Environmental impact assessment of energy crops cultivation and use

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Scope of the study

⇨ *to evaluate the environmental effects*

positive and negative

due to the production of different energy crops in Europe

Why?

⇨ **Energy crop systems**

- ✓ **Intensive use of land**
- ✓ **Pressure on natural resources**
  - ❖ **biodiversity, water, soil**
- ✓ **Increment of agrochemicals inputs**

Why?

⇨ **Energy crop systems**

- ✓ **offer ecological advantages over fossil fuels**
  - ❖ **by contributing to reduction**
    - ❖ **greenhouse gases**
    - ❖ **acidifying emissions**

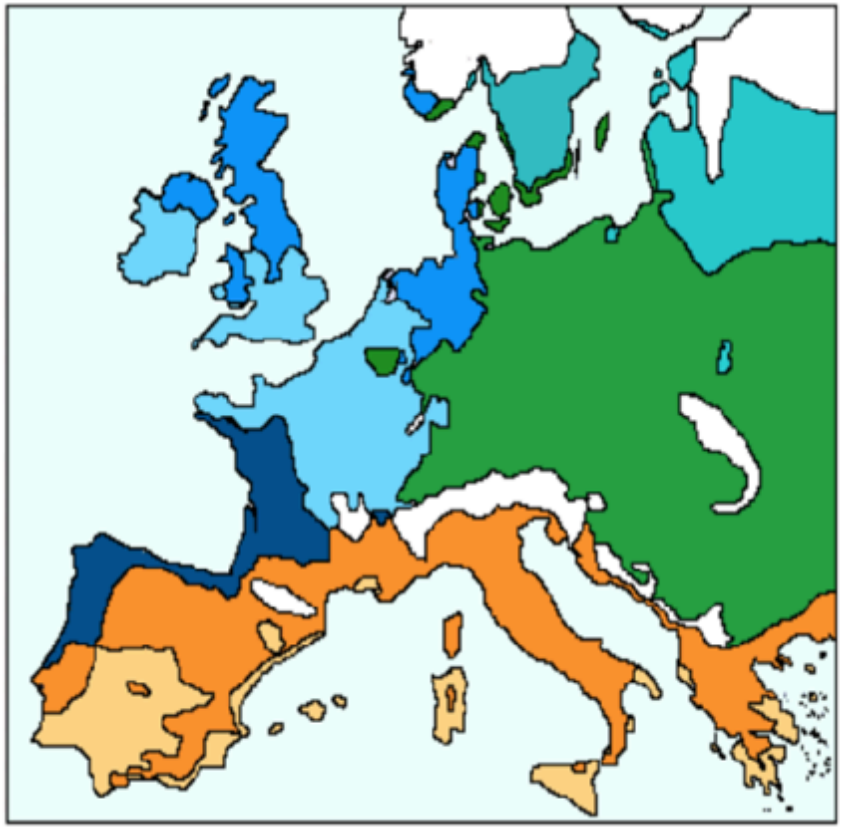
Methodological approach

15 Energy Crops

- **Oil crops:** Rapeseed, Sunflower, Ethiopian Mustard
- **Sugar crops:** Sugar beet, Sweet sorghum
- **Fiber crops:** Hemp, Flax
- **Lignocellulosic crops:** Reed canary grass, Miscanthus, Switchgrass, Giant reed, Cardoon
- **Woody crops:** Poplar, Willow, Eucalyptus

- **Food crops:** wheat, potato
- **Reference System:** Fallow

Methodological approach



Nemoral (NEM)
Rape seed, hemp, reed canary grass, poplar, wheat, potato, fallow

Continental and Pannonian (CON)
Rape seed, sugar beet, flax, miscanthus, willow, wheat, potato, fallow

Atlantic North (ATN)
Rape seed, hemp, miscanthus, switchgrass, willow, wheat, potato, fallow

Atlantic Central (ATC)
Rape seed, sugar beet, flax, miscanthus, switchgrass, poplar, wheat, potato, fallow

Lusitanian (LUS)
Rape seed, sweet sorghum, hemp, miscanthus, willow, eucalyptus, wheat, potato, fallow

Mediterranean North and Mediterranean Mountains (MDN)
Sunflower, sweet sorghum, hemp, giant reed, poplar, wheat, potato, fallow

Mediterranean South (MDS)
Ethiopian mustard, sweet sorghum, flax, cardoon, eucalyptus, wheat, potato, fallow

Oil crops || Sugar crops || Fiber crops || Lignocellulosic crops
Woody crops || Food crops || Reference crop

Impact categories studied

- ⇨ Emissions to soil, air and water
- ⇨ Impact on soil
- ⇨ Impact on mineral and water resources
- ⇨ Waste production and use
- ⇨ Implications on Biodiversity and Landscape

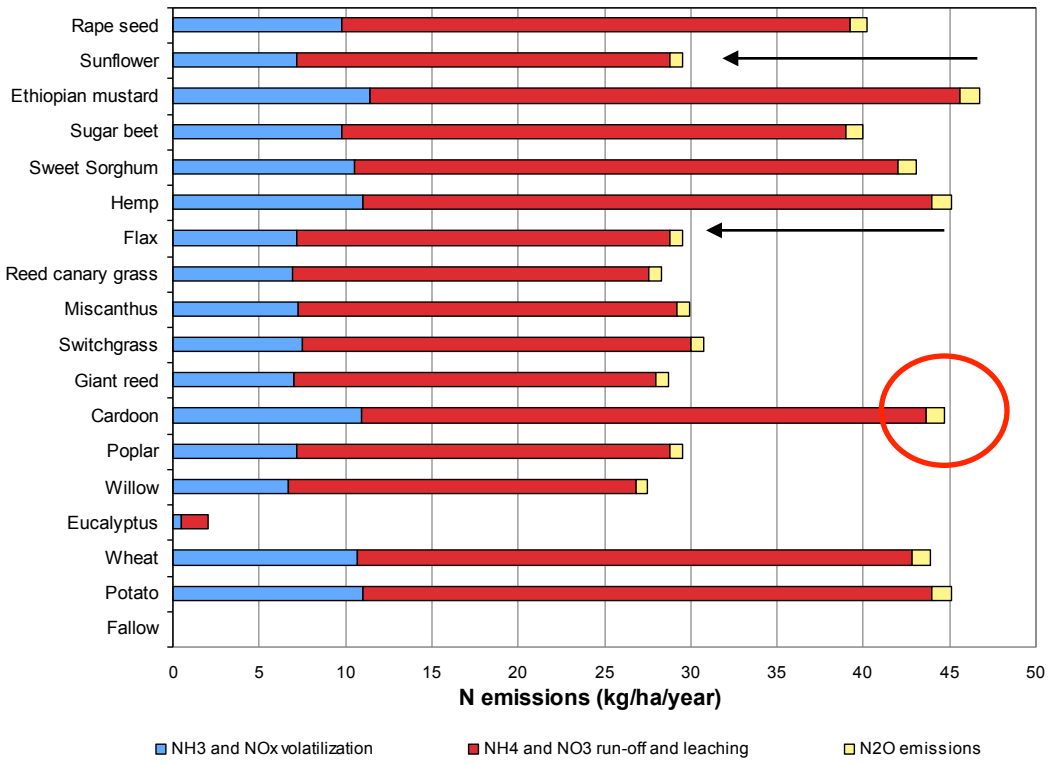
Data

- ⇨ Field data from literature
- ⇨ National Organizations
- ⇨ International Organizations
  - ⇨ Mostly from small-scale and experimental sites
    - ⇨ Available data is low
    - ⇨ Upscale to a commercial level can lead to different conclusions from this study

