European Commission

FARMING PRACTICE INTERCROPPING

IMPACT: CROP YIELD

Reference 20

Iverson, AL; Marin, LE; Ennis, KK; Gonthier, DJ; Connor-Barrie, BT; Remfert, JL; Cardinale, BJ; Perfecto, I 2014 Do polycultures promote win-wins or trade-offs in agricultural ecosystem services? A meta-analysis J. Appl. Ecol. 51, 1593–1602 10.1111/1365-2664.12334

Background and objective

Increasing crop diversity through the use of polycultures has often been proposed as a means to achieve win-win scenarios among ecosystem services in agroecosystems. Yet, the vast majority of empirical studies performed to date have examined how crop diversity influences ecosystem services individually. Authors examine the effect of polycultural cropping on two agricultural ecosystem services: biocontrol of herbivorous pests (reduction in pest abundance or plant damage, increase in natural enemy abundance) and yield of a focal crop (grams of consumable product per plant). In so doing, authors explore whether polycultural cropping promotes a trade-off or a win-win relationship between these two ecosystem services.

Search strategy and selection criteria

Authors conducted a literature search on 18 December 2011 in ISI Web of Science, returning 1479 publications (for keywords, see Appendix S1 in Supporting Information). To augment this search, authors reviewed the bibliographies of two key reviews of intercropping and Pest and disease control (Andow 1991; Letourneau et al. 2011). Authors also surveyed co-authors for additional known papers. 1. The study was an empirical investigation that directly measured yield and at least one biocontrol variable in agricultural fields with at least two levels of plant species richness (e.g. monoculture and polyculture). We considered fields as polycultures only if the multiple species were grown in the same field. Species richness included both harvested crops and non-harvested plants (e.g. cover crops). Yield was defined as total biomass of the plant tissue for which the crop is grown (e.g. fruit, seed, fibre or leaf weight), not overall plant biomass. Metrics of biocontrol were as follows: (i) abundance of arthropod herbivores, (ii) abundance of natural enemies of pests, (iii) degree of pest parasitism or (iv) amount of plant damage. 2. Crop species richness differed between treatments at a single point in time (i.e. crop rotations not included). 3. Experimental treatments varied based on plant species richness, rather than on other forms of diversity (e.g. genetic diversity). 4. The treatment (i.e. monoculture or polyculture) had more than one replicate.

Data and analysis

Authors calculated log response ratios for yield and biocontrol variables. Authors calculated the mean and 95% confidence intervals of the effect sizes using the estimated means generated from generalized linear mixed models (GLMMs), using study as a random factor. All statistical analyses were conducted using R, version 2.13.1. Studies were weighted by sample size according to the 'weights' element within the glmer function (for GLMMs, lme4 package) and compared to the non-weighted values. As conclusions did not differ when values were weighted, authors present only nonweighted results. Authors tested results for publication bias by calculating Rosenthal's failsafe value using the Fail-safe Number Calculator.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
26	Multiple crops	Intercropping	Monoculture	Metric: Per-plant crop yield from only the main crop; Effect size: Logarithm of ratio of the considered metrics in the intervention to the considered metrics in the control	87.5

Results

- Intercropping with substitutive design showed a 40% increase for yield over monocultures.
- Intercropping with additive design showed a 24% decrease for yield over monocultures.

Factors influencing effect sizes

- Crop/cultivar combinations : When additive studies were split into those with legumes vs. without legumes as secondary vegetation, polycultures with legumes did not show reduced yields, whereas polycultures with non-legumes as secondary crop still reported a significant decrease in yield. Moreover, the negative effect of intercropping was significant only for maize and not for legumes or other crops, even though the trend was still strongly negative for the latters.

Conclusion

Intercropping that maintains overall plant density constant compared to monoculture (substitutive design) increased per-plant yield from only the main crop over monocultures. Intercropping that increases overall plant density compared to monoculture (additive design) had a negative effect on per-plant yield from only the main crop over monocultures. Well-designed polycultures can produce win-win outcomes between per-plant, and potentially per-unit area, primary crop yield and biocontrol.