TRansition paths to sUstainable legume-based systems in Europe

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Benefits of introducing legumes into food systems

Life Cycle Assessment of legumes and legume based products

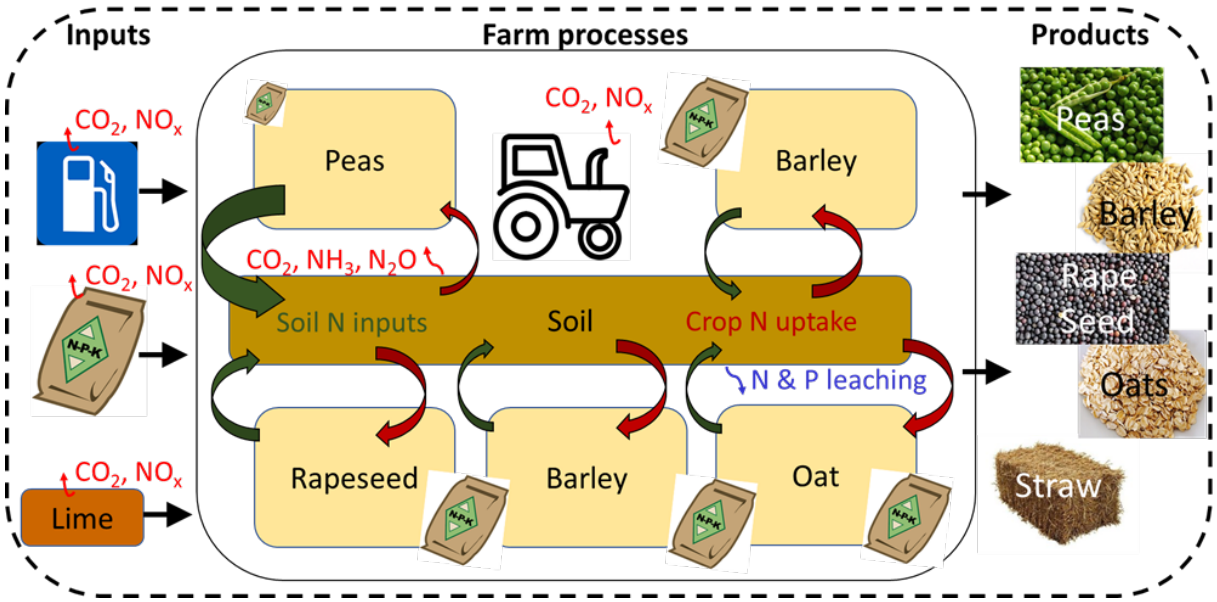
Objective "**TR**ansition paths to s**U**stainable legume based systems in **E**urope" (**TRUE**) is a **practice-research** partnership of 24 institutions, which aims to identify the best routes, or "transition paths" to increase **sustainable legume cultivation and consumption** across Europe. **Just 2%** of European farmland is planted with legumes; integrating legumes into cropping systems and pastures could help to make farming more sustainable. This leaflet summarises research that shows why introducing legumes into food systems can be **environmentally and economically beneficial**, for farmers and wider society.

What is a legume? *Legumes are plants that **biologically fix nitrogen (N)** from the air, reducing our dependence on synthetic N fertilisers. Whilst such fertilisers have played a vital role in delivering food security, they also contribute to N pollution that causes up to **€320 billion** of damages to the environment and health across Europe annually[1]. Common legume crops include: **peas, chickpeas, field beans, fava beans, soybeans, lentils, lupines, red clover** and **white clover**.*

Benefits of legumes

- ✓ Reduce need for synthetic fertilizers (*for themselves & following crops*)
- ✓ Break pest & disease cycles in cereal rotations
- ✓ Improve soil quality
- ✓ Increase biodiversity
- ✓ Deliver nutritious food & feed products (*high in protein & fiber*)

Environmental footprints represent the **environmental impact** arising from the **production of food & feeds**, including on-farm emissions from soils and tractors as well as off-farm emissions from fertilizer manufacture and downstream processing of commodities into food & feed (*see diagram below*). Legumes such as peas **require less fertiliser** input than other crops, though do produce **smaller yields** than cereals. Legumes also contribute substantially to **soil N**, reducing fertilizer inputs for other crops in the rotation, but also contributing to emissions and nutrient leaching from soils. Overall, **legumes can reduce the environmental footprint** of harvested crops, and derived **food & feed products**.



