



> Land use efficiency to protein production of French dairy cattle contrasted in their feeding systems

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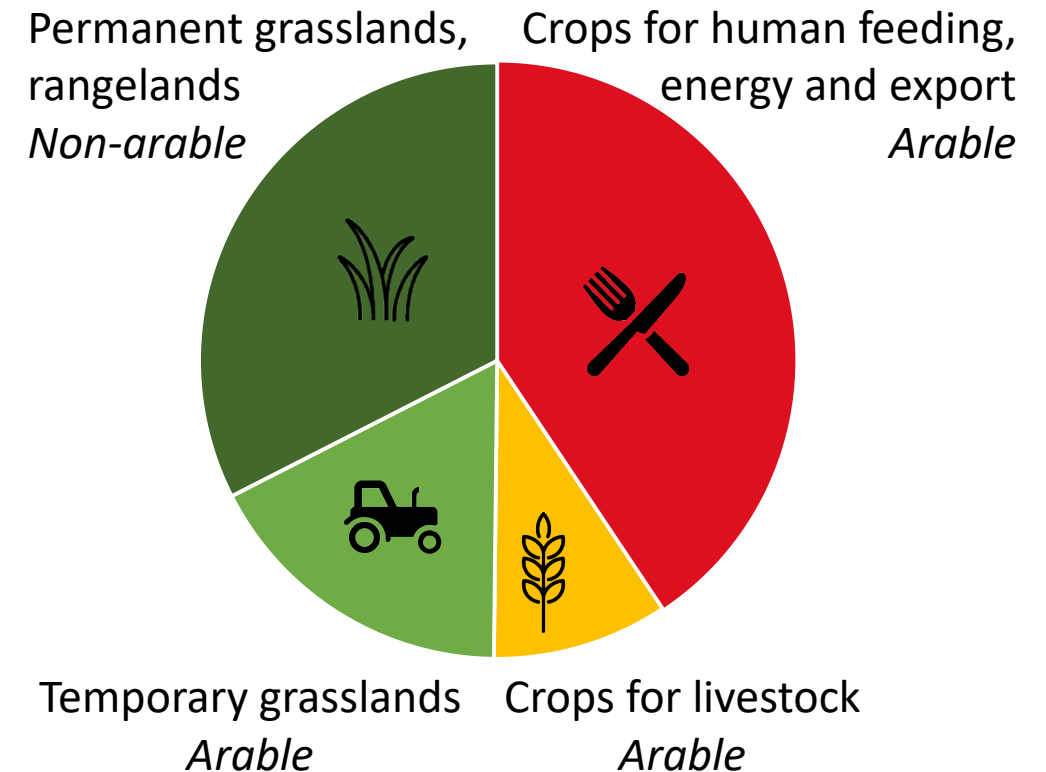
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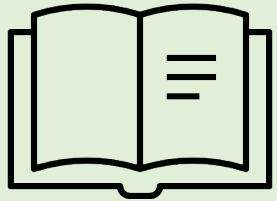
➤ Introduction

- In a context of limited resources, ruminant production raises the question of efficient land use, as a component of environmental sustainability
- Indeed, in France livestock uses 56% of the agricultural area
 - but 55% of this area are permanent grasslands, that are for a large part non-arable and contribute to C storage, biodiversity, quality products and landscape
- The aim of this study was to evaluate the land use efficiency for protein production of French dairy cattle systems differing in their feeding systems (maize vs grasslands)



Agricultural land utilisation in France, 2020

➤ Assessing land use efficiency



Common metric to assess
land use efficiency:
area used / kg animal source food



26 - 54 m² .kg⁻¹ milk
37 - 2100 m² .kg⁻¹ meat

Nijdam et al., 2012



Land Use Ratio :
potential of plant production /
animal production on the same land
(Van Zanten et al., 2016 ; Hennessy et al., 2021)



