Agroforestry and yield

Reference 7

Rivest D; Paquette, A; Moreno, G; Messier C. 2013 A meta-analysis reveals mostly neutral influence of scattered trees on pasture yield along with some contrasted effects depending on functional groups and rainfall conditions. Agriculture, Ecosystems and Environment 165: 74-79. doi: 10.1016/j.agee.2012.12.010

Background and objective

Scattered trees in agricultural landscapes are declining worldwide due to intensive land use and are often perceived by farmers as having negative impacts on agricultural production. Large-scale assessments in different biomes of agricultural yield in scattered tree ecosystems remain rare. This study addressed the following key questions: (1) What is the overall effect of scattered trees on pasture yield across different biomes and species? (2) Does the effect of scattered trees on pasture yield differ between different tree functional groups? (3) Does decreasing annual rainfall influence the effects of scattered trees on pasture yield? (4) Are the latter interactions mitigated among tree functional groups?

Search strategy and selection criteria

The literature published between 1989 and 2011 was investigated using the following electronic databases: CAB Abstracts, Biological Abstract, Scopus and Google Scholar. Titles, abstracts and keywords were searched using these keywords: agroforestry parkland, dehesa, grassland production, grazed woodlands, herbaceous production, montado, paddock trees, pasture understory, pasture yield, savanna, scattered tree, silvopastoral system, tree-grass. Data collection was limited to experimental plots that included exclusively an unimproved herbaceous layer (i.e. unfertilized, nonirrigated, not sown with genetically improved varieties) to avoid possible confounding effects of agricultural inputs with that of tree environment. Data collection was restricted to results in which means, variance (standard deviation, standard error, or confidence intervals), and sample size (i.e. total number of repetitions) were reported directly as numerical or graphical data in the paper, or were made available to us through personal communication with the authors. Data were considered only if pasture yield estimates for a specific year was available together with precipitation (mm) for the same year.

Data and analysis

The effect size is defined as Hedge g (standardised difference). g is adjusted with the small-sample correction factor. First, a simple random effects model was used to test the overall effect of trees on pasture yields. A mixed-effects model was then performed by including tree functional group and annual precipitation as moderators. Significant differences between groups were explored using contrasts. Mixed-effects models were built for each group including precipitation as a moderator. Moderators were tested using between-groups heterogeneity (QM), which estimates the amount of heterogeneity in effect sizes that is explained by a given moderator while controlling for others. A plot of the effect sizes against sample size (not shown) revealed a funnelshaped distribution of the data points (Z = −0.273, P = 0.785), as would be expected in the absence of publication bias.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
27	Scattered trees on pastures	Pasture directly beneath the canopy of scattered mature trees.	Pasture away from tree crowns in open areas.	Hedges g (standardized difference) comparing herbaceous aboveground biomass yields between plots beneath the scattered trees and the control.	75%

Results

- Overall, tree overstorey had a neutral effect on total herbaceous aboveground biomass, with a non-significant (n = 73, Z = −1.268, P = 0.205) mean effect size of −0.39 and 95% CI ranging from −1.00 to 0.21.
- The tree functional groups had a significant effect on effect sizes (QM = 21.44, d.f. = 3, P < 0.0001). The effect size was negative and significant for Eucalyptus (g = −2.49 +- 1.97, P = 0.0135), positive and near-significant for N2-fixing (g = 1.73 +-1.91,P = 0.076), and near zero and non-significant for deciduous (g = 0.16 +- 0.61, P = 0.838) and evergreen oak (g =−0.37+-1.66, P = 0.666). Mean effect sizes were ordered among groups as: N2-fixing > deciduous = evergreen oak > Eucalyptus.
- Annual precipitation had no significant effect on effect size across all tree functional groups when these were taken together (QM = 0.30, d.f. = 1, P = 0.584).
- Linear mixed-models within each tree functional group revealed significant effect of annual precipitation for the Eucalyptus (QM = 12.16, d.f. = 1, P = 0.0005) and N-fixing (QM = 9.04, d.f. = 1, P = 0.0026) groups.
- A positive linear relationship (r2 = 0.35) between effect size and annual precipitation was found for the Eucalyptus group, while a negative linear relationship (r2 = 0.61) was found for the N2-fixing group.

Factors influencing effect sizes

Precipitation and tree species: eucalyptus competition and N-fixing facilitation increase in the driest conditions and eucalyptus has negative effect on pasture yields in dry conditions.

Conclusion

The meta-analysis provides evidence that the net effect of trees on pasture yield was nul across the four studied tree functional groups, i.e. pasture yield beneath and outside the canopy of scattered trees did not differ.