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Bio-Economy: Chances, Challenges, and Perspective of the System as a Whole

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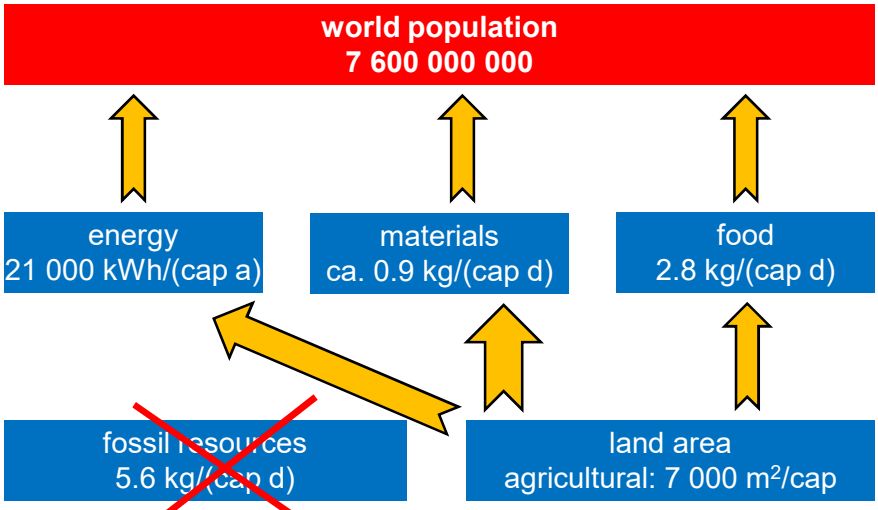
agenda

- motivation
- world population
- utilization of land-area
- bio-economy: chances & challenges
- consequences

Pfennig, A., 2019:
Sustainable Bio- or CO2 economy: Chances, Risks, and Systems Perspective.
ChemBioEng Reviews, 6(3), 90-104.
https://doi.org/10.1002/cben.201900006

THE major driver



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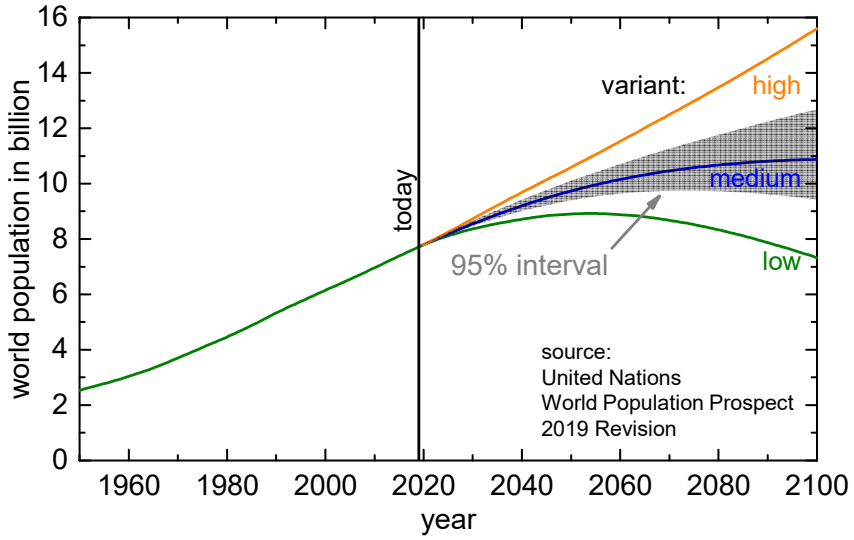
future development of world population



