Shifts in the swiddens with intensification: what evidence exists for the Trenbath model?

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Background

Trenbath (1985) postulated that with intensification, repeated cropping & shortening fallow phases, a „spline point“ will be reached at which tree regeneration fails completely and there will be a regime shift to a grassland

Objectives

- Systematic review of literature on impacts of intensification in shifting cultivation systems on fallow vegetation in the humid and sub-humid tropics
- Assess the strength of evidence for Trenbath's model

Methods

Literature Review: keyword searches (02.03.2018) in 'Web of Science' with +500 hits, 20 suitable sources

The following combinations of words was searched for as a topic (TS) in articles or book chapters:

- TS=("shifting cultivat*" OR "swidden" OR jhum OR dhum OR "shifting agricult*" OR "long fallow*") AND TS=(urea OR phosphate OR glyphosate OR ammonium OR nitrate OR potassium OR fertilizer OR fertiliser OR chloride OR "round-up" OR "mechanical till*" OR "mechanised till*" OR "mechanized till* OR "tractor till* OR manure OR burn OR mulch OR "short fallow*" OR "shortening fallow*" OR "shorter fallow*" OR "reducing fallow*" OR "reduced fallow*" OR "bush fallow*" OR "fallow age") AND TS=(tree OR grass OR Poaceae OR Imperata OR Gramineae OR musanga OR dicot* OR chromolaena OR biomass OR "carbon stock")).
- (TS=("shifting cultivat*" OR "swidden" OR jhum OR dhum OR "shifting agricult*" OR "long fallow*") AND TS=intensif*). This search resulted of which only three were included in the paper.
- (TS=("shifting cultivat*" OR "swidden" OR jhum OR dhum OR "shifting agricult*" OR "long fallow*") AND TS=(urea OR phosphate OR glyphosate OR ammonium OR nitrate OR potassium OR fertilizer OR fertiliser OR chloride OR "round-up" OR "mechanical till*" OR "mechanised till*" OR "mechanized till* OR "tractor till* OR manure OR burn OR mulch OR "short fallow*" OR "shortening fallow*" OR "shorter fallow*" OR "reducing fallow*" OR "reduced fallow*" OR "bush fallow*" OR "fallow age") AND TS=resilien*.

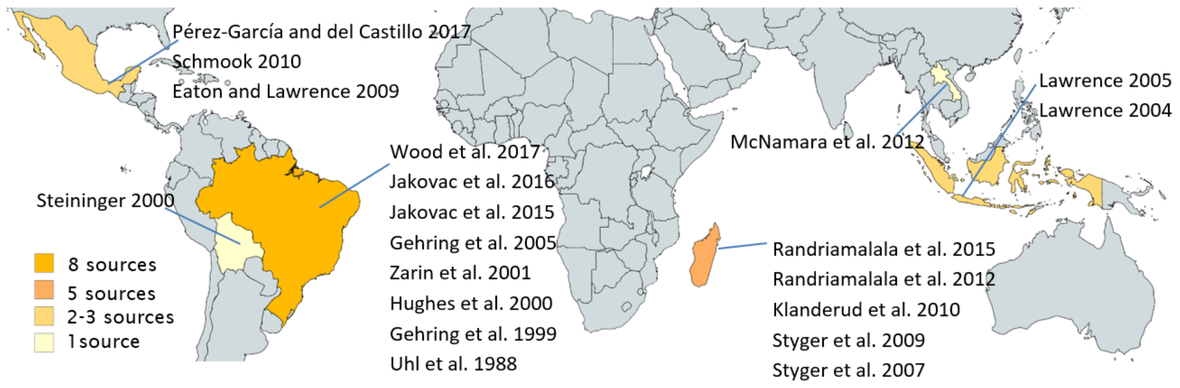

Fig 1: Location of studies considered for this study by country

Results Part 1: Intensification through increasing no of cultivation cycles

Biodiversity (6 refs)

