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Background and objective

Intercropping exploits species complementarities to achieve sustainable intensification by increasing crop outputs per unit land with reduced anthropogenic inputs. Authors carried out a global meta-analysis to assess land and fertilizer N use efficiency in intercropping of maize and soybean as compared to sole crops.

Search strategy and selection criteria

Authors searched for relevant publications using the terms ("Maize" or "Corn") and "Soybean" and "Intercrop*", in the topic field in three databases: CNKI (<http://www.cnki.net>), WanFang DATABASE (<http://g.wanfangdata.com.cn/index.html>) and Web of Science (<http://apps.webofknowledge.com/>). The set of publications was refined by selecting publications mentioning "Nitrogen", "Grain yield" and "Field" in the topic field. In Web of Science, authors searched literature published from 1980 to 2018, and obtained in total 265 publications including 12 publications published in Chinese which were included from this subdataset. Authors excluded reviews and conference papers, studies focusing on diseases and weeds, and some studies with reporting problem, e.g. missing sole crop yield, without intercropping configuration information, a reported LER value different from the one calculated from the yield, or incorrect experiment design.

Data and analysis

All analyses were conducted in R, using the R function lme. Twelve mixed effects models were fitted to the data. Model selection was conducted using the R functions AIC and Anova. Authors did not weight the studies according to measures of precision of the estimates extracted from the literature since this information was provided in a minority of the 88 publications. Authors made funnel plots for both LER and FNER to determine whether there was evidence of publication bias.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
100	Maize and soybean	Intercropping	Monoculture	Metric: Land equivalent ratio (LER); Effect size: Sum of the fractions of the intercropped yields divided by the sole-crop yields	93.75

Results

- The worldwide average LER of maize/soybean intercropping was 1.32 ± 0.02 , indicating a substantial land sparing potential of intercropping over sole crops.

Factors influencing effect sizes

- Sowing time : LER increased as the temporal niche differentiation between the two species was increased by sowing or harvesting one crop earlier than the other as in relay intercropping, i.e. with only partial overlap of the growing periods of the two species.
- Soil organic matter : LER increased with soil organic matter.
- Geographical area : The LER was greatly different among continents: the average LER was 1.48 ± 0.087 in Europe, 1.41 ± 0.038 in Asia (except China), 1.38 ± 0.051 in Africa, 1.06 ± 0.066 in North America, 1.04 ± 0.17 in South America, and 0.95 ± 0.13 in Australia.

Conclusion

Maize/soybean intercropping is a promising practice to meet the challenge of sustainable development and food security. It is important not only for smallholder agriculture in developing countries, e.g. in Africa, to meet demands for calories and protein, but also for organic farming and land sparing in developing countries.