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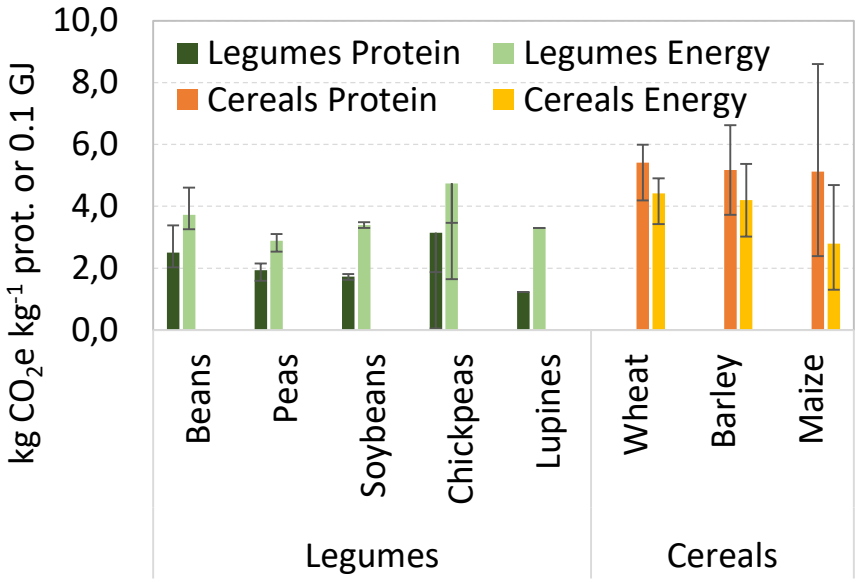
Legume footprints



Data sources: *Reckling et al. (2016)*[2], *Ecoinvent v3.6*[3], *TRUE project*[4]

The graph to the left displays carbon **footprints per kg protein** and per 0.1 GJ **digestible energy** contained in five legume crops and three cereal crops. Footprints vary considerably depending on **management practices**, and per kg of yield are similar between legumes and cereals. However, **low inputs** coupled with a **high nutritional density** mean that legumes deliver nutrition (protein & energy) at lower environmental cost **(smaller carbon footprint)** than cereals.

Legume product footprints Advances in **food processing** coupled with **demand for healthy and sustainable products** by both business and consumers is driving **innovative use of legumes** in place of cereals. Researchers on the *TRUE* project are calculating the environmental footprints of exciting **new legume products**.

*The starch from peas can be used to produce alcohol, leaving protein-rich coproducts that provide an excellent animal feed. Producing one liter of gin from peas (pictured right) instead of wheat can **avoid up to 4.2 kg CO_2e** of greenhouse gas emissions that cause climate change (equivalent to driving 25 km). **Pea gin** has a **smaller footprint** than wheat gin across 12 of 14 environmental impacts studied[3].*

*Peas can also substitute beef in meatballs, producing **"protein balls"** with a per-serving **carbon footprint 84% lower** than for beef meatballs – whilst also delivering **more fiber** and **less fat**. Meanwhile, producing **pasta** from **chickpeas** rather than durum wheat increases the nutritional value of pasta, and reduces the carbon footprint per **unit of nutrition** by 75%.*

What's the bottom line? Lower yields and lack of demand has constrained legume production across Europe. However, the health & sustainability credentials of legumes are receiving more attention, creating new opportunities for cultivating and marketing innovative legume products. In the context of depleted soils, high dependence on polluting inputs and plateauing cereal yields, the **introduction of legumes** in to short cycle rotations **can reduce environmental impact**, diversify farm outputs and enhance profitability. These benefits become apparent when a broad perspective and medium time-horizon is applied.

References 1. Sutton, M. A. *et al.* Too much of a good thing. *Nature* **472,** 159–161 (2011). 2. Reckling, M. *et al.* A cropping system assessment framework—Evaluating effects of introducing legumes into crop rotations. *Eur. J. Agron.* **76,** 186–197 (2016). 3. Wernet, G. *et al.* The ecoinvent database version 3 (part I): overview and methodology. *Int. J. Life Cycle Assess.* **21,** 1218–1230 (2016). 4. Leinhardt, T. *et al.* Just the tonic! Legume biorefining for alcohol has the potential to reduce Europe's protein deficit and mitigate climate change. *Environ. Int.* **130,** 104870.

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