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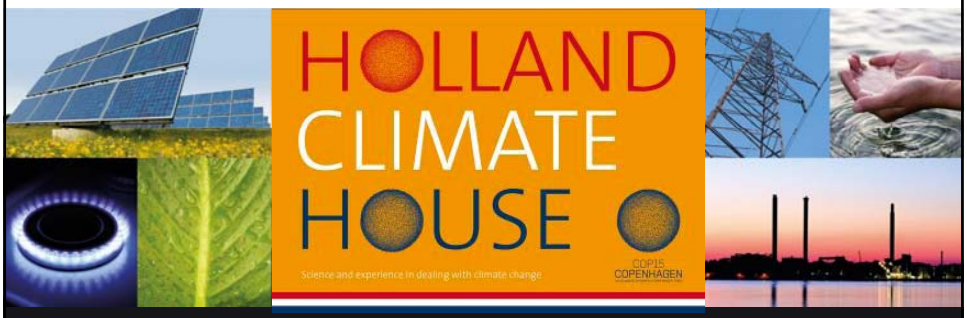
Energy research Centre of the Netherlands

VU University Amsterdam

Biomass for climate change, how to keep the balance right?

Jan Willem Erisman



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Presentation overview

- Bioenergy need and availability
- Conversion technologies
- Environmental impacts
- Nitrogen and Carbon interactions
- Concluding remarks

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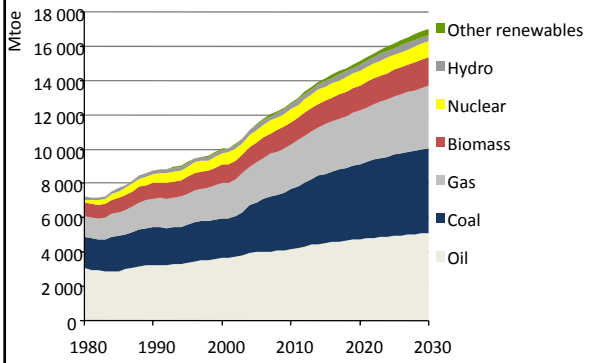
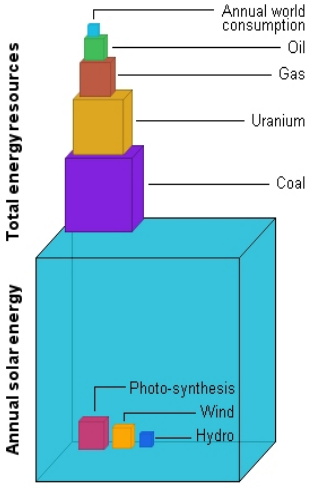
World primary energy demand





Bron: IEA World Energy Outlook 2008

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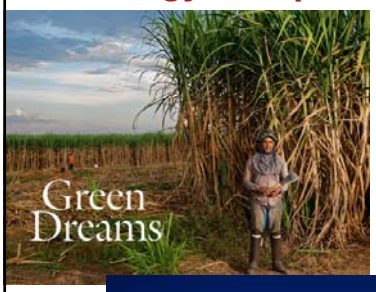
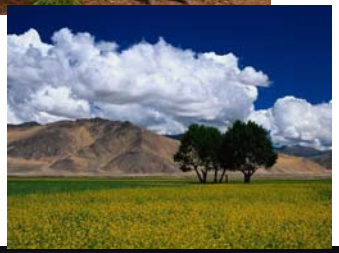
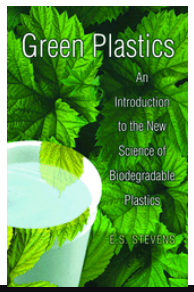
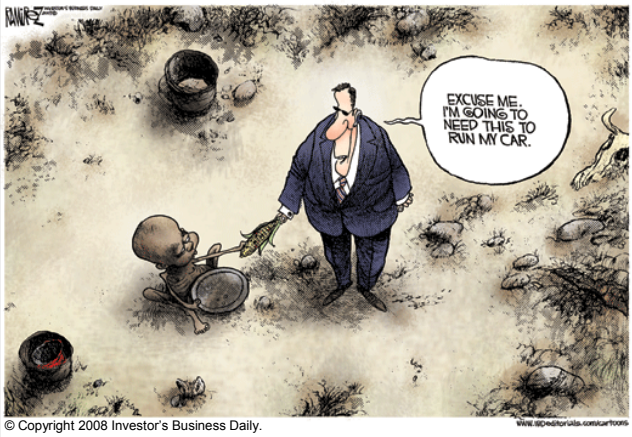
Bioenergy: the possitive side