Emissions to soil, air and water

- ***Fertiliser related emissions:***
  - **Applied N**
    - **Leaching and runoff of NH_4^+ and NO_3^- (eutrophication)**
    - **Volatilization of NH_3 and NO_x (acidification)**
    - **Emissions of N_2O (GH effect, ozone depletion)**

Emissions to soil, air and water



❖ **Run-off and leaching**

➢ important fraction on N emissions

⇨ **Annual crops**

⇨ ↑ N emissions

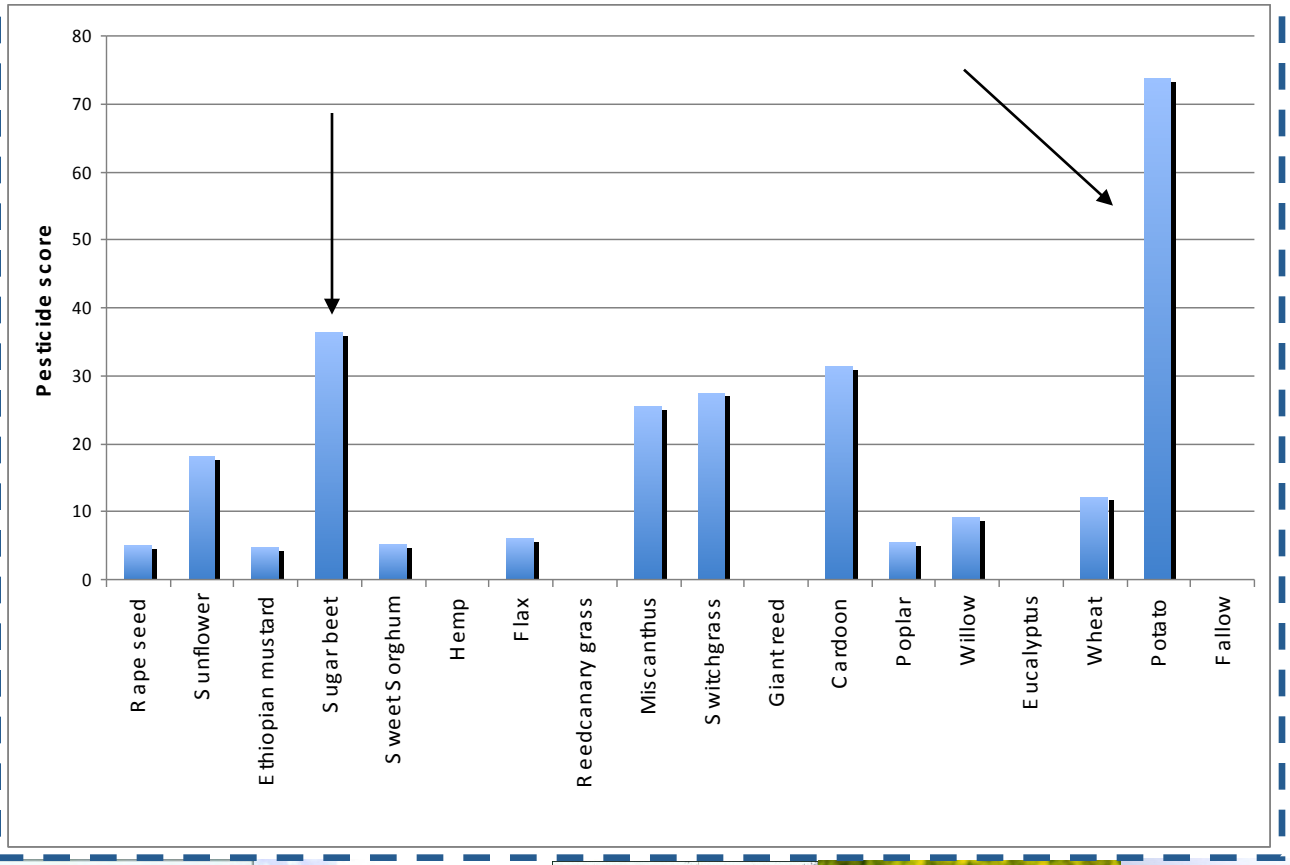
❖ **Root/rhyzome dynamics-perennials**

⇨ **Not accounted**

Emissions to soil, air and water

- **Pesticide related emissions:**
  - **Risk to ecosystems**
    - **Human health can be affected**
    - **Acute toxicity to water organisms**
    - **Toxicity to fauna**
  - **Pesticide score was established/crop**
    - **amount of pesticide applied**
    - **Toxic characteristics of the pesticide**

Emissions to soil, air and water



- ❖ **Energy crops**
  - ➢ low impact
- ⇨ **crops penalized**
  - ⇨ Sugarbeet
  - ⇨ Potato

Impact on Soil

- **Nutrient Status:**
  - Is fertilisers NPK application balanced?
    - P accumulation or neutrality in the soil - all crops
      - Lower levels should be applied
        - Sweet sorghum
        - Potato
    - N and K
      - most crops deplete soil reserves

Impact on Soil

⇨Surplus K

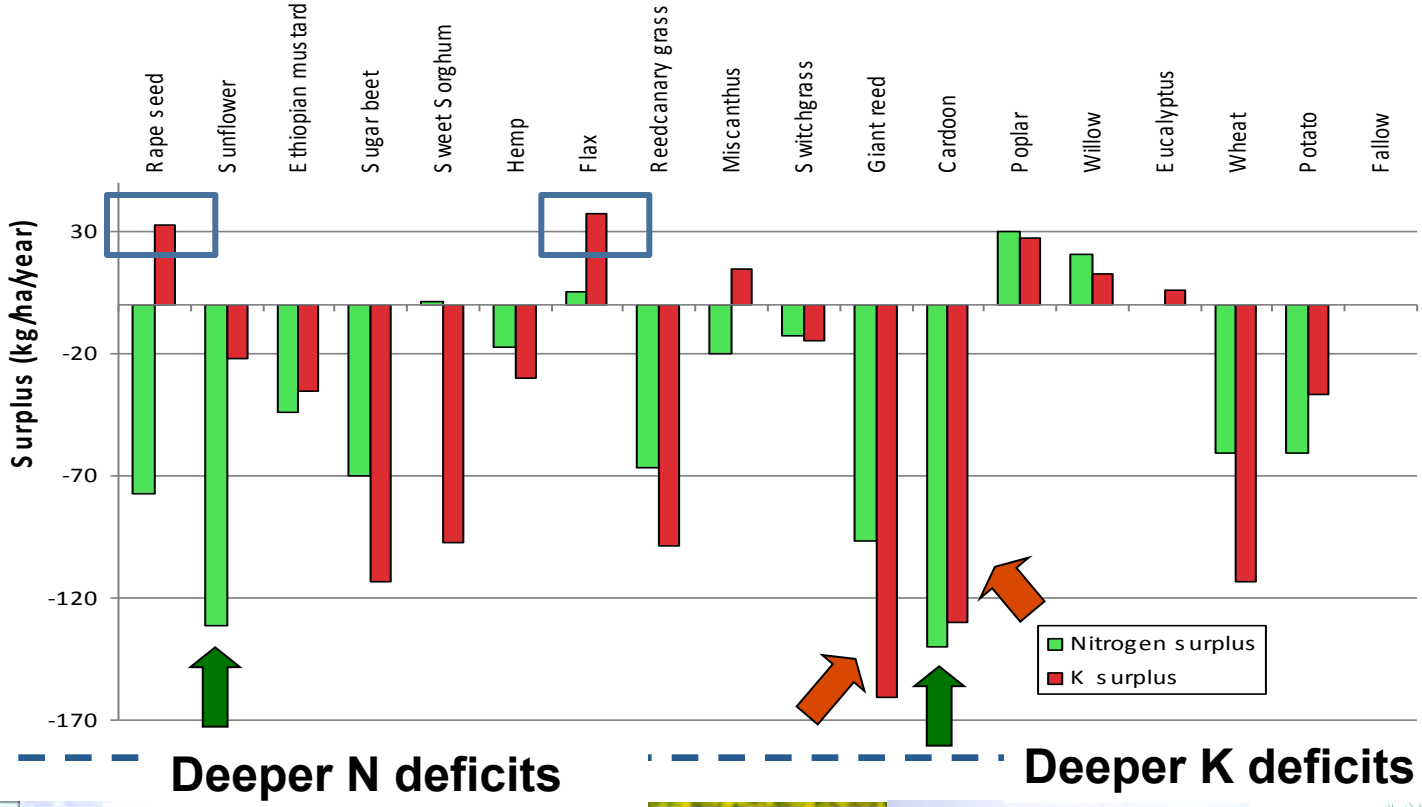
⇨ Eutrophication of terrestrial ecosystems