No reference
in France

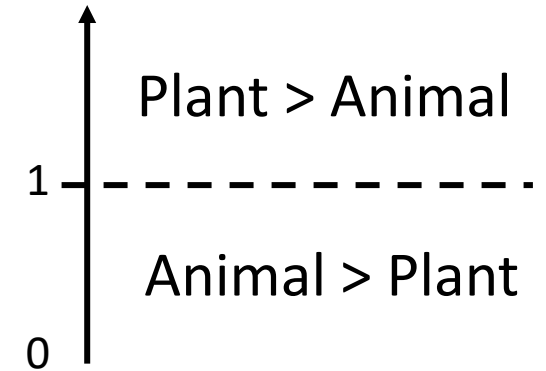
Application at the
farming system level



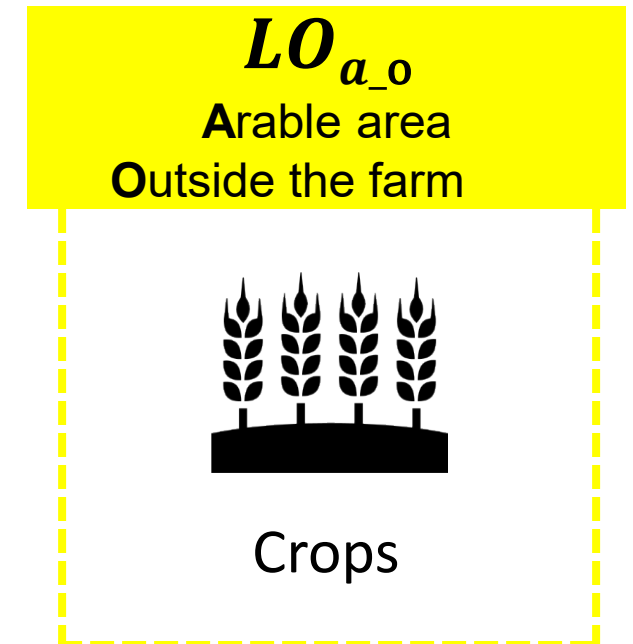
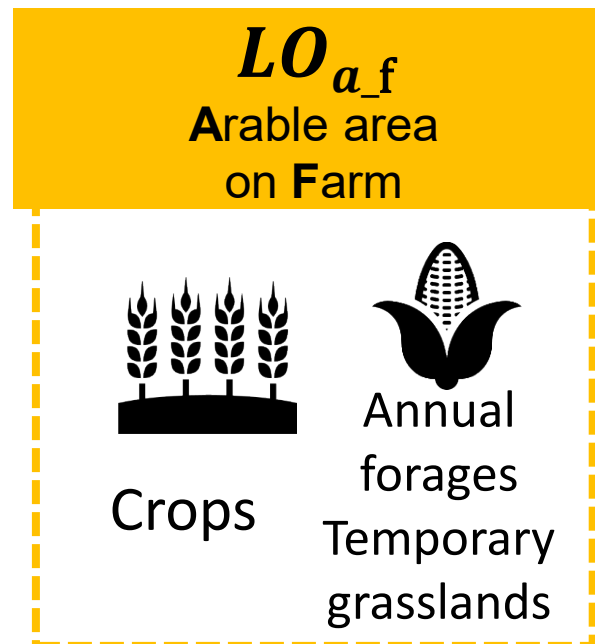
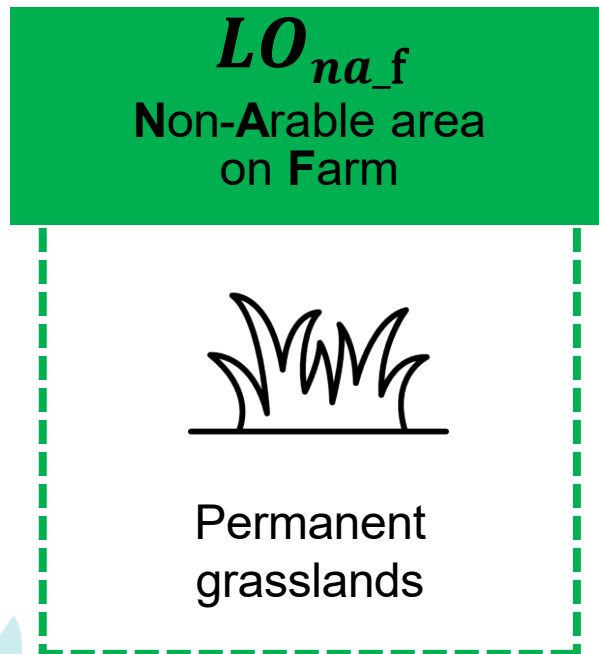
➤ Land use ratio