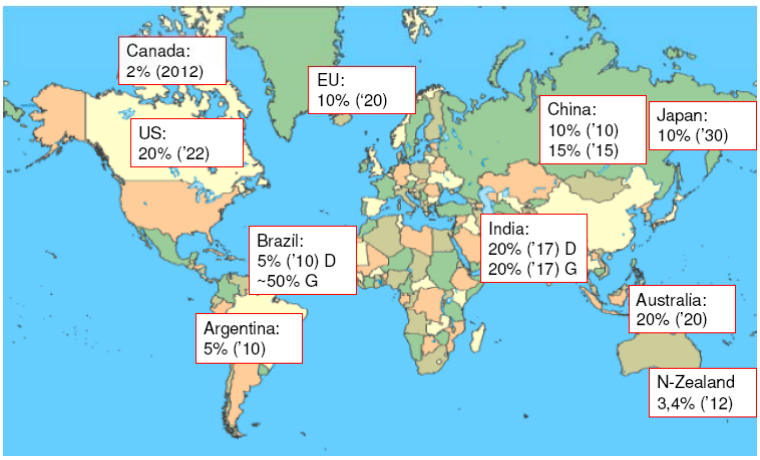




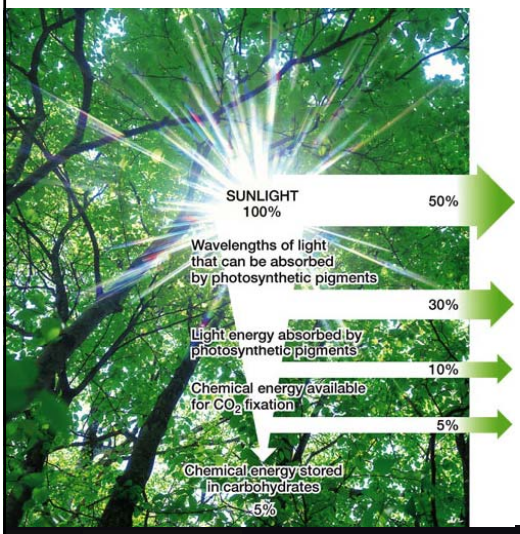
Bioenergy: negative sentiment



Biofuel targets in the world



Efficiency of solar energy for biomass production



By adding nutrients and water:

- yield increase factor 5
- energy yield factor 9
- economic factor 7
- CO_2 reduction 60%

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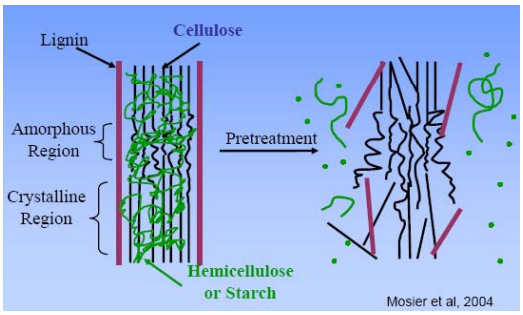
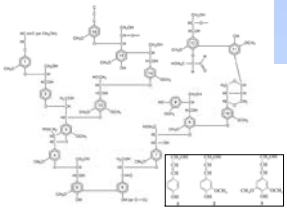
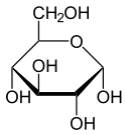
Biomass conversion into products

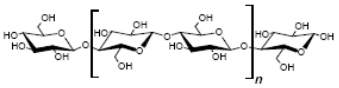




Lignin (spruce)



Glucose C6 sugar



Cellulose

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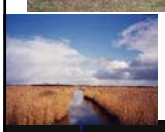
Integrated Biorefinery - Options



Feedstock production, collection, handling & preparation

Hydrolysis Acids, enzymes	Sugars and Lignin
Gasification High heat, low oxygen	Synthesis Gas
Digestion Bacteria	Bio-gas
Pyrolysis Catalysis, heat, pressure	Bio-Oil
Extraction Mechanical, chemical	Carbon-Rich Chains
Separation Mechanical, chemical	Plant Products

USES

Fuels:
- Ethanol
- Biodiesel
- Hydrogen

Power:
- Electricity
- Heat

Chemicals
- Plastics
- Solvents
- Chemical Intermediates
- Phenolics
- Adhesives
- Furfural
- Fatty acids
- Acetic Acid
- Carbon black
- Paints
- Dyes, Pigments, and Ink
- Detergents
- Etc.

