Vingsted August 22 -2013

Self-sufficiency of fuels for tractive power in small-scale organic agriculture

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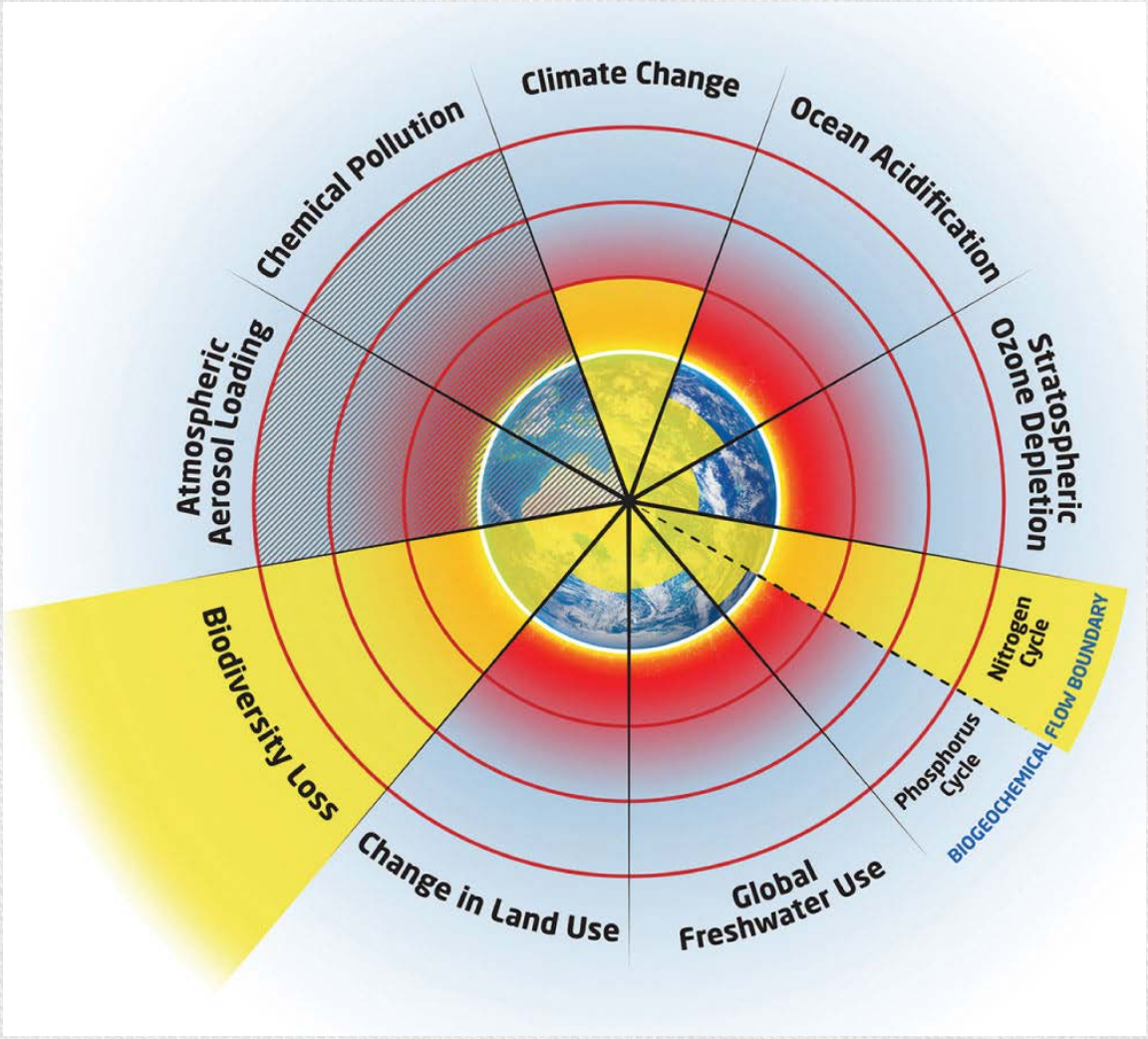
Land distribution:
8 ha arable land
5.5 ha meadow land
3.5 ha pasture
18 ha forest (10.5 ha grazed)

High input agriculture contribute to crossing the ”Planetary boundaries”



Rockström et al., 2009

Fuel for tractive power

Draught horse power?

- Comparable to other biofuels, since there is a conversion of biomass into work, with biological by-products
- ”Efficiency” of biomass into work is similar to other, liquid biofuels
- Power output suitable for smaller scale

Energy crops at a farm

- Offsets food production
- Theoretical and practical limitations by e.g. crop sequence
- Draught horses make use of indispensable leys => easier to put into a well-composed crop sequence

Research question

How (much) does biomass-derived tractive power affect the food production at the farm?

Measure:
Number of people the farm can supply, **Np**

- **Model of Np:**
  - Animal and crop production integrated
  - Animals should not eat what humans could eat
  - Feedplans and harvests combined to decide number of animals and offspring
  - Harvests, meat, milk and egg decides how many people the farm can supply
  - 2500 kcal/person and day

Scenarios

I. Conventional diesel for tractor (reference scenario)
II. Rapeseed oil for tractor combined with one draught horse
III. Ethanol from wheat as tractor fuel. The ethanol produced off-farm in large scale facility
IV. Ethanol from potato in tractor, ethanol produced on farm

”Waste” for fuel?

Is the existence of ”waste” a product of badly optimized systems?

“In fact, when animals live on farms the very idea of waste ceases to exist; what you have instead is a closed ecological loop.”

(Pollan, 2006).

Results

Scenario	I	II	III	IV
Description	Diesel	Rapeseed oil and horse	Wheat ethanol	Potato ethanol
Np	69	65	53	57
% of Np_I	100	94	77	82

Discussion: context

- Globally 0.2 ha arable land per person – our farm need to supply 58 persons
- This is managed when using draught horse power combined with rape-seed oil in a tractor, but not when using ethanol from wheat or potato for tractive power
- Future fuel shortage – agriculture may be prioritized?
- Draught horses reduces total fuel requirement, can be appropriate power output for small-scale
- Benefits in terms of less soil compaction

Weekly diet from studied system

Product	Quantity	Unit (per week)
Rapeseed oil	70	g
Wheat flour	660	g
Oat meal	340	g
Buckwheat (whole)	370	g
Potato	2.030	kg
Vegetables	6.540	kg
Meat from lamb	49	g
Meat from calf	235	g
Meat from poultry	14	g
Egg	268/3.7	g/number of eggs
Milk	11.7	kg

Discussion: production

- Milking cattle – efficient food production from leys
- No milk, only sheep – 50 % less people supplied
- Larger meat production by keeping calves for two years age instead of one, small impact on Np
- Larger yields had significant increase on Np
- Optimization? Larger yields depletes nutrients faster…

Conclusion

Horse power...

Thank you for your Attention!

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