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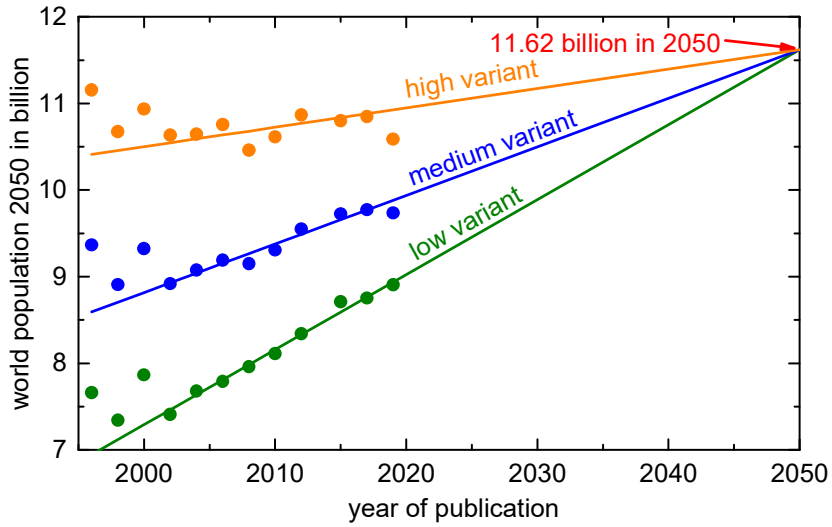
development of UN-WPP prediction for 2050



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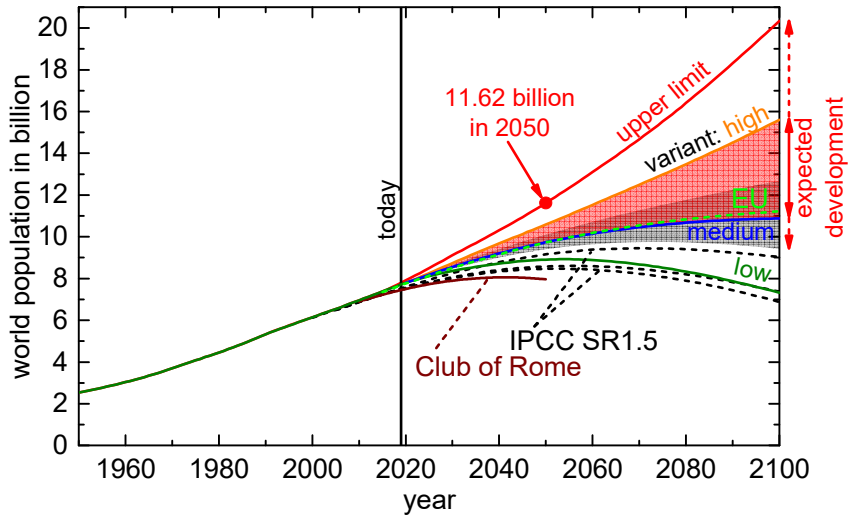
future development of world population



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modelling approach

- not an IAM (integrated assessment model)
- based on simple balances:
  - influence of individual parameters directly visible
  - main drivers easy to realize

$$\text{required land area} = \frac{\text{world population} \times \text{demand per person}}{\text{land-area specific productivity}}$$

negative influence of too detailed models:
H. Hasse, 2003: Thermodynamics of Reactive Separations.
in: K. Sundmacher, A. Kienle (Eds):
Reactive Distillation. Status and Future Directions.
Wiley-VCH, Weinheim

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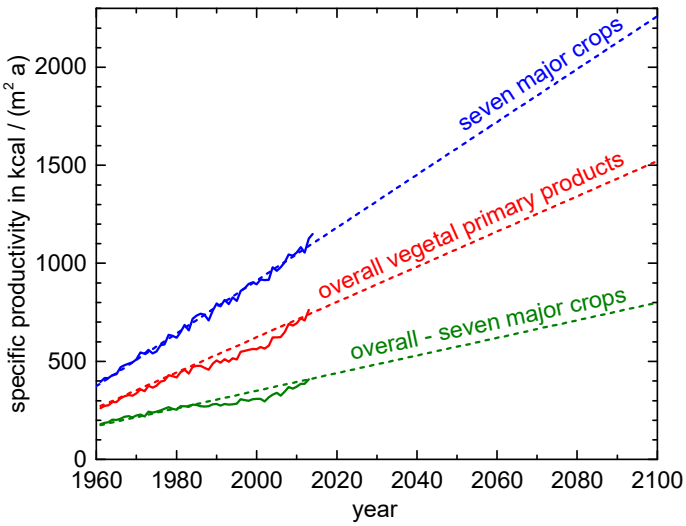
land-area specific agrigultural productivity



seven major crops:
- barley
- corn
- oil palm
- rice
- soybeans
- sugar cane
- wheat