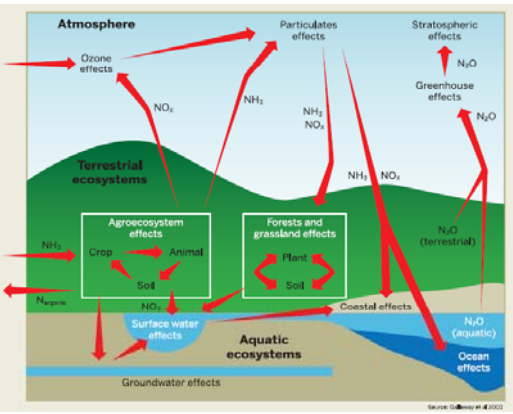
Food and Feed

Potential environmental impacts

- Land use, biodiversity and landscape protection
- Growing of biomass similar impacts as agriculture:
  - pesticides
  - Fertilization: nitrogen, phosphorus
  - Water use
  - Soil, water and air quality
- Conversion and use of biomass
  - Air quality (ammonia, PM, NOx, VOC's)
  - Net-GHG balance: N_2O, CO_2 exchange
  - Ash issues
- Interaction of N and C with climate: Nitrogen as fertilizer and from combustion

The reactive nitrogen formation and the cascade

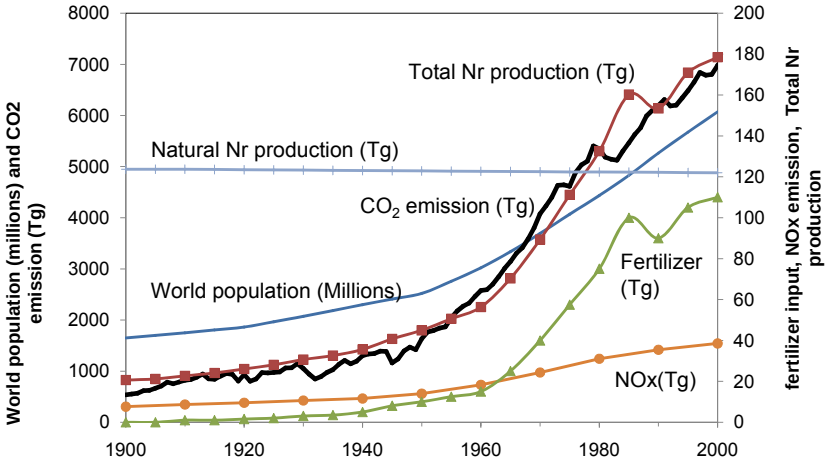
Natural & anthropogenic sources



Cascade through the environment

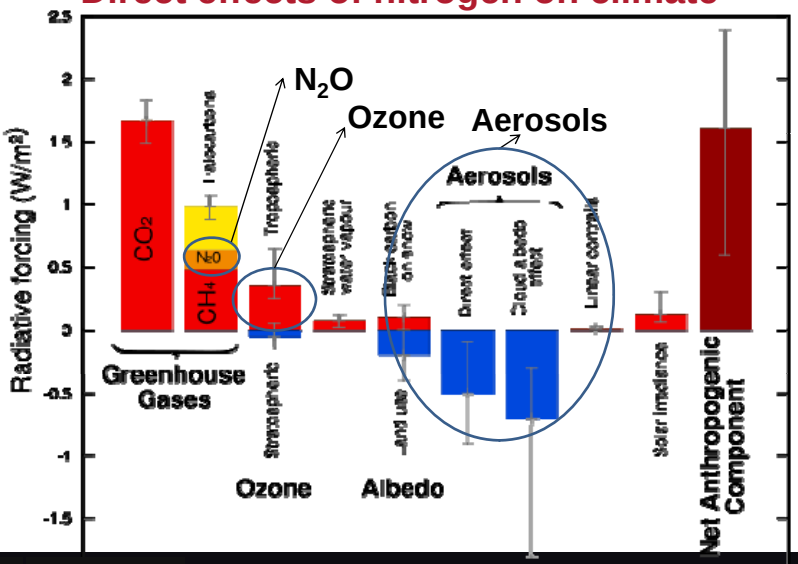
Effects

Nr for food and from energy between 1900 - 2000

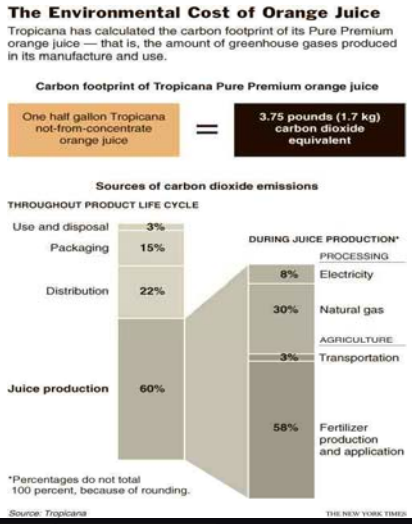


48% of the global population lives because of fertilizers

Direct effects of nitrogen on climate



The carbon footprint of orange juice is Nitrogen!

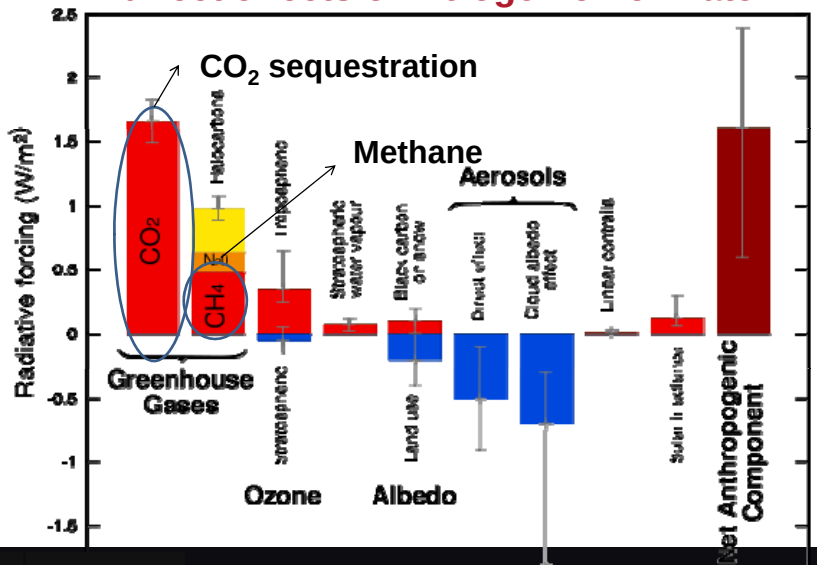


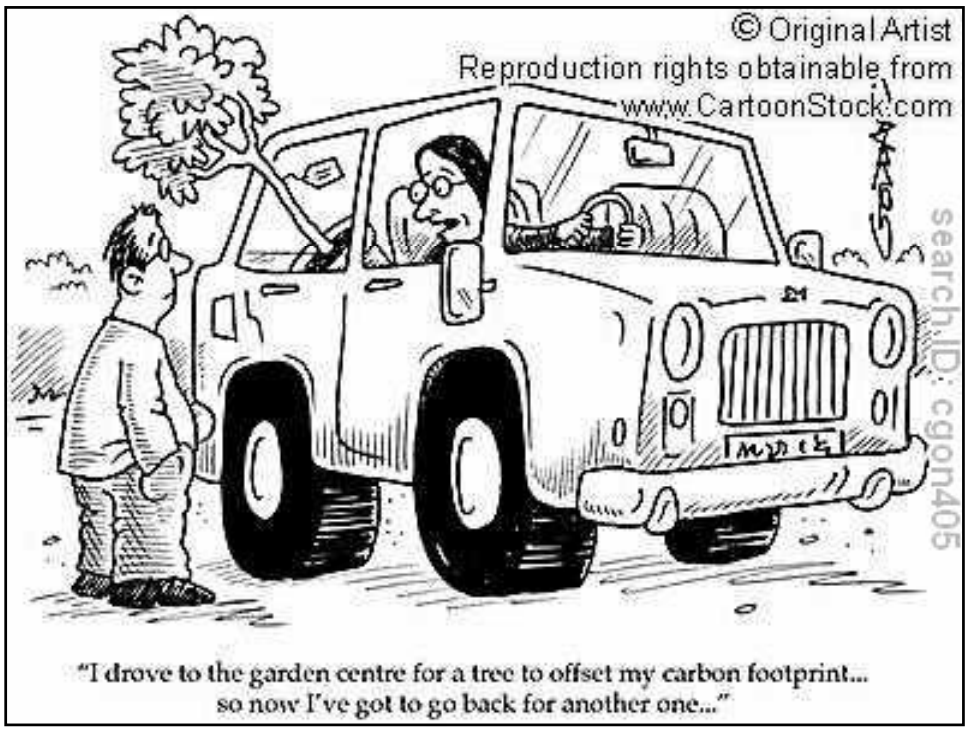
The New York Times

How Green Is My Orange?

and my other food and biofuels?