$$LUR = \frac{\sum_{i=1}^n \sum_{j=1}^m (LO_{ij} \times HDP_j)}{HDP \text{ of 1 kg of ASF}}$$

LO : Land area Occupied
 HDP : Human digestible protein
 ASF : Animal source Food
 i : feed ingredient
 j : type of land used



type of land classification

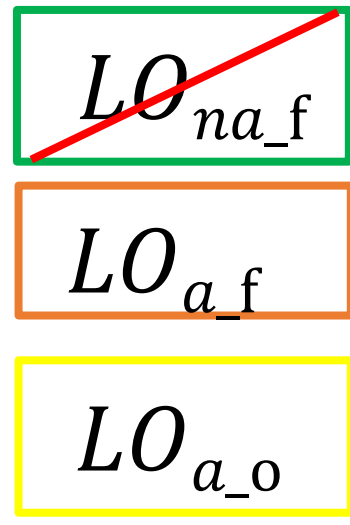


➤ Land use ratio: *potential plant production*

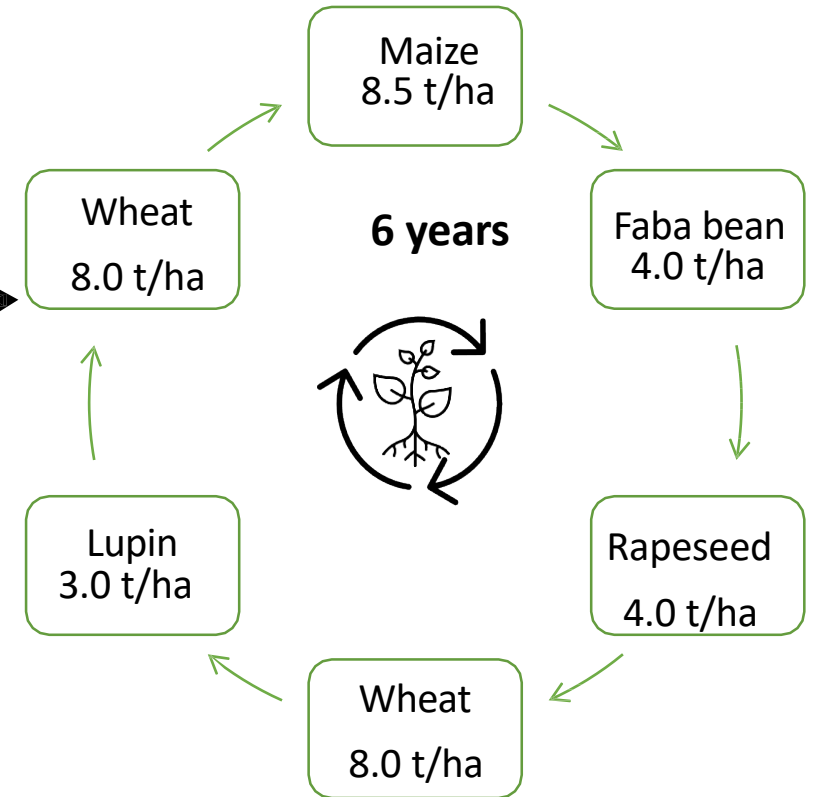


Production scenarios toward agroecology (Wezel et al., 2020)

