Market Driven Afforestation:
Trajectories in Environmental Sustainability under Land Use Intensification

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