⇨ Rape seed

⇨ Flax

⇨Hampered by excess K aplication

Impact on Soil

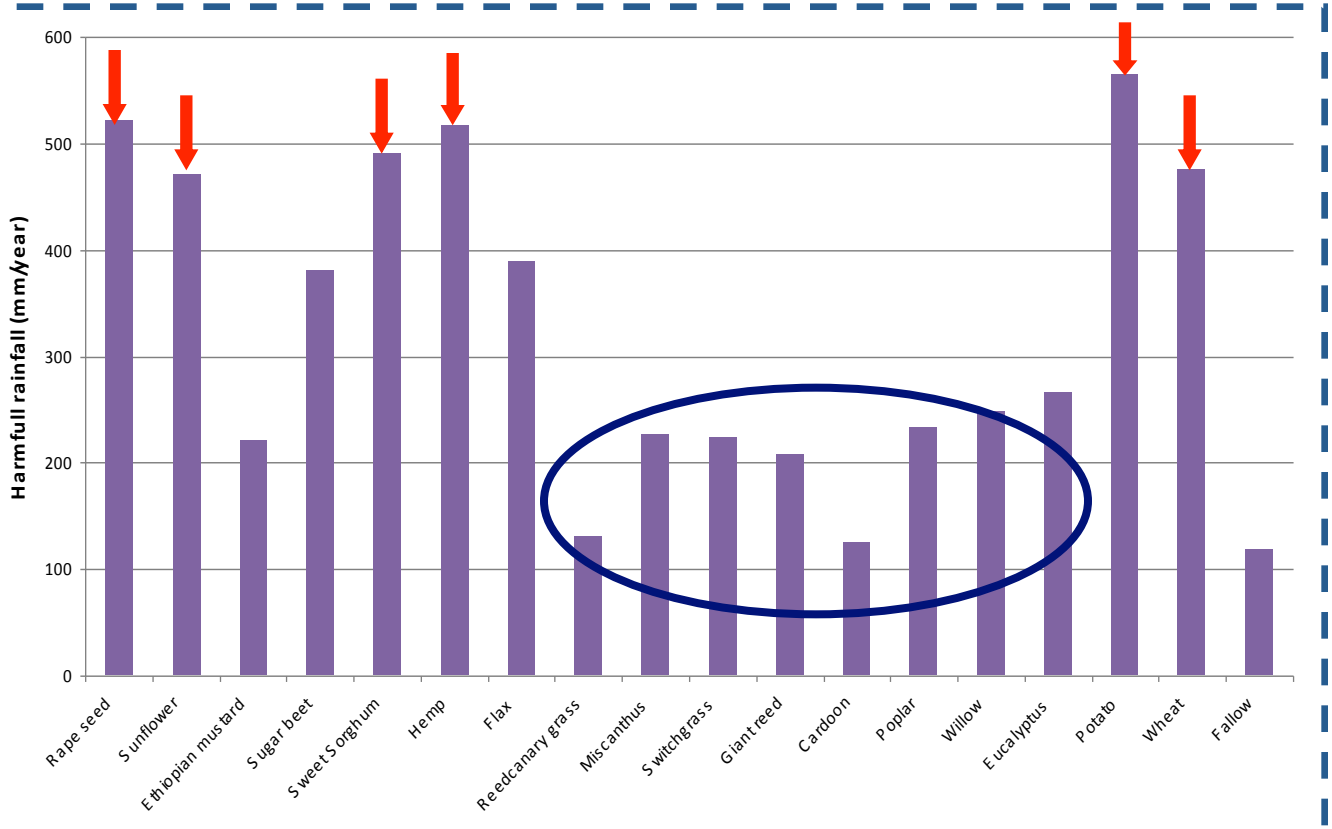


Impact on Soil

- **Erosion:**
  - potential damage caused by rainfall
    - Dependence on site

    crossed with
  - soil cover characteristics of the crops
    - during their cultivation cycles
      - Dependence on crop
  - each region erosion control actions

