FARMING PRACTICE INTERCROPPING

IMPACT: CROP YIELD

Reference 4

Li, CJ; Hoffland, E; Kuyper, TW; Yu, Y; Zhang, CC; Li, HG; Zhang, FS; van der Werf, W 2020 Syndromes of production in intercropping impact yield gains Nat. Plants 6, 653–660 10.1038/s41477-020-0680-9

Background and objective

Intercropping, the simultaneous production of multiple crops on the same field, provides opportunities for the sustainable intensification of agriculture if it can provide a greater yield per unit land and fertilizer than sole crops. Authors performed a global meta-analysis to quantify the effect of intercropping on the yield gain, exploring the effects of crop species combinations, temporal and spatial arrangements, and fertilizer input.

Search strategy and selection criteria

The dataset was built by combining a database built by Yu et al. (Yu, Y., Stomph, T.-J., Makowski, D. & van der Werf, W. Temporal niche differentiation increases the land equivalent ratio of annual intercrops: a meta-analysis. Field Crops Res. 184, 133–144. 2015) and a database built by Li et al. (Li, C. J. et al. Yield gain, complementarity and competitive dominance in intercropping in China: a meta-analysis of drivers of yield gain using additive partitioning. Eur. J. Agron. 113, 125987. 2020) From the original database of Yu et al., all the data records of grain-producing intercrops (such as cereals, legumes and oilseed crops) that provided data on species densities were extracted (539 records). We removed the duplicate data records (9 publications and 31 data records) in the two datasets. All intercrops in the resulting database were grain-producing intercrops.

Data and analysis

Linear regression with mixed-effects models (function lme in R package nlme) was used for the analyses. Authors used the publication and the experiment within publications as random effects to account for differences among the studies (publications) and the experiments (sites × years) within studies. A variance model (function varIdent in R package nlme) was used to account for the heterogeneity of variance between intercrops with and without maize. The associations between the yield gain (NE) of intercrops and the variables were further visualized with principal component analysis, using the vegan package in R.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
132	Multiple crops	Intercropping	Monoculture	Metric: Overall yield gain (NE, difference between the observed yield and the expected yield), land equivalent ratio (LER); Effect size: Difference of of the considered metrics between intervention and control, Sum of the fractions of the intercropped yields divided by the sole-crop yields	81.25

Results

- The overall yield gain (NE) in intercropping was 1.5 ± 0.1 Mg ha−1 (mean ± s.e.m.) in this global dataset.
- Intercropping increased the relative use efficiency of land (LER).

Factors influencing effect sizes

- Crop/cultivar combinations : The yield gains was 2.1 ± 0.1 Mg ha−1 in intercrops with maize, approximately four times as high as in intercrops without maize (0.5 ± 0.1 Mg ha−1). The yield gains due to intercropping increased with the temporal niche differentiation of the intercrops (i.e. the proportion of the total growing period of the crop mixture during which species grow alone) both with and without maize. The average LER of intercrops with maize (1.29 ± 0.02) was significantly greater than the average LER of intercrops without maize (1.16 ± 0.02).
- Fertiliser application : High nutrient inputs increased yield gain only in intercrops with maize.
- Crop spatial arrangement : Yield gains were significantly greater in strip and alternate-row intercrops (1.5 ± 0.1 and 1.4 ± 0.1 Mg ha−1,respectively) than in fully mixed intercrops (1.0 ± 0.2 Mg ha−1).

Conclusion

Intercropping offers opportunities for the sustainable intensification of both high- and low-input agriculture.