

# New land-use based method to assess organic dairy farming efficiency

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## WHY?

Feeding the growing world population requires **wise use of arable land** to ensure efficient energy and protein production. While ruminants can convert grass into nutritious food for humans, their efficiency goes down when fed on arable land, leading to feed-food competition that negatively impacts planetary health.

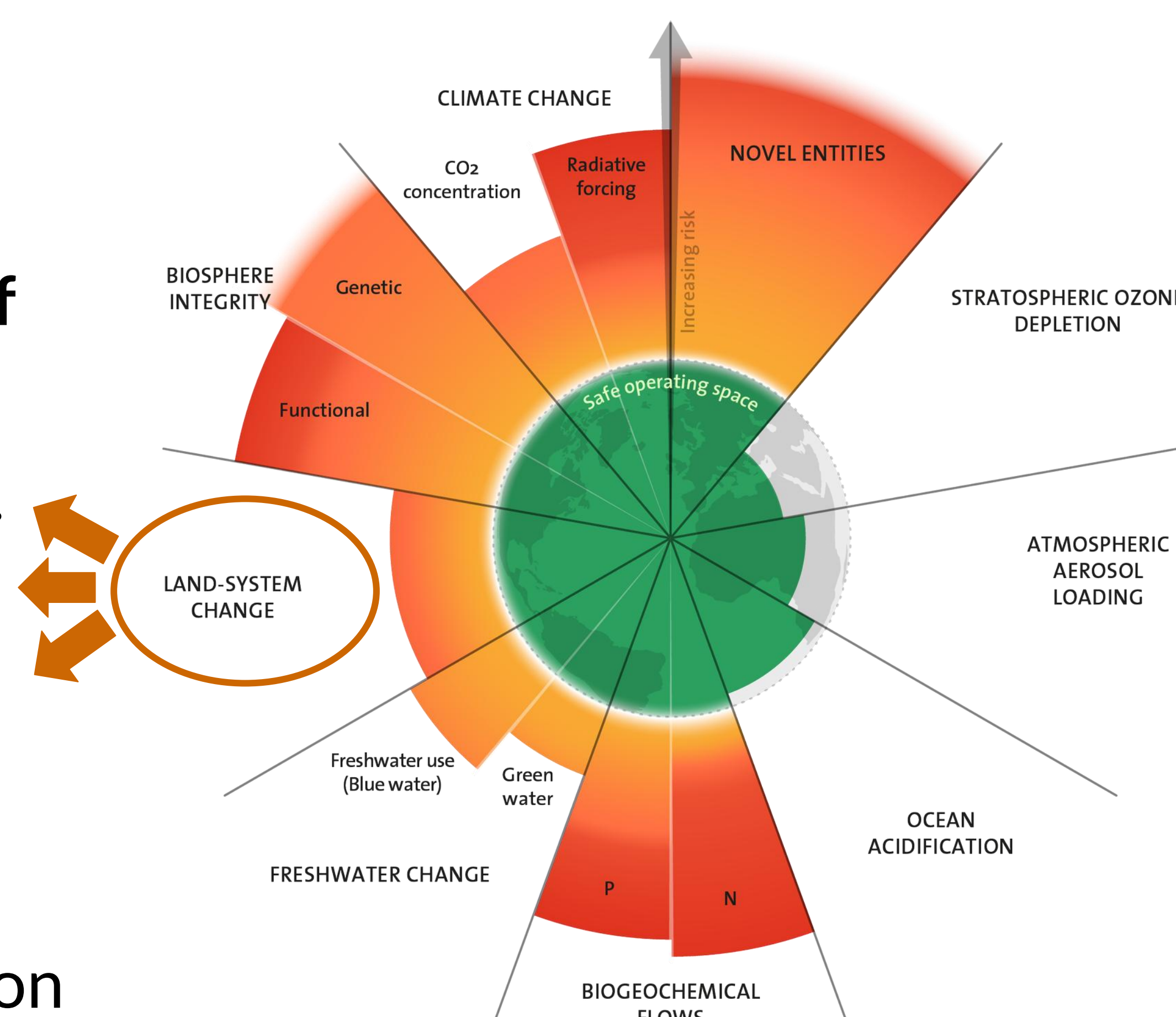


Figure 1: the planetary boundaries framework. Credit: "Azote for Stockholm Resilience Centre, based on analysis in Richardson et al 2023" <https://www.stockholmresilience.org/research/planetary-boundaries.html>

## EFFICIENCY

Efficiency of dairy cattle farms is typically measured as output per cow (e.g., *annual milk yield per cow*), or economics (e.g., *the gross margin*), or environmental efficiency (e.g., *greenhouse gas emissions per liter milk*). However, the characteristics of the land used for feeding the cattle is rarely considered, despite that cows can feed on land not suitable for growing crops, but suitable for pastures and biodiversity promotion.

## OBJECTIVES

To foreground relations between dairy cattle, land characteristics and land use, when measuring efficiency in a mixed-methods study. To perform a situated analysis of four Danish organic case farms considering landscape characteristics, farm designs, land use, food outputs, weather conditions, farmer considerations and motivations.

## LAND-USE EFFICIENCY MEASURE

Feed-food competition assessed as land-use ratio (LUR) compare current to hypothetical plant-based food outputs (i.e., pLUR for quality-adjusted protein, and eLUR for human-digestible energy) on the same land.

**New:** Land characteristics - and leys/no leys - included in scenarios.

$$LUR = \frac{\text{Potential plant} - \text{sourced food output}}{\text{Current food output}}$$

## LUR INTERPRETATION

eLUR (or pLUR) <1 indicates a farm producing more energy (or protein) for human consumption than a pure food crop production would have on the suitable area used by the farm.

## FOUR DANISH CASE FARMS RANKED ACCORDING TO LUR<sub>ley</sub> DATA FROM 2022-2023

- 1) dairy production on marginal soils  
eLUR<sub>ley</sub>=0.91-0.99;  
pLUR<sub>ley</sub>=0.39-0.42
- 2) feed-no-food mixed grassfed dairy cattle-crop system: eLUR<sub>ley</sub>= 1.01-1.14; pLUR<sub>ley</sub>=0.89-0.96
- 3) high-yielding dairy farm with crop production: eLUR<sub>ley</sub>= 1.35-1.74; pLUR<sub>ley</sub>=0.75-0.82
- 4) regenerative grass-based dairy production on good arable land: eLUR<sub>ley</sub>= 4.04-3.59; pLUR<sub>ley</sub>=1.74-1.54

NB: Uncertainties due to difficulties getting precise data on input/output

## CONCLUSION

Keeping cattle for dairy production on marginal soils poor for growing crops, and 'feed-no-food' mixed cattle-crop production can be more efficient and land use wise (despite having lower milk production per cow) than pure plant food in systems aiming to protect the environment.

