

### Reference 3

Sileshi, G; Akinnifesi, FK; Ajayi, OC; Place, F 2008 Meta-analysis of maize yield response to woody and herbaceous legumes in sub-Saharan Africa PLANT AND SOIL, 307, 1-19. 10.1007/s11104-008-9547-y

### Background and objective

In parts of West, Central, East and southern Africa, where the fallow periods have been shortened and cultivation has been extended for more than 2 years, maize yields generally decline rapidly. Promising alternatives include the use of nitrogen-fixing and weed-suppressing legumes planted as improved fallows. Assessing whether or not there is a consistent evidence for yield benefits using green manure from herbaceous and woody legumes in sub-Saharan Africa. The specific objectives of this analysis were to (1) provide a comprehensive, quantitative synthesis of published reports on the effect of woody and herbaceous green manure legumes on maize yield, (2) conduct parametric estimation of the magnitude of yield response and (3) determine the factors that moderate the response.

### Search strategy and selection criteria

The studies included were located by searching through computer library databases. However, this alone does not provide a comprehensive search. Therefore, it was supplemented with checking the references of published studies and manual searching through conference abstracts, published proceedings, book chapters, monographs and direct contacts based on the authors' extensive knowledge on studies conducted in the Sub-Saharan Africa. 1) Have been published in a refereed journal, book chapter or peer-reviewed proceeding; 2) Have originated from sub-Saharan Africa; 3) Have reported maize yield from at least one legume species used for green manure or improved fallow (treatment) and a corresponding maize yield from an unfertilized plot (control); 4) Be a well designed, randomized and replicated experiment either on a research station or on farmers' fields; 5) Have reported the mean (and if possible the standard deviation or variance) as numerical or graphical data or this was available by personal communication.

### Data and analysis

Computation of the variance ( $v_i$ ) for each  $i$ th study was done following Miguez and Bollero (2005). Effect sizes were weighted by the reciprocal of their variances. A mixed modelling approach was adopted in this analysis. The Akaike information criterion was used as measure of parsimony in deciding on the linear mixed model that gives the correct estimate of the 95% CI. Publication bias and normality in the data were assessed using descriptive statistics and normal quantile-quantile (Q-Q) plots.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
94	Maize crops in Africa	1) Natural fallow; 2) Improved fallow (legume herbaceous species); 3) Improved fallow (legume coppicing species); 4) Improved fallow (legume non-coppicing species)	Continuously cropped unfertilized maize monoculture	Metric: Crop yield; Effect size: 1) Logarithm of ratio of the considered metrics in the intervention to the considered metrics in the control; 2) Difference of the considered metrics between intervention and control	75

### Results

- Natural fallows had yields equal to the control in 27% of the cases. However, overall yield difference (D) between natural fallows and control fully fertilised maize crops was positive ( $0.3 \text{ t ha}^{-1}$ ) and significant. The 95% confidence intervals of response ratio (RR) from the natural fallow included 1, indicating a lack of difference between the unfertilized maize and maize grown after natural fallows.
- The 95% confidence interval of mean response ratio (RR) in herbaceous fallows ( $1.49-1.90$ ) did not overlap 1, indicating a significant positive effect on yields after improved fallows compared to control continuously cropped unfertilized maize monocultures. The 95% confidence interval of mean yield difference (D) after herbaceous fallows compared to continuously cropped unfertilized maize monoculture ( $0.8-1.2 \text{ t ha}^{-1}$ ) did not overlap 0, indicating a significant positive effect on yields after improved fallows.
- The 95% confidence interval of mean response ratio (RR) in fallows with coppicing species did not overlap 1, indicating a significant positive effect on yields after improved fallows compared to control continuously cropped unfertilized maize monocultures. The 95% confidence interval of mean yield difference (D) after fallows with coppicing species compared to continuously cropped unfertilized maize monoculture did not overlap 0, indicating a significant positive effect on yields after improved fallows.
- The 95% confidence interval of mean response ratio (RR) in fallows with non-coppicing species ( $1.27-1.43$ ) did not overlap 1, indicating a significant positive effect on yields after improved fallows compared to control continuously cropped unfertilized maize monocultures. The 95% confidence interval of mean yield difference (D) after fallows with non-coppicing species compared to continuously cropped unfertilized maize monoculture ( $0.88-1.41 \text{ t ha}^{-1}$ ) did not overlap 0, indicating a significant positive effect on yields after improved fallows.
- The normal Q-Q plots also indicate the presence of asymmetry and publication bias. In the Q-Q plot of the yield difference, the curve is slightly U-shaped, indicating that the data are skewed to the right.

### Factors influencing effect sizes

- Site productivity : The yield difference of natural fallows compared to the control became narrower as site productivity increased.
- Fallow length : The 3-year rotation gave higher RR compared to the 1- and 2- year improved fallows. However, no significant effect was found for D.
- Post-fallow cropping season : There was no difference in RR between the one and two season and one and three season post-fallow crops. Variability in response increased with post-fallow cropping. However, the 95% confidence intervals of D indicate that response is higher in the first post-fallow crop ( $1.3-1.9 \text{ t ha}^{-1}$ ) than in the third ( $1.0-1.2 \text{ t ha}^{-1}$ ).

- Fertiliser recommended dose in post-fallow cropping season (%) : RR for fallows of non-coppicing legumes was 28% higher when post-fallow plots were amended with 50% of the recommended dose of fertilizer than the similar plots that were not amended. Although amendment with 100% of the recommended dose of fertilizer increased yields by 56%, response was highly variable.
- Interaction between fertiliser recommended dose and post-fallow cropping season : In post-fallow plots not amended with fertilizer, yield declined with the length of post-fallow cropping until it approached yields from the control in the third season.

## **Conclusion**

The global maize yield response to improved fallows with legume species is significantly positive and higher than unfertilized maize and natural vegetation fallows.