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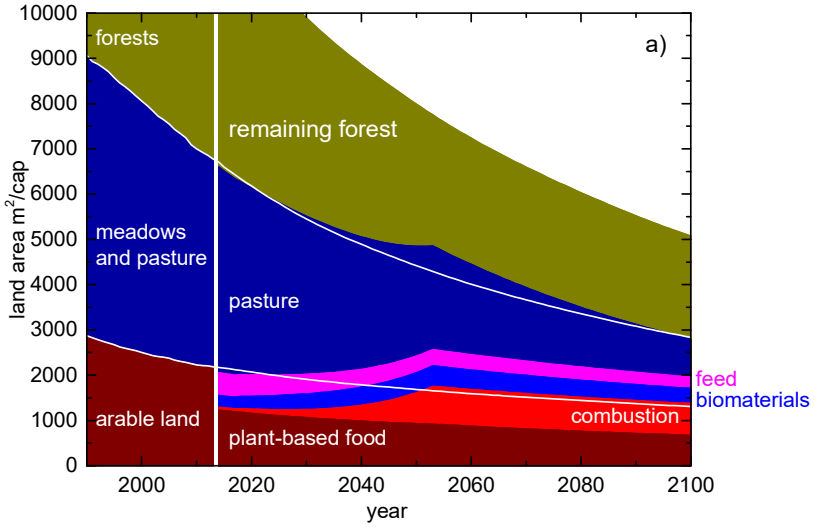
land-area: challenging, high pop. variant



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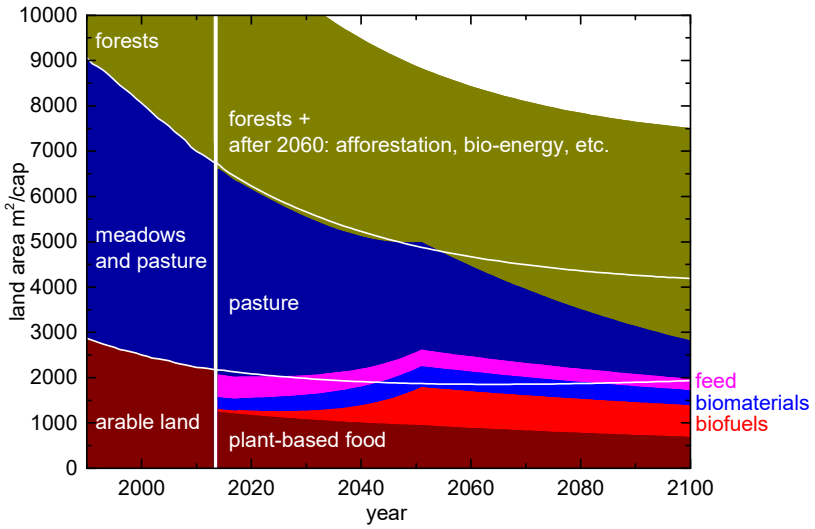
land-area: challenging, medium pop. variant



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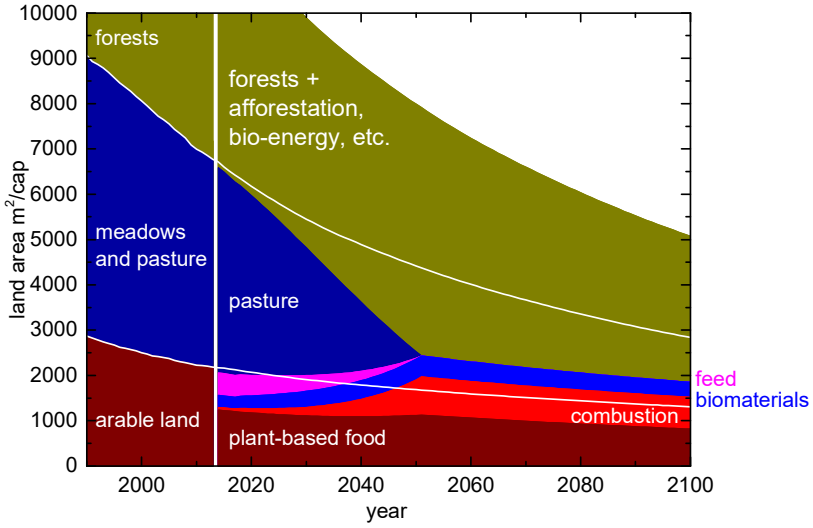
land-area: challeng., high, vegetal



