Nitrogen flow network and energy performance in contrasted organic farms

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Background

Organic farming (OF) presents a promising solution to address the mitigate negative environmental impacts of agriculture. Central to OF are the principles of enhancing nitrogen (N) self-sufficiency and reducing reliance on non-renewable energy. However, few studies have explored the interconnected relationship between N flows and energy use in farm management practices[1].

Objectives

This study sought to characterize N-flows and energy investment in OF with different types of fertilization and feeding practices.

Methods

We surveyed eight different OF in Brittany, France, including vegetable (ID1-3), mixed crop-livestock (ID4-7) and cereal farms (ID8). N-flows were assessed through a combination of material flow and ecological network analysis[2]. Energy investment were considered as direct energy and human labour (Fig. 1).

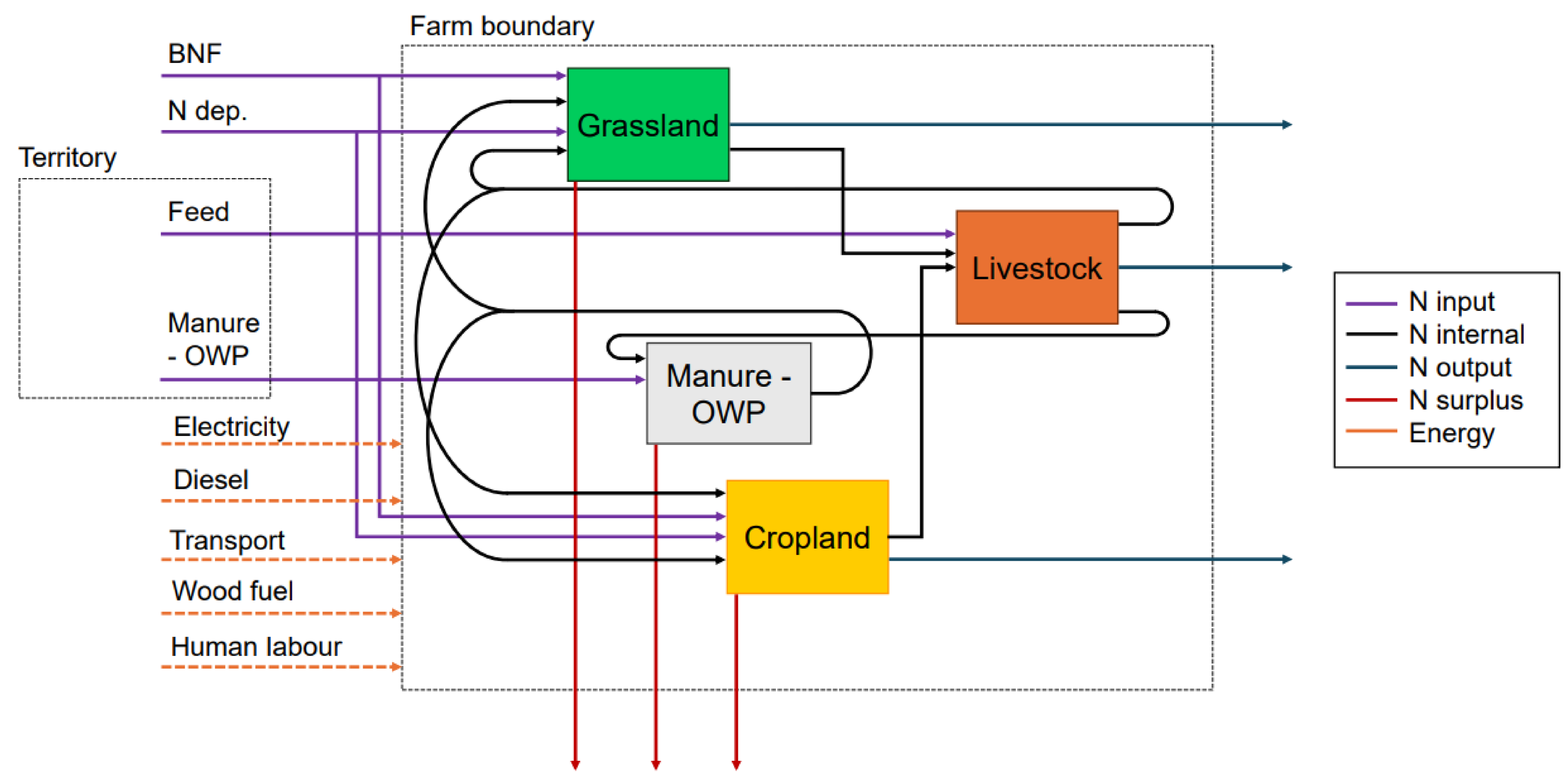

Figure 1. Framework of the N-flow and energy analysis. Imports of feed, manure, and organic waste product (OWP) are divided between local (L) (i.e., ≤ 50 km from the farm) and non-local (NL).

We used 5 indicators to assess N-flows:

- Productivity ($prod_{farm}$, kg N·ha^{-1}·yr^{-1})
- Balance ($balance_{farm}$,kg N·ha^{-1}·yr^{-1})
- N use efficiency (NUE_{farm} , %)
- Self-sufficiency, both at farm (SS_{farm} , %) and local (SS_{local}, %) scale
- Finn cycling index (FCI)

Findings

- BNF was the first or second largest N input (35-72%) (Fig. 2a).
- External input were local about 65-95% for vegetable farms and 97-100% for mixed crop-livestock farms.
- On-farm fuel was on average the largest (44%) energy investment (Fig.. 2b).