Impact on Soil - Erosion



⇨ perennials lower erosion risk

↑rainfall interception, ↑ surface cover, longer time

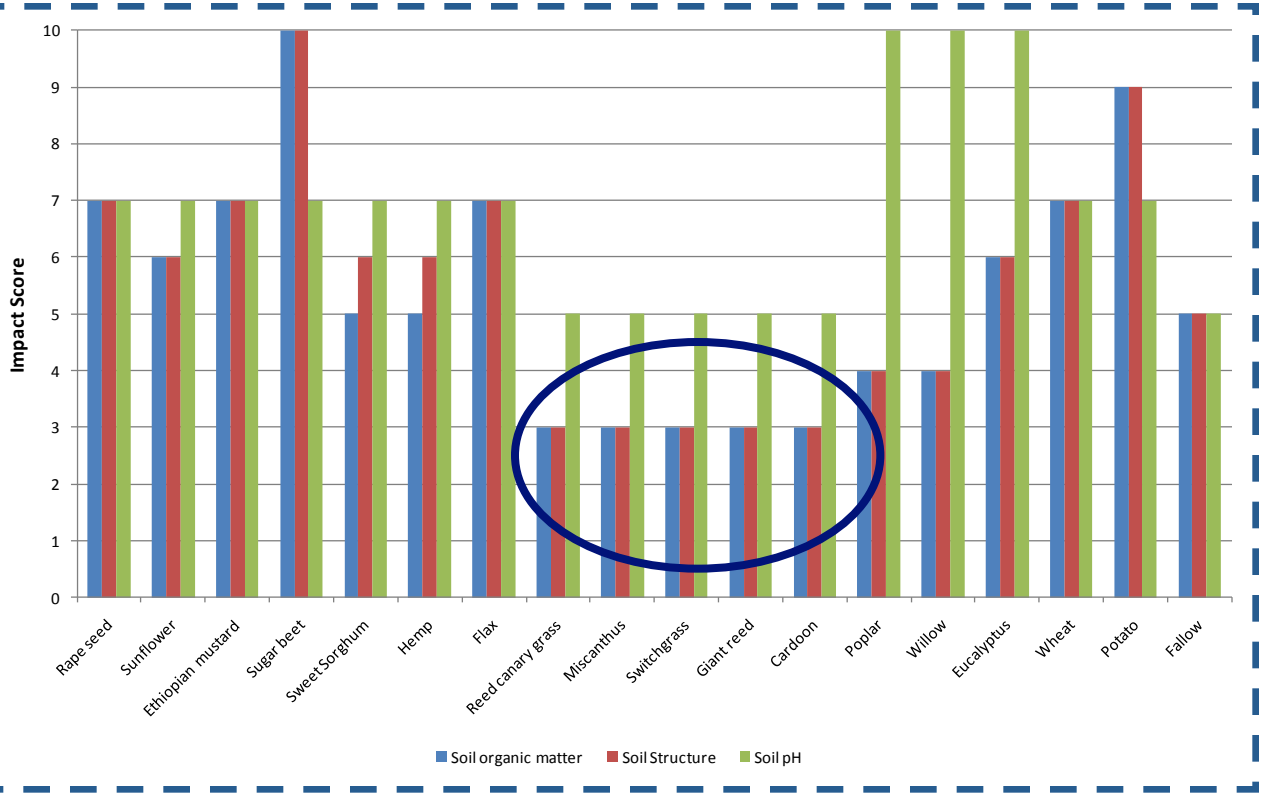
⇨Annuals Higher erosion risk







Impact on Soil – Soil Properties



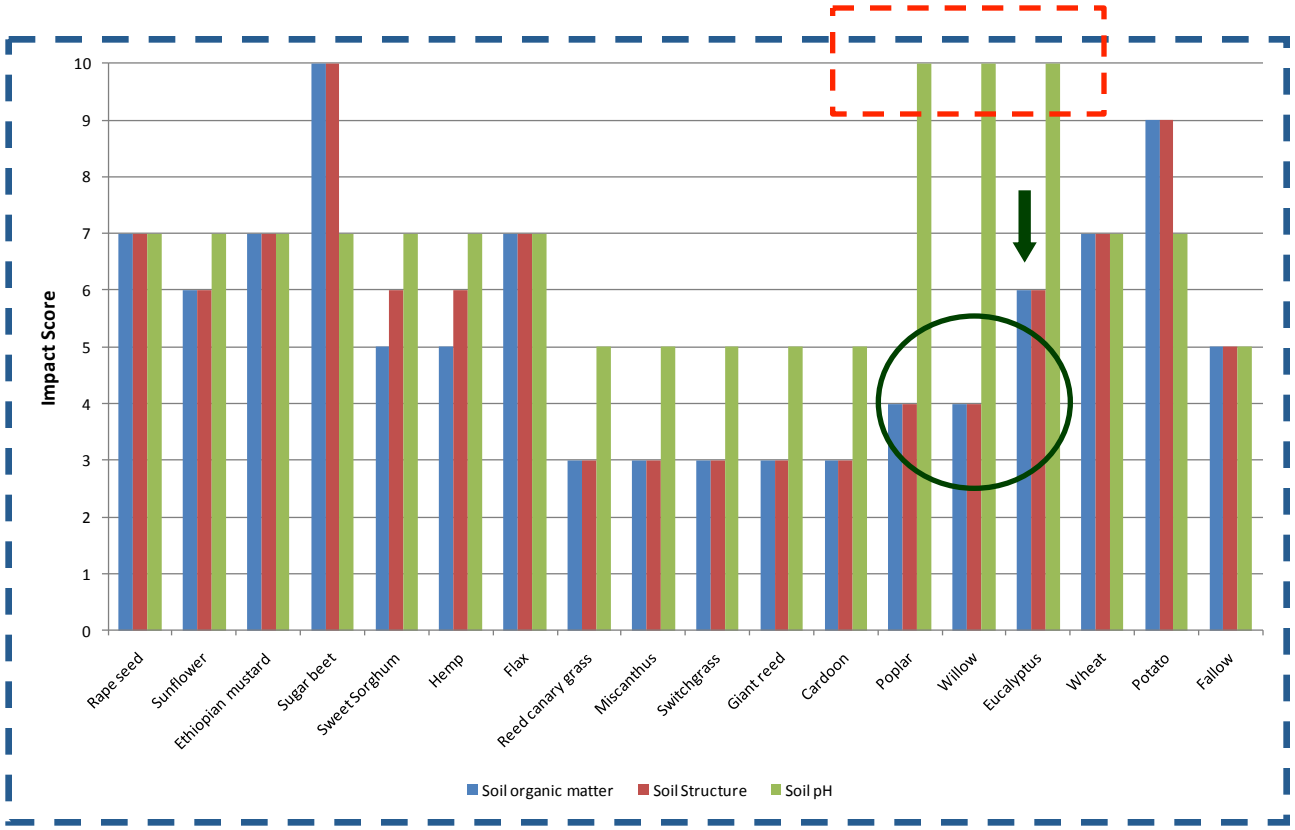
⇨ higher SOM

⇨ Better structure

⇨ pH not affected

⇨ Permanence in the soil, inputs of residues, root development, soil amendment not so intensive

