclear
- LCA can help in clarifying these consequences
  - Carbon accounting
  - Land use and land use change
  - Biodiversity (?)
- LCA can help in guiding production technology development
  - Process simulation
  - Scale
- Several projects are under way in order to build up knowledge base about LCA of bio-materials

# Thank you for your attentation

# Questions?