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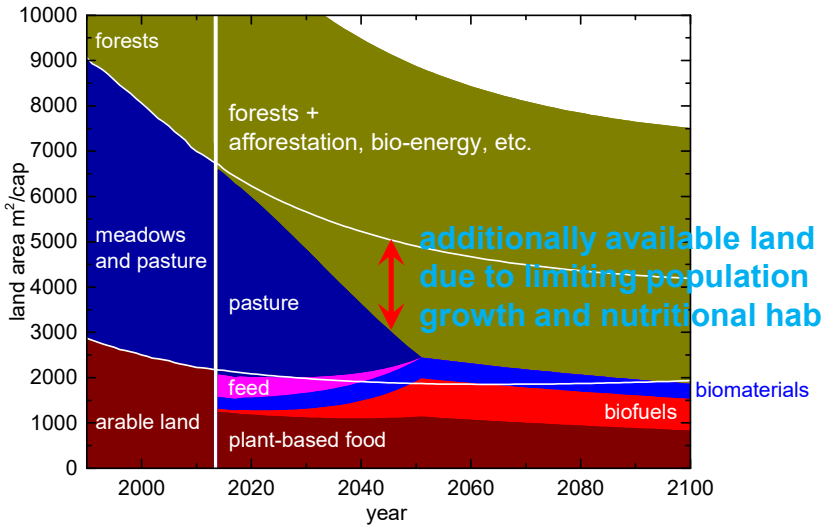
land-area: challeng., medium pop., vegetal



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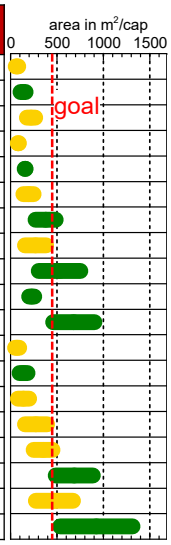
options for bio-based chemicals 2050

gen	feedstock	products
first generation	sugar beet	sugar or ethanol + CO_2
		ethanol
		ethylene
	sugar cane	sugar or ethanol + CO_2
		ethanol
	corn	sugar or ethanol + CO_2
		ethanol
	wheat	sugar or ethanol + CO_2
		ethanol
	oil palm	plant oil
	rape seed	plant oil
second	miscanthus/reeds	sugar or ethanol + CO_2
		ethanol
	wood	sugar or ethanol + CO_2
		ethanol
third	corn straw	sugar or ethanol + CO_2
		ethanol
	wheat straw	sugar or ethanol + CO_2
		ethanol



ranges:
maximum national and world average productivity projected for 2050

color:
- technically realized
- partly pilot-plant

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bio- vs. CO_2-economy

- utilize CO_2 from point source
  - methane 1124 € / tC
  - methanol 844 € / tC
- utilize CO_2 from air
  - methane 1650 € / tC
  - methanol 1360 € / tC
- starch from wheat 616 € / tC
- crude oil ≈ 440 € / tC

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conclusion

bio-based chemistry:
- cheaper, developed technology
- competition for land area

CO_2-based chemistry:
- more expensive, new processes
- no fertile land area required

Choices:

A. CO_2-based chemistry
- significant economic & technological risks for our future

B. bio-based chemistry, conventional
- more people undernourished
- cut down forests

C. bio-based chemistry, vegan, 2 children per family
- cheap, developed, enough space for ecology

You choose with your daily choices!

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