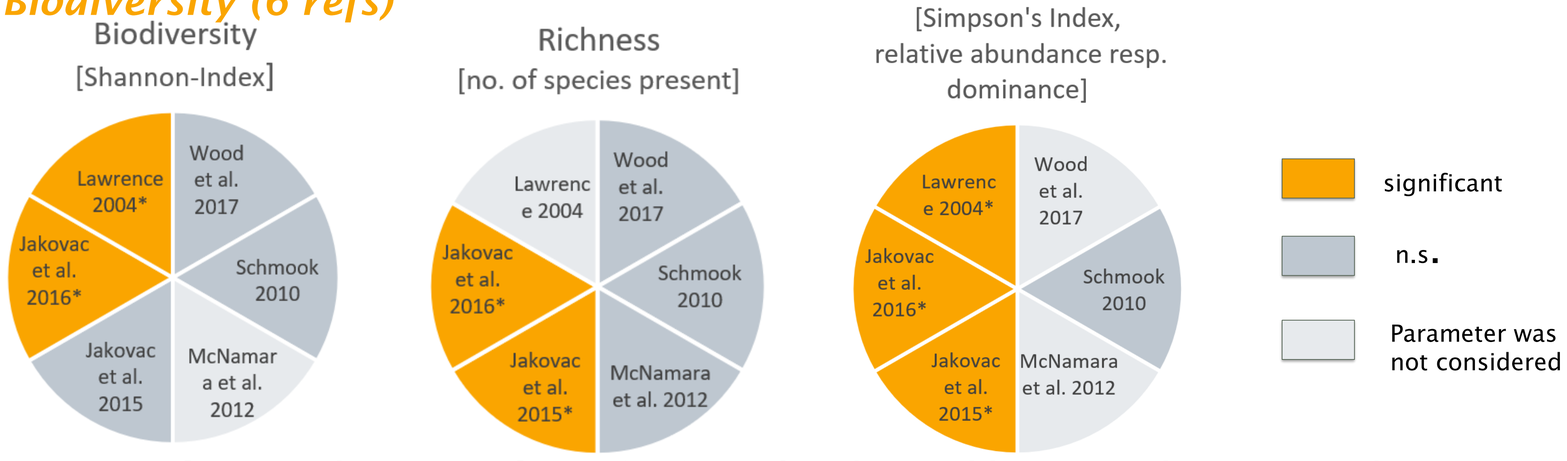

Fig 2: Significant and non significant (n.s.) results obtained by six studies in regards to biodiversity , species richness and evenness

*__all significant results__ reported __a decrease__ of the parameters __biodiversity, species richness and evenness__ with increasing cropping intensity

Aboveground Biomass (8 refs)

- 4 non significant results
  (Hughes et al. 2000; Gehring et al. 2005; Wood et al. 2017; Steininger 2000)
- 4 significant results
  (Eaton and Lawrence 2009A; Zarin et al. 2005B; Styger et al. 2009; Lawrence 2005)

→ **Mean decrease in aboveground biomass production** per cultivation cycle: **-11.75%**

Composition (7 refs)

- Significant **decrease in tree proportion** and **increasing proportion of herbs** with increasing no of cultivation cycles (Klanderud et al. 2010; Styger et al. 2007; Jakovac et al. 2015)
- **Increased proportion of plants with a strong sprouting capacity** with increasing no of cultivation cycles (Styger et al. 2009; McNamara et al. 2012; Randriamalala et al. 2012; Jakovac et al. 2015; Jakovac et al. 2016).

Results Part 2: Intensification through intensified cultivation practices

Burning (1 ref)

Burning leads to a strong reduction in cover of woody species compared to unburned control. (Gehring et al. 1999)

Fig 3: Burning in shifting cultivation

Tillage (3 refs)

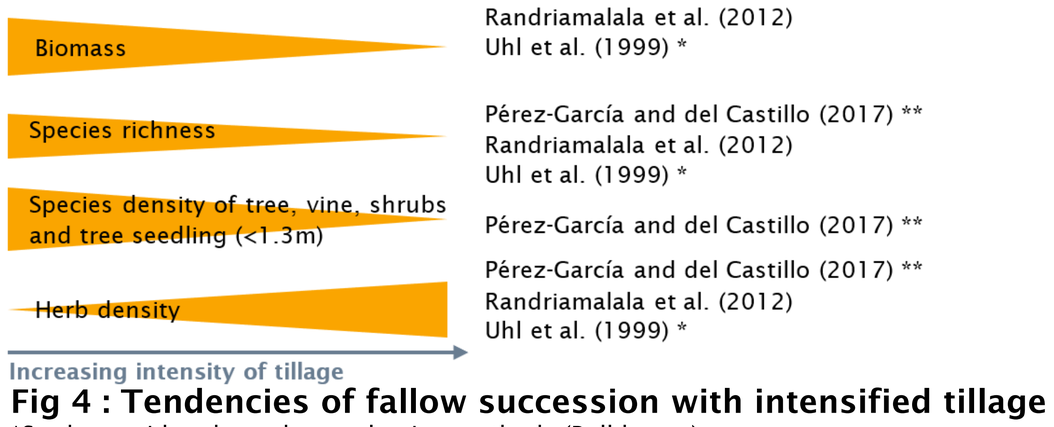

Fig 4 : Tendencies of fallow succession with intensified tillage

*Study considered very heavy clearing methods (Bulldozers)

**Study analyzed the combined effect of tillage, fertilizer application and short fallows

Summary

- Fallow **biomass decreased** with intensified tillage
- **Species richness and density** of trees, shrubs and vines **decreased** with intensified tillage and burning
- **Herb density and grass cove-rage increased** with both more intensive tillage and burning

Conclusions

- With **intensification**, **fallow biomass & biomass accumulation rates decreased** in fallows worldwide
- These impacts are partly attributed to an **increase in herb-dominance** and **decrease in tree dominance**
- No evidence found that intensification leads irreversibly to permanent grasslands
- However, there was a discernible **shift** of plant composition towards **herbs and grasses**

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