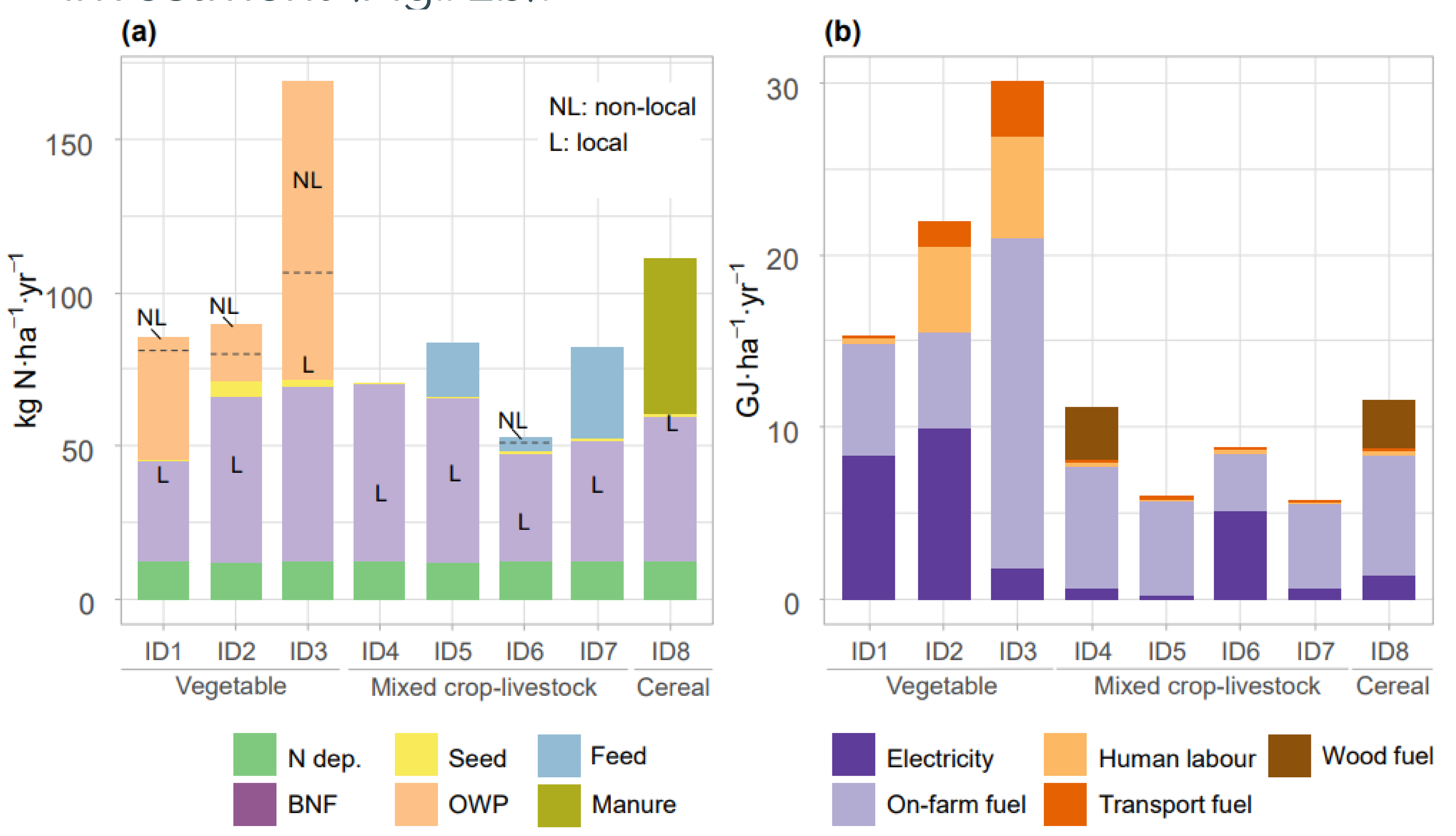

Figure 2. N input (kg N·ha^{-1}·yr^{-1}) (a) and energy invested (GJ·ha^{-1}·yr^{-1}) (b).

- Vegetable and cereal farms had the highest NUE as they were the more productive (Table I).
- Mixed crop-livestock farms recycled the most N and were the most self-sufficient.

Table I. Values of N and energy indicators for eight organic farms.

Indicator	Units	Vegetable			Mixed crop livestock				Cereal
		ID1	ID2	ID3	ID4	ID5	ID6	ID7	ID8
$prod_{farm}$	kg N·ha^{-1}·yr^{-1}	26	32	108	34	46	10	19	74
$balance_{farm}$	kg N·ha^{-1}·yr^{-1}	59	58	61	37	37	42	63	37
NUE_{farm}	%	31	35	64	48	55	19	23	67
SS_{farm}	%	52	74	41	100	79	91	63	54
SS_{local}	%	95	84	65	100	100	97	100	100
FCI	NA	0	0	0	0.40	0.45	0.53	0.53	0

Conclusion

✓ The availability of local N resources plays a critical role in the overall farm N network flow design.
✓ The diversity of N strategies influence the energy invested in OF.

Acknowledgments

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References

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