Impact on Soil – Soil Properties



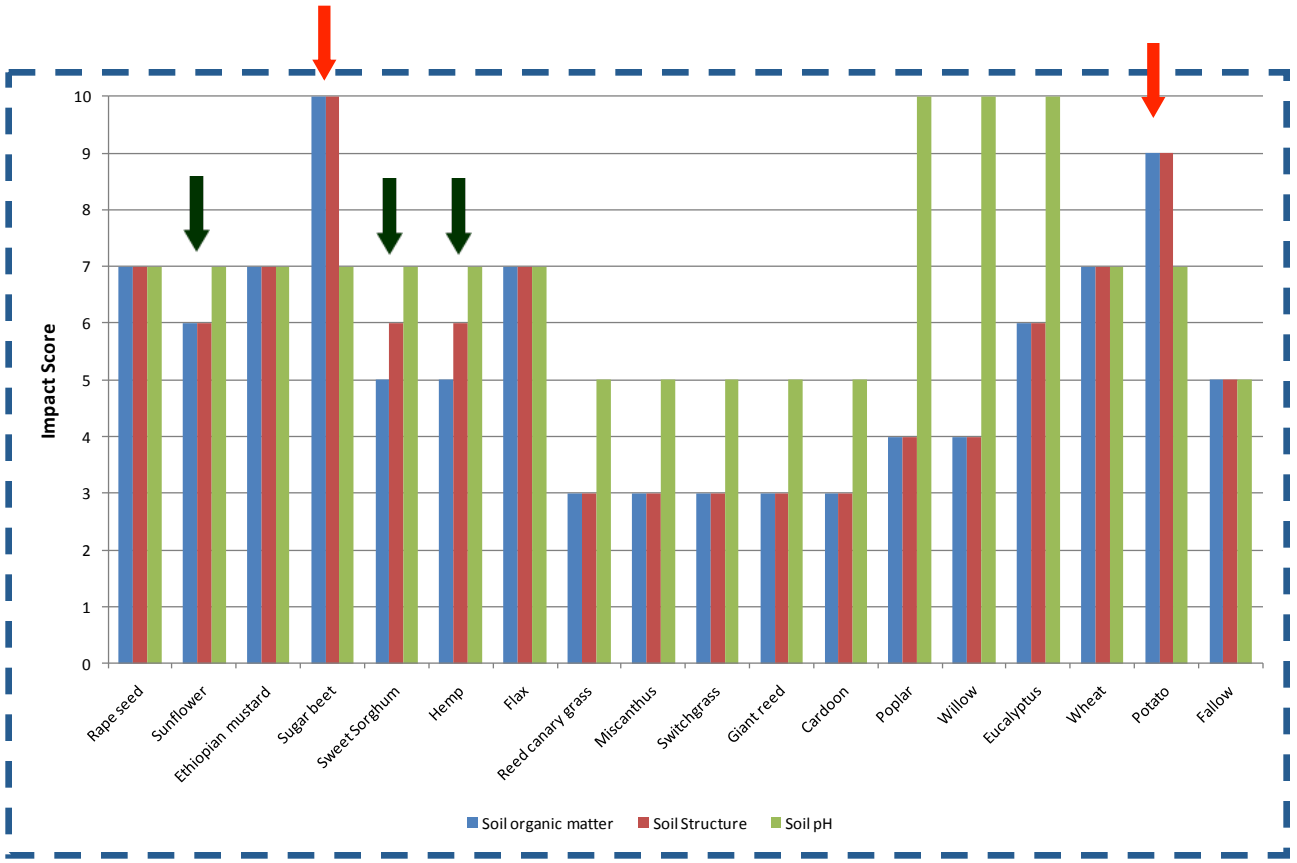
⇨Woody crops

⇨ less SOM and structure

⇨allelopathy, reduction of vegetation

⇨ Woody´s also increase soil acidity

Impact on Soil – Soil Properties



⇨ annuals

⇨ most damaging

⇨ high soil revolving, short permanence, litter removal, high soil amendment

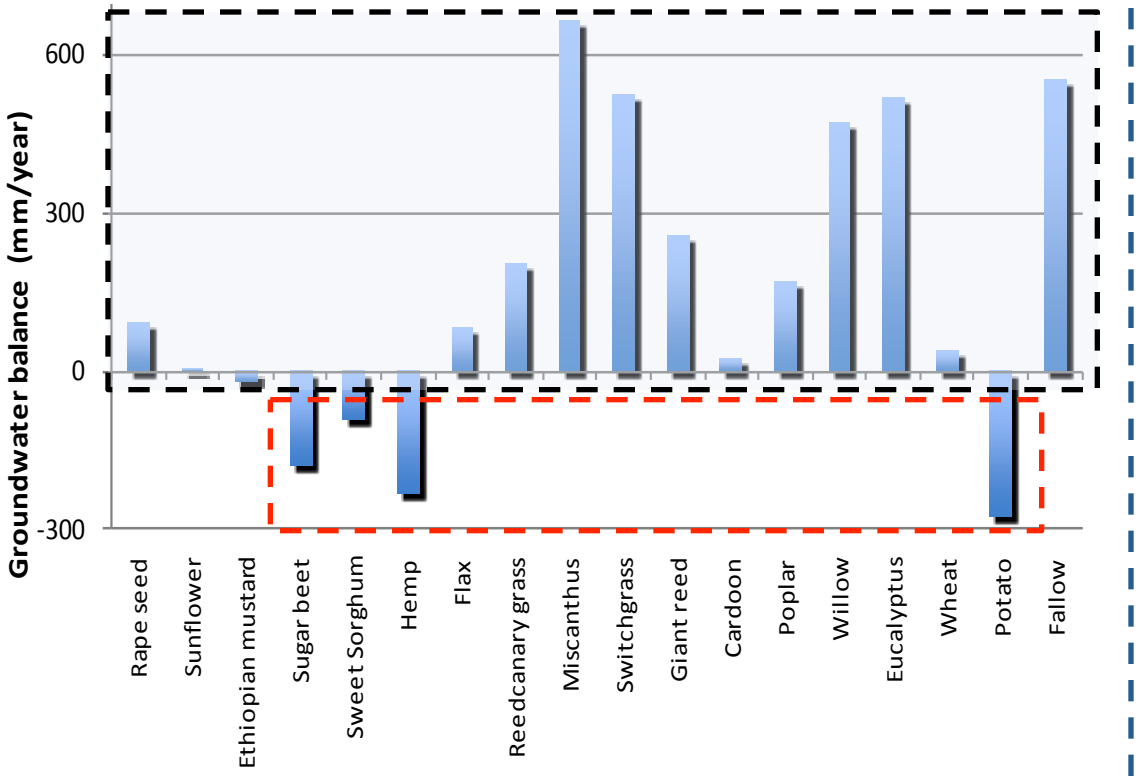
⇨Lower impact

⇨deep roots/litter left

⇨Penalized

⇨Harvest removes soil

Impact on water resources – water balance

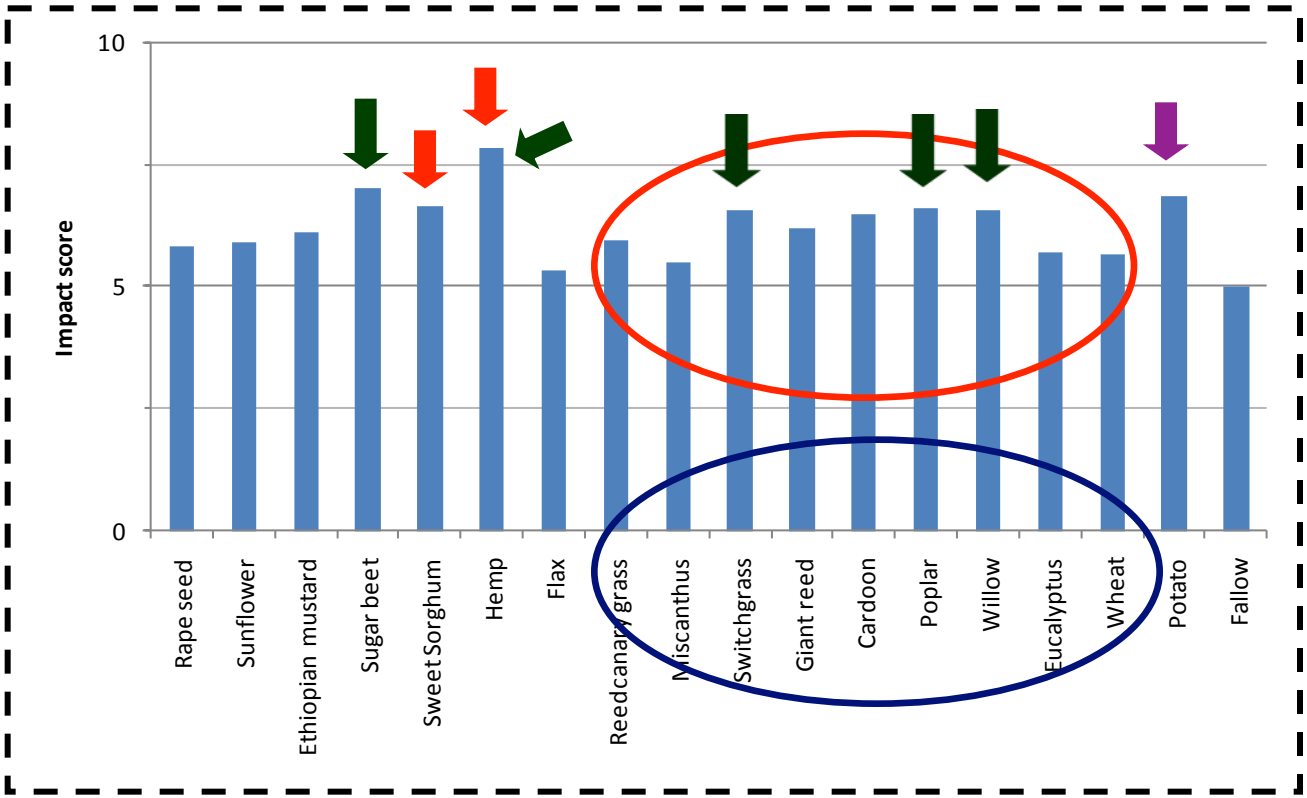


⇨Most crops sufficed by rainfall

⇨Allocation ↑ water-demanding crops to regions ↑precipitation

⇨water depletion

Impact on water resources - Hydrology