- Long crop rotations
- Cereals & legumes
- Low inputs

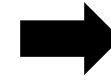


6 years crop rotation



➤ Land use ratio: *animal protein production*

$$LUR = \frac{\sum_{i=1}^n \sum_{j=1}^m (LO_{ij} \times HDP_j)}{HDP \text{ of 1 kg of ASF}}$$



protein for human /
kg animal product

Milk

From the
data at the
farm level

- Sold milk (kg)
- Milk protein content (g/kg milk)

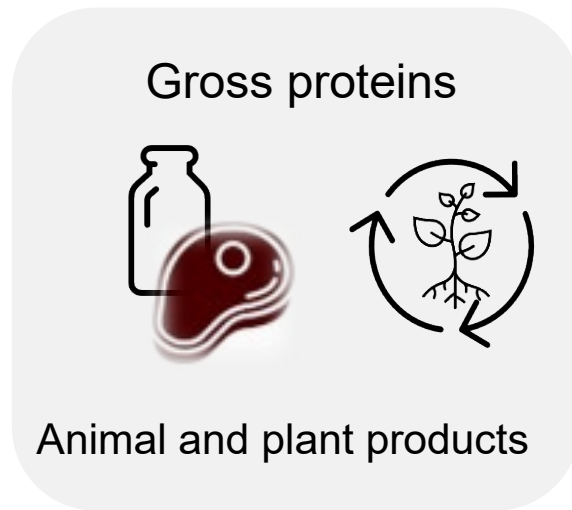
Meat

- Meat produced (kg)
 - Carcass yield
 - Meat yield
- Protein content (g/kg)



➤ Land use ratio: *2 ways of expressing the quality of plant and animal protein*

$$LUR = \frac{\sum_{i=1}^n \sum_{j=1}^m (LO_{ij} \times HDP_j)}{HDP \text{ of 1 kg of ASF}}$$



Van Zanten
et al., 2016

Digestibility
of proteins for
humans (%)

Digestible
proteins (kg)

Hennessy
et al., 2021

HEP (%)
Human Edible Protein
(Laisse et al., 2018)

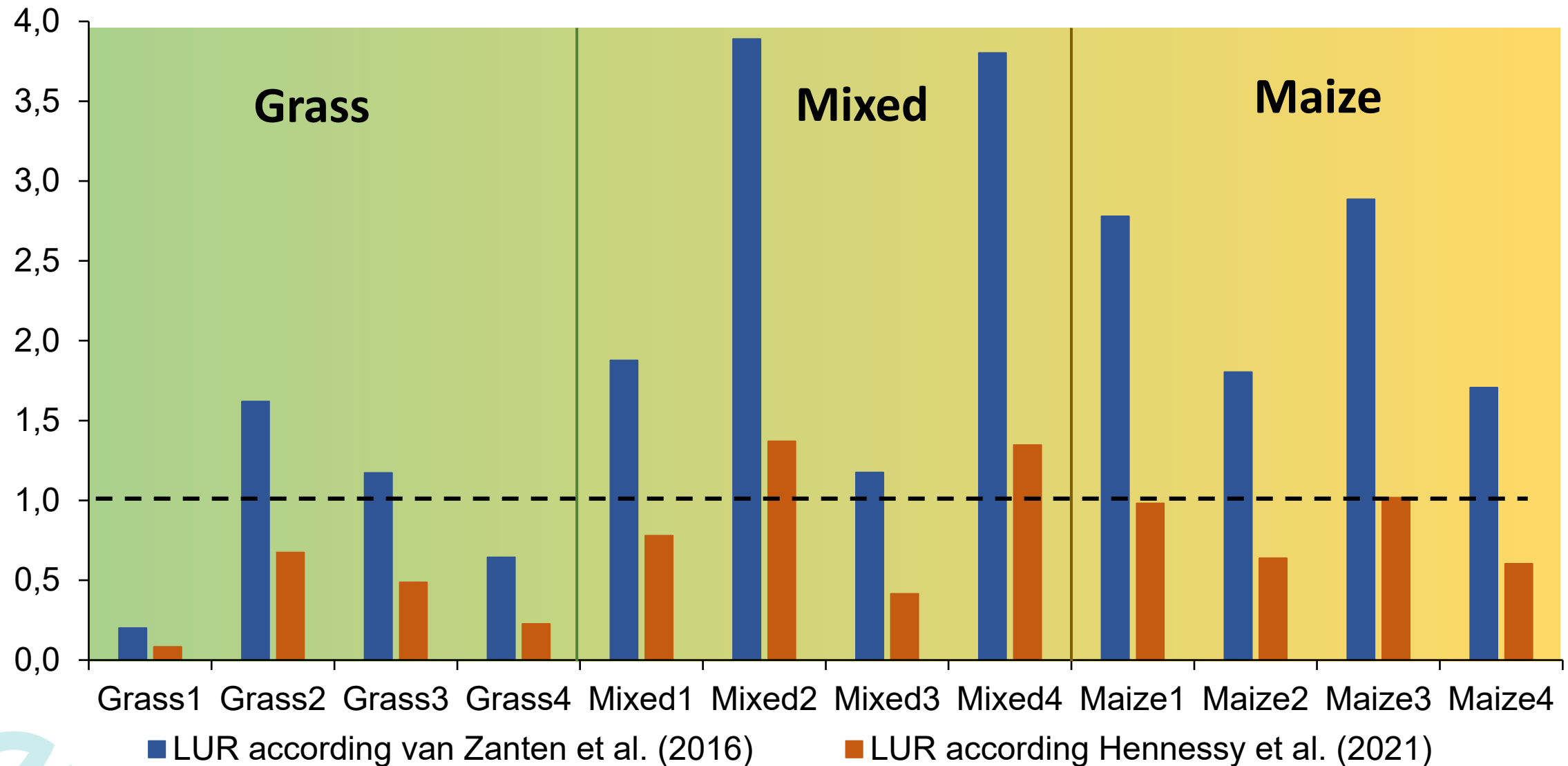
DIAAS (%)
Digestible Indispensable
Amino Acids Score
(FAO, 2013)

