Agroforestry and water retention

Reference 3

Basche, AD; DeLonge, MS. 2019 Comparing infiltration rates in soils managed with conventional and alternative farming methods: A meta-analysis, PloS one, 14 (9): e0215702. doi: 10.1371/journal.pone.0215702

Background and objective

Water infiltration is a critical ecosystem function that can mitigate drought and flood risk by facilitating water entry into the soil and reducing water losses by runoff. This is a particularly important ecosystem function given predicted climate changes, especially the trend toward increasing rainfall variability, leading to heavier intensity rainfall events and impacts in non-irrigated agricultural regions when there are longer periods without rainfall The primary goal of this analysis was to synthesize published field-experiments investigating impacts of agricultural practices (no till, cover crops, crop rotation, introducing perennials, crop and livestock) on water infiltration rates and to gain insight into mechanisms impacting infiltration rates. Here, only results focusing on perennials are reported.

Search strategy and selection criteria

The literature search was conducted using EBSCO Discovery Service (detailed in Basche and DeLonge) and only included field experiments in English language peer-reviewed literature through 2015 (the earliest publication that met our criteria was from 1978). Keyword strings included: infiltration W1 rate AND crop* for all searches, and additional keywords were used for individual practices. These searches returned approximately 700 studies, of which 79 fit our criteria. The USDA-NRCS Soil Health Literature database was used to find additional papers, leading to 10 more studies for a total of 89. The main criteria for inclusion were field experiments that: 1. Measured and reported steady-state infiltration rates, defined as the volume of water entering the soil over a designated period; 2. Compared one of the alternative practices of interest relative to select conventional controls in a standardized way.

Data and analysis

For statistical analyses, the five practices were analyzed separately because there were notable differences in experimental designs and control treatments. A linear mixed model (lme4 package in R) was used to calculate means and standard errors for the five practices. The statistical model also included a random effect of study to account for the factor of similar environments and locations in the cases where experimental designs allowed for multiple paired observations

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
8	Agricultural systems	Introducing perennials (perennial grasses, agroforestry, managed forestry) as water retention soil managing practices.	Conventional management of annual crops in cropland.	Logarithm of ratio of water infiltration rate in introducing-perennials practices to water infiltration rate in conventional management in cropland.	94%

Results

- Experiments comparing perennial treatments to annual crops showed a largely significant improvement in infiltration rates (59.2%, confidence interval 18.2–100.2%, n = 40 from 8 experiments).
- These experiments included three types of perennial systems: agroforestry, perennial grasses, and managed forestry.
- There is also evidence that introducing perennials and designing diversified landscapes can improve soils in similar ways, likely by providing vegetative protection of soils above- and below-ground, and including living roots throughout the year.
- NA
- NA

Factors influencing effect sizes

Aridity index, study lenght and type of soil influence the effect of the intervention.

Conclusion

The overall trend quantified by this analysis is a clear potential for improve water infiltration rates in response to introducing perennials.