⇨ soil cover minimizes run-off, benefiting perennials

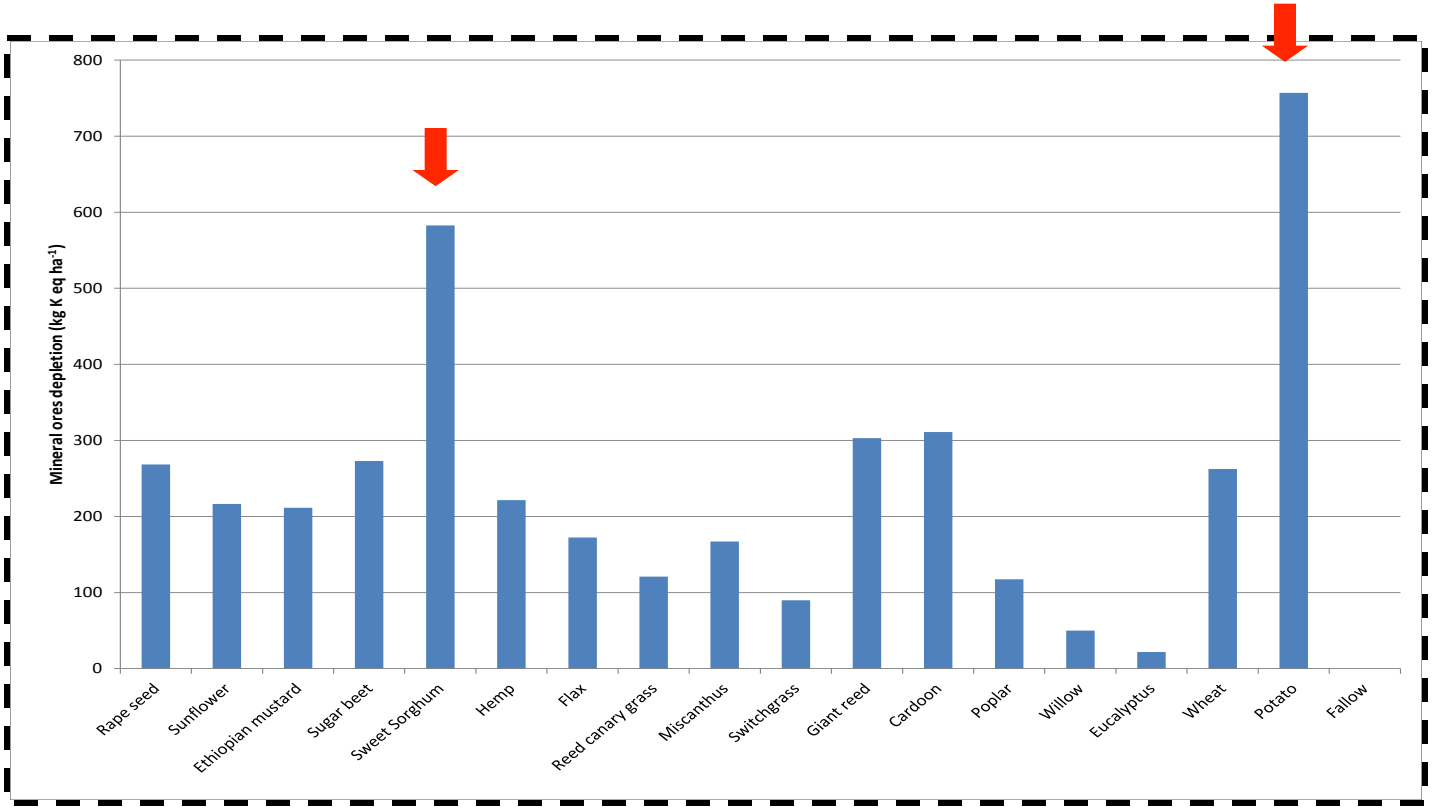
⇨ short permanence in soil

⇨Negative aspect: aquifer refilling slows down

⇨ Deeper roots

⇨High water needs

Impact on mineral resources

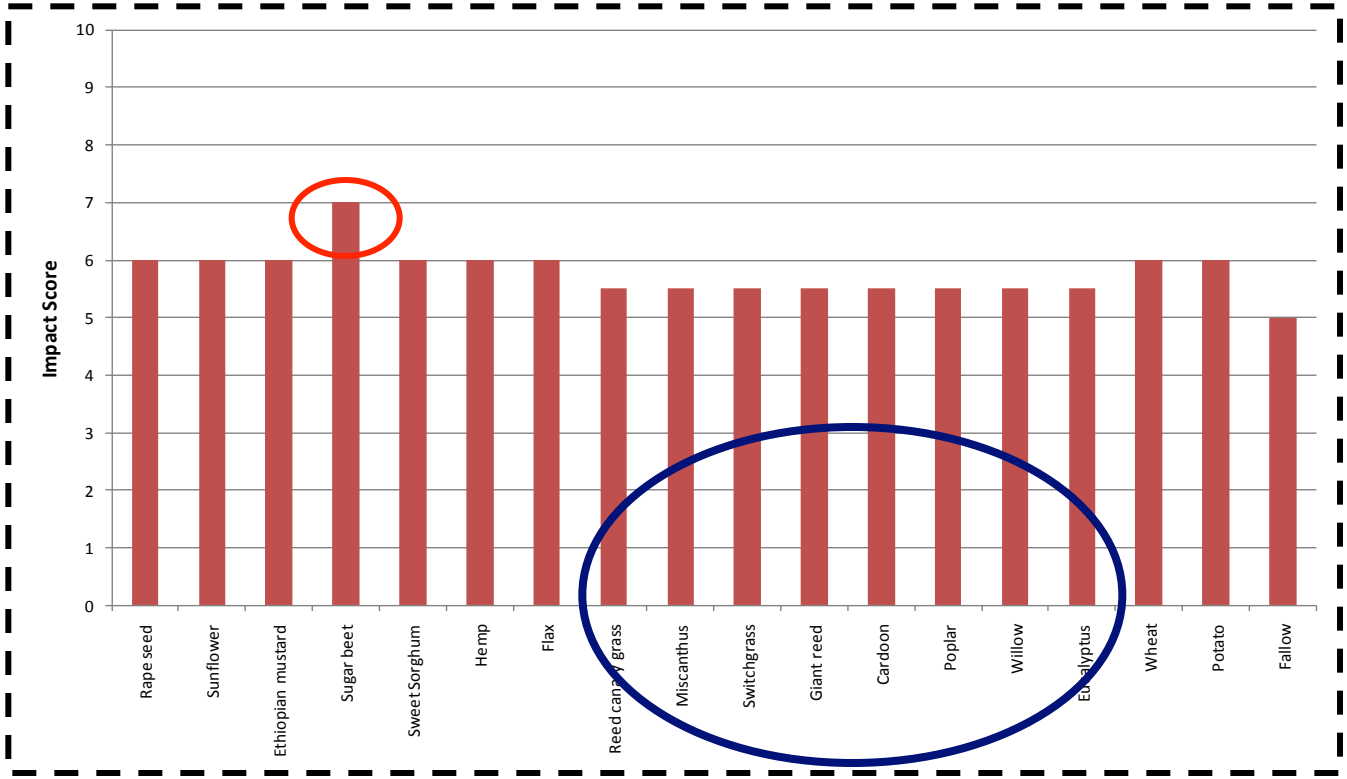


⇨Perennials are less P and K demanding

⇨Differences to annuals not so significant

⇨ higher risk

Waste production and use

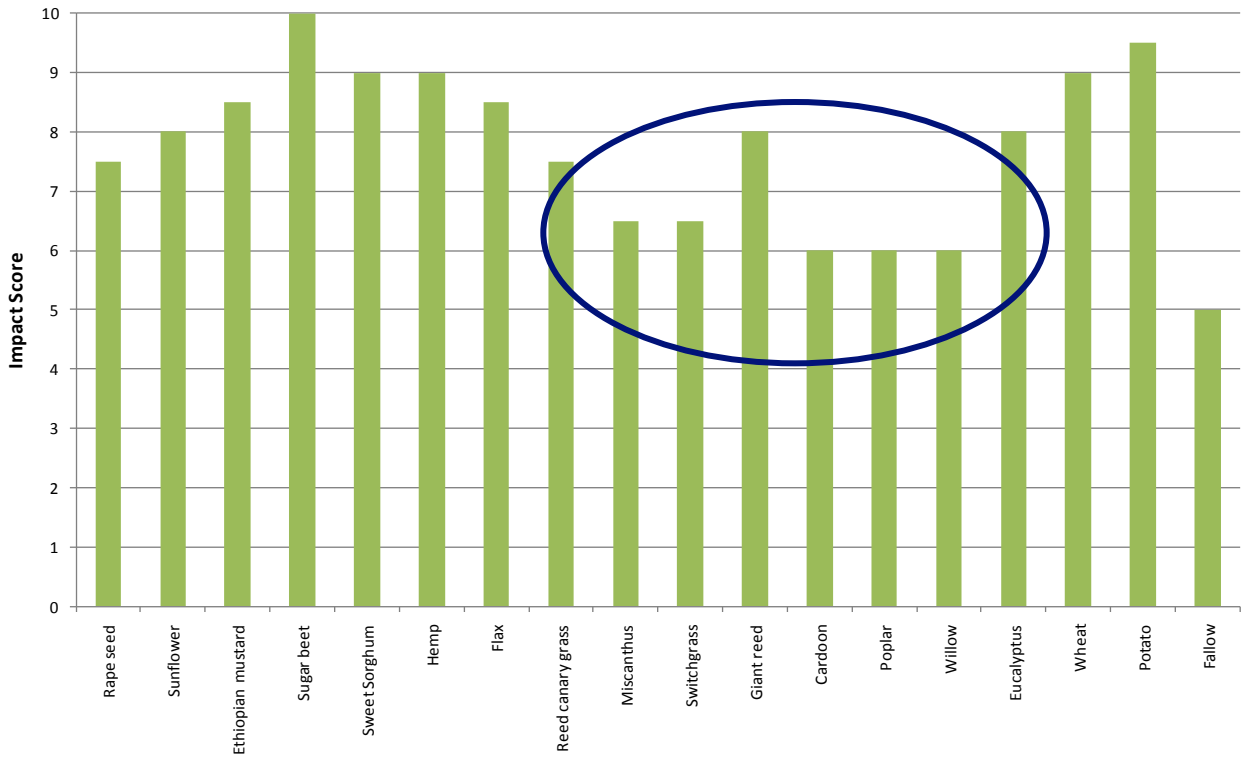


⇨ less waste, because less management intensive

⇨higher risk, soil sticking during harvest

⇨all, apt remediators

Biodiversity

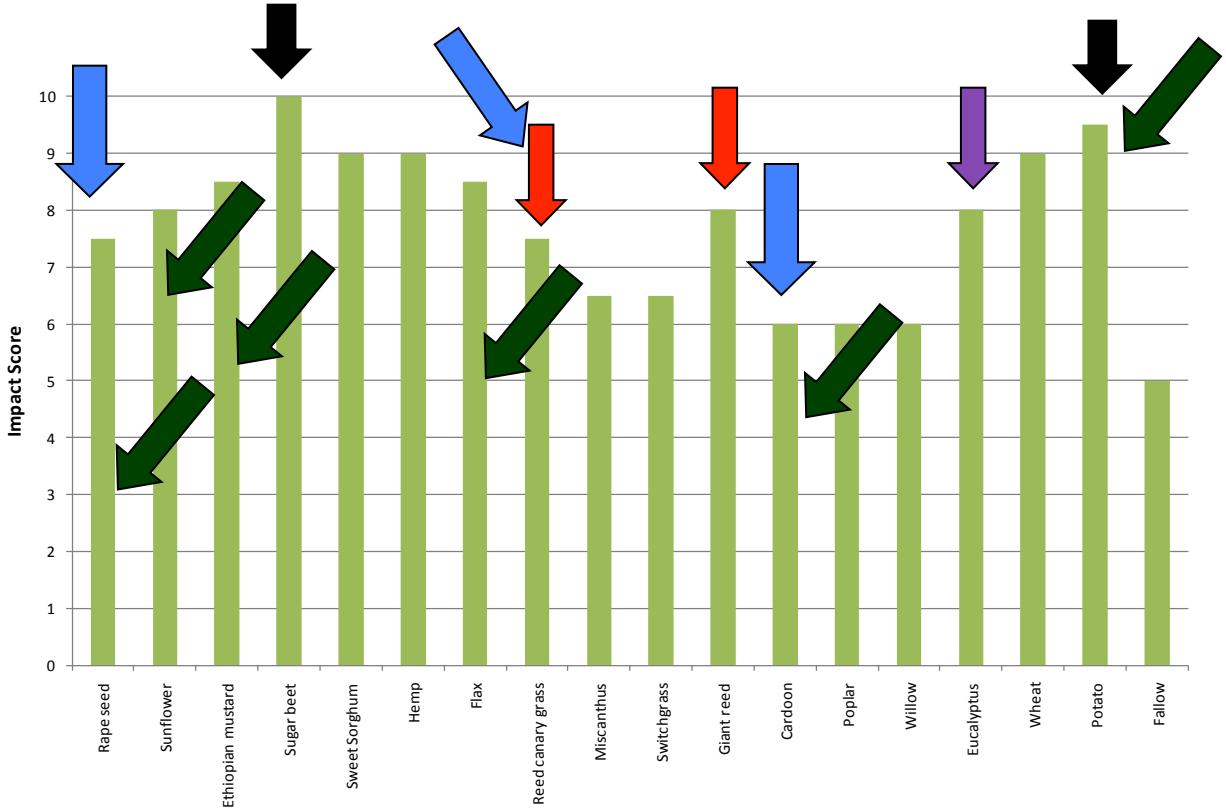


⇨ all crops, monoculture, infringement to biodiversity

⇨ reduced soil tillage, agrochemicals, high biomass