Edible proteins
x DIAAS (kg)

➤ Application to 12 dairy farms case-studies

	Grass-based (n=4)	Mixed (n=4)	Maize-based (n=4)-
Feeding system	> 80% grass 0% maize	< 80% grass 10-20% maize	< 60% grass > 20% maize
Total land used for animal production (ha)	75.6 ± 13.6	75.2 ± 25.9	94.2 ± 28.4
Milk production (kg cow ⁻¹ y ⁻¹)	5618 ± 674	6412 ± 731	8086 ± 1313
Non-arable land used (%)	66.3 ± 27.6	21.8 ± 32.9	20.1 ± 14.5
Land used to produce animal protein (m ² kg ⁻¹)	78.6 ± 13.6	53.0 ± 11.4	33.6 ± 5.4
Digestible animal protein produced (kg ha ⁻¹)	126.6 ± 28.5	184.4 ± 33.5	287.9 ± 42.5
Potential digestible plant protein produced (kg ha ⁻¹)	108.1 ± 65.6	509.0 ± 306.3	643.9 ± 116.6
Edible animal protein produced × DIAAS (kg ha ⁻¹)	153.8 ± 34.7	224.2 ± 40.5	350.1 ± 51.2
Potential edible plant protein produced × DIAAS (kg ha ⁻¹)	51.1 ± 32.9	223.5 ± 126.5	276.6 ± 50.1

➤ LUR varies with the feeding system and the way of expressing the quality of proteins



➤ Discussion and conclusion

- Although the LUR calculations rank the systems in the same order, the results highly depend on
 - the non-arable feature of permanent grasslands
 - the potential level of plant production on the land used for protein or other nutrients
 - the way the relative nutritional quality between animal and plant products is assessed
- Grass-based ruminant systems can be an efficient utilization of land for protein production for humans, in particular when they use non-arable grasslands
- Metrics to assess land-use efficiency need to be further investigated to be generalized to the diversity of animal production systems



Thank you for your attention!