Indirect effects of nitrogen on climate

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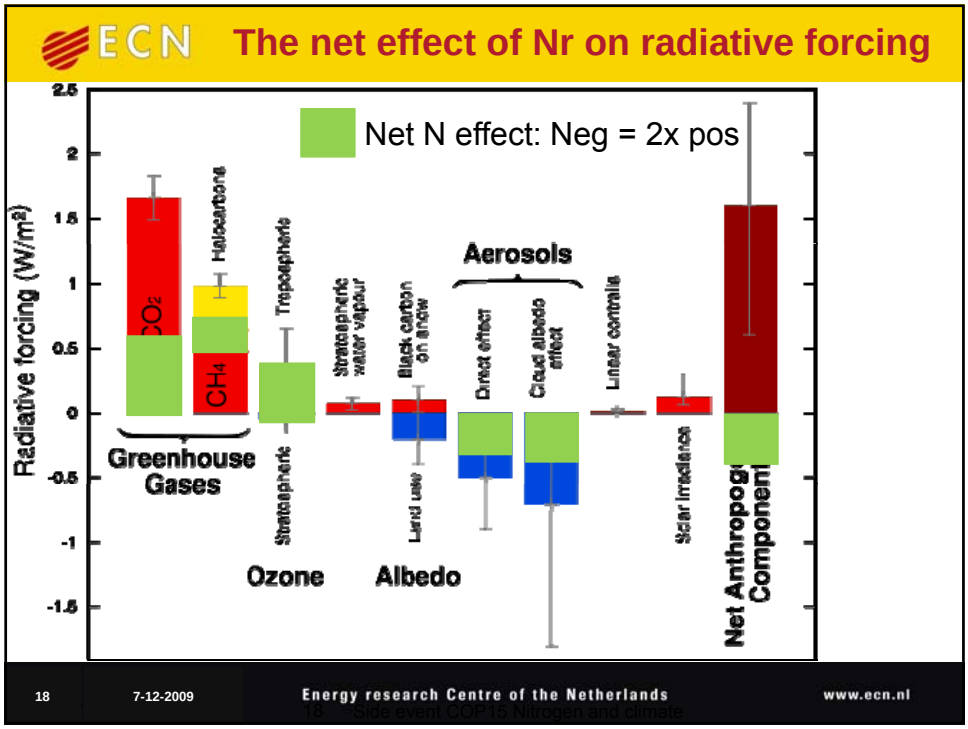
searchID: cgon405
"I drove to the garden centre for a tree to offset my carbon footprint...
so now I've got to go back for another one..."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The net effect of Nr on radiative forcing
Net N effect: Neg = 2x pos
Radiative forcing (W/m²)
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
CO2
CH4
Halocarbons
Greenhouse Gases
Tropospheric
Stratospheric
Ozone
Stratospheric water vapour
Black carbon on snow
Land use
Albedo
Aerosols
Direct effect
Cloud albedo effect
Linear contrails
Solar irradiance
Net Anthropog
Componen
18
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18 Side event COP15 Nitrogen and climate

Opportunities for GHG and N emission reduction

- **Fertilizer production**
  - N_2O abatement
  - Carbon sequestration
- **Fertilizer use**
  - Right time, place, technology, rate
  - Slow release fertilizers
- **Crop and land management**
  - Nitrogen and water management
  - Crop selection
  - Tillage
  - Optimize energy/food yields
- **Product efficiency**
  - Bioenergy/food

ECN catalyst to reduce 50% N_2O at fertilizer plants

Concluding remarks

- Bioenergy is essential for the future energy supply. However, it has to be produced and converted in a sustainable way.
- Nitrogen losses from agriculture and biomass production has direct and indirect impacts on the carbon cycle and on the radiative balance
- Nitrogen deposition can lead to additional carbon sequestration and to impacts on biodiversity and ecosystem services
- Currently LCA studies show a net negative impact of nitrogen on the greenhouse gas balance (N_2O): balance is not right.
- Nitrogen management is essential for the environment and can have a positive effect on climate
- We call for a Special report on Nitrogen and Climate.

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Thank you for your attention!

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NitroEurope IP

TFRN