⇨ favors soil microfauna, gives shelter to invertebrates and birds

Biodiversity



⇨ aggressive

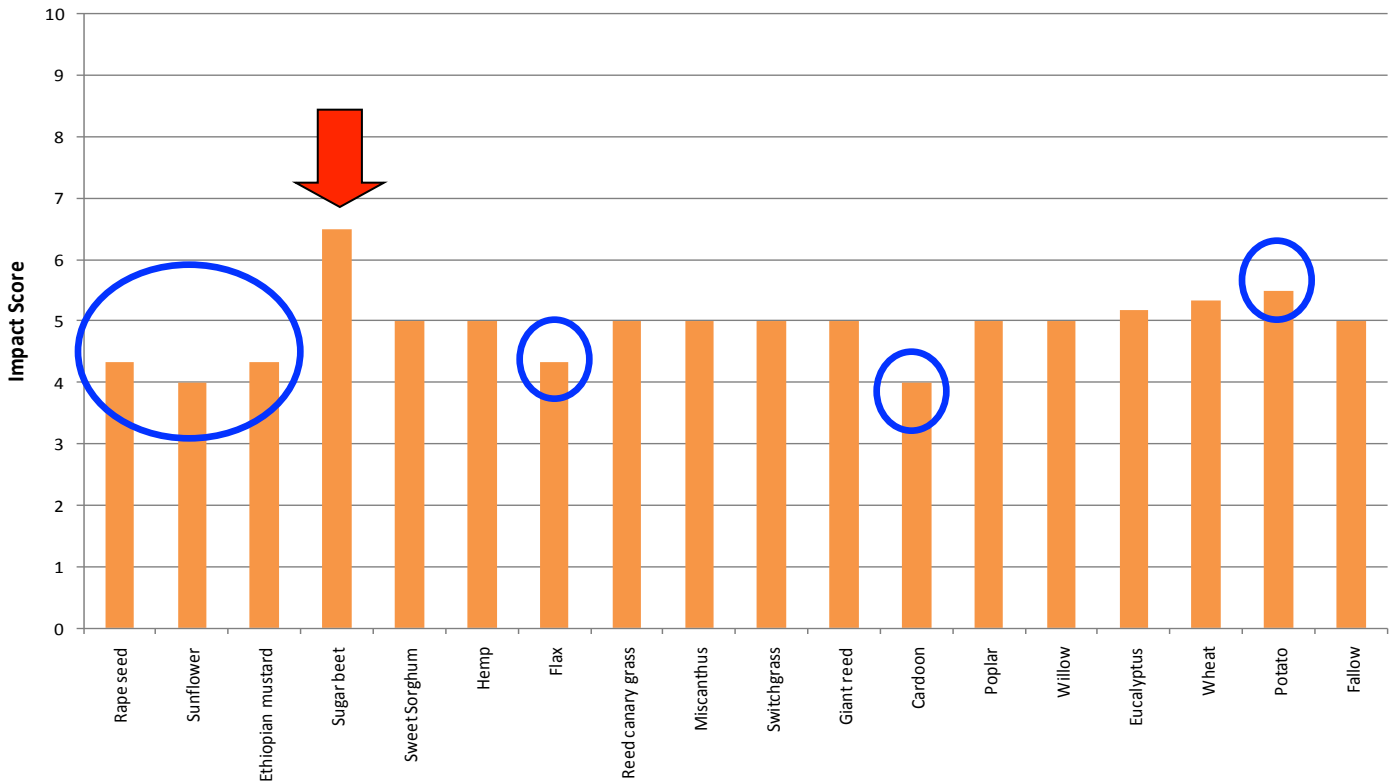
⇨ allelopathy

⇨Soil cover removal

⇨ benefits from being native

⇨Blossoming give benefits

Landscape



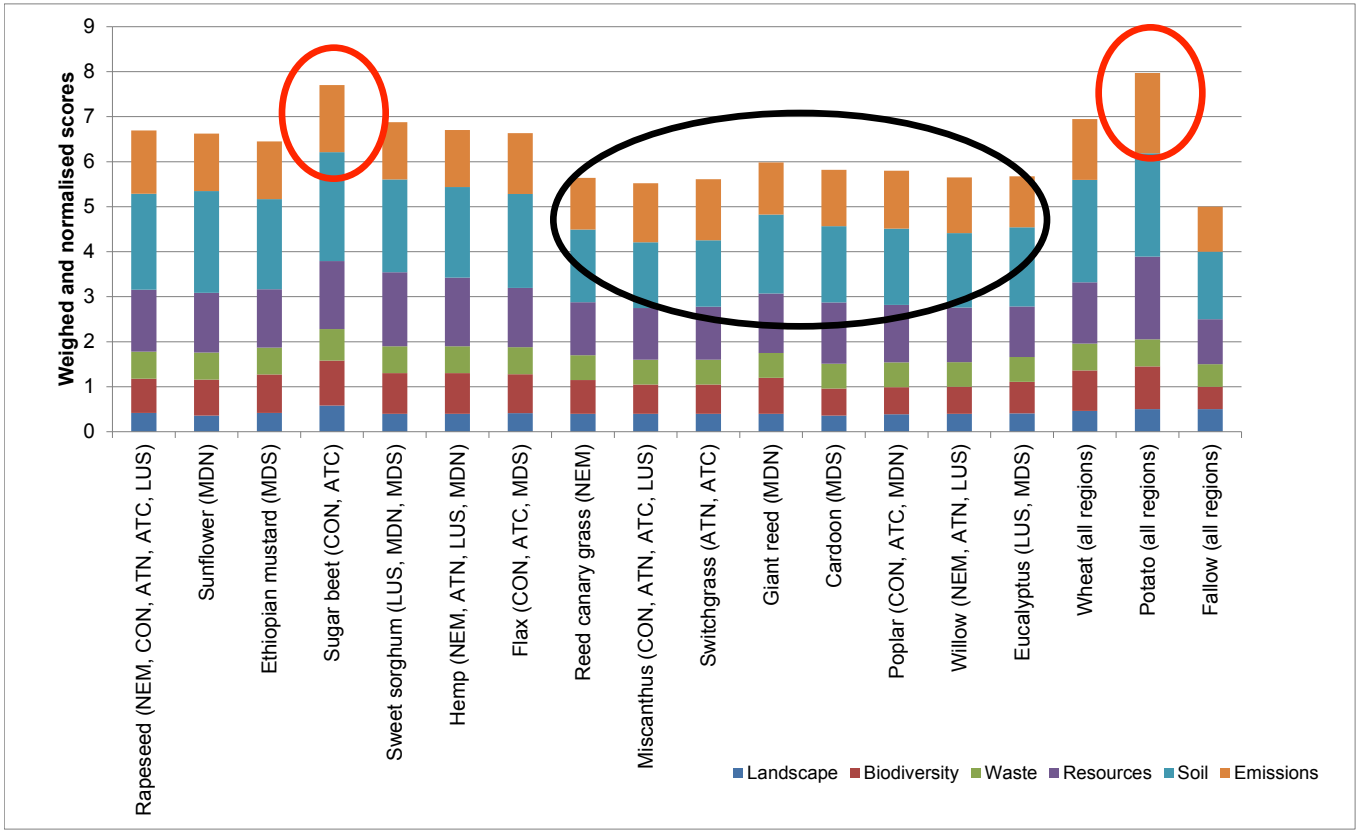
⇨Structure

⇨Color

⇨blossoming crops - benefits

⇨highly uniform, ground-hugging crop

Overall results



⇨ lower overall impact

⇨crops with highest impact

⇨All, lower impact then potato

⇨All, but sugarbeet, lower impact then wheat

Conclusions and recommendations

⇨ growing energy crops does not inflict higher impact on the environment

⇨compared to wheat and potato farming for food, traditional crops in Europe

(Regarding the studied categories)

Conclusions and recommendations

⇨ Annual crops

⇨ More impact on the environment

⇨ markedly due to biodiversity and erosion

⇨ Annual and woody crops

⇨ more damaging to soil quality

⇨ Differences among crop types, not so evident for the remaining categories

Conclusions and recommendations

- ⇨ Impact reduction strategies
  - ⇨ Limited to crop management options
    - ⇨ Influences emissions, nutrient status and mineral ore depletion
- ⇨ Other, are site-specific dependent
  - ⇨ Intertwined with crop traits

⇨ Adequacy crop-location – important issue

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Thank you

for your attention