Agronomic and economic complementarity promotes substantial gains in a pea-lentil intercrop

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Introduction

Intercropping is an important step towards sustainable intensification. **Most successful intercrops combine cereals with legumes**, relying on ecological complementarity, specifically complementary nitrogen-acquisition strategies. Here, we demonstrate that substantial and stable benefits can also arise from a legume–legume intercrop.

Material and methods

We evaluated mixtures of lentil (*Lens culinaris*) and pea (*Pisum sativum*) across three years and two farms with contrasting soil pathogen pressures in Switzerland, testing seeding ratios and varietal combinations (**Fig. 1**). Joint sowing, ease of seed separation after harvest and legume-only intercrop facilitate management and rotation planning.

Results

Optimal intercrops, consisting of 25% pea and 75% lentil, **consistently outperformed monocultures** (**Fig. 2, 3**). Specifically, semi-leafless pea varieties sown at such low densities interconnected and formed a supportive canopy (**Fig. 4**) that improved lentil standability, harvestability and LER **(Fig. 2)**. This was most pronounced under extreme weather conditions that otherwise increased lodging and disease pressure.

Since peas and lentils differed strongly in their susceptibility to soil-borne foot diseases, the mixture reduces risks of legume soil fatigue and allows for more flexible crop rotation strategies (not shown).

Fig. 1: Mixtures of investigated intercropping proportions. From left: pure peas (80 kernels m^{-2}), pea-lentil-mixture 3:1 (60:60 kernels m^{-2}), pea-lentil-mixture 1:1 (40:120 kernels m^{-2}), pea-lentil-mixture 1:3 (20:180 kernels m^{-2}), pure lentil (240 kernels m^{-2}).

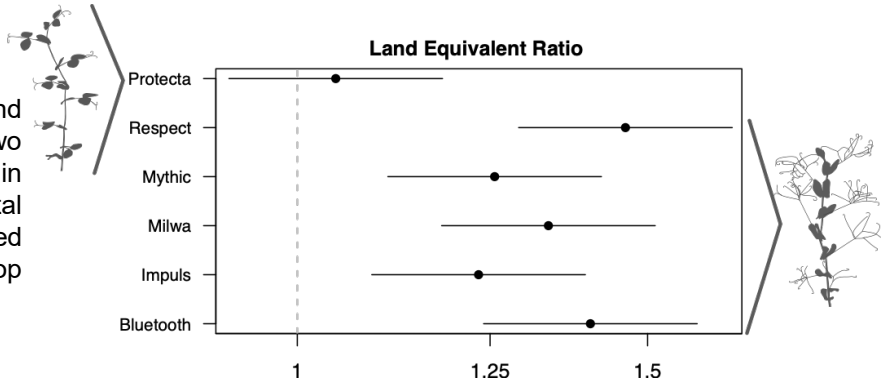

Fig. 2: 95 % confidence intervals of **land equivalent ratios** (LER) of different pea varieties across two years and sites, and using two different lentil varieties as intercropping partners. Semi-leafless pea varieties (Respect, Mythic, Milwa, Impuls, Bluetooth) achieved significant higher LER than leaf-type Protecta (grown for comparison).

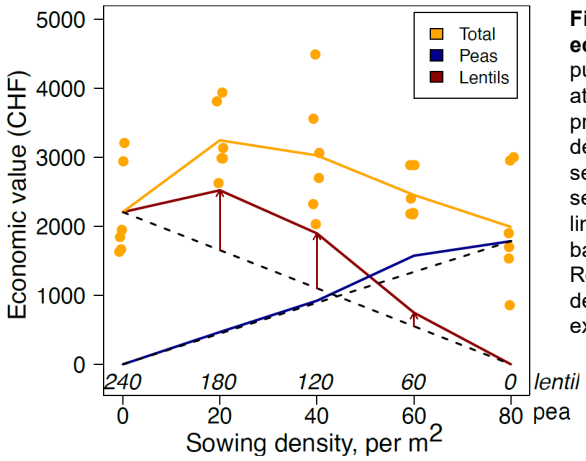

Fig. 3: Estimated economic value of the pure crops and mixtures at different sowing proportions (pea sowing densities: 0 - 80 seeds/m^2; lentil 240 - 0 seeds/m^2). Dashed lines: expected values based on monocultures. Red arrows: lentil value deviations from expectations.

Fig. 4: Pea-lentil-intercropping: the peas prevent the lentils from lodging and improve harvestability (Fislisbach, 2021).

Conclusions

Intercropping of lentil and semi-leafless pea across two sites and years achieved LER of >1.3 and generated 24% higher economic returns than expected based on monocultures (10% more than the higher-valued crop). Agronomic and economic complementarity - rather than classical ecological niche differentiation - can underpin productive, stable, and market-oriented intercrops, offering a viable pathway to increase gluten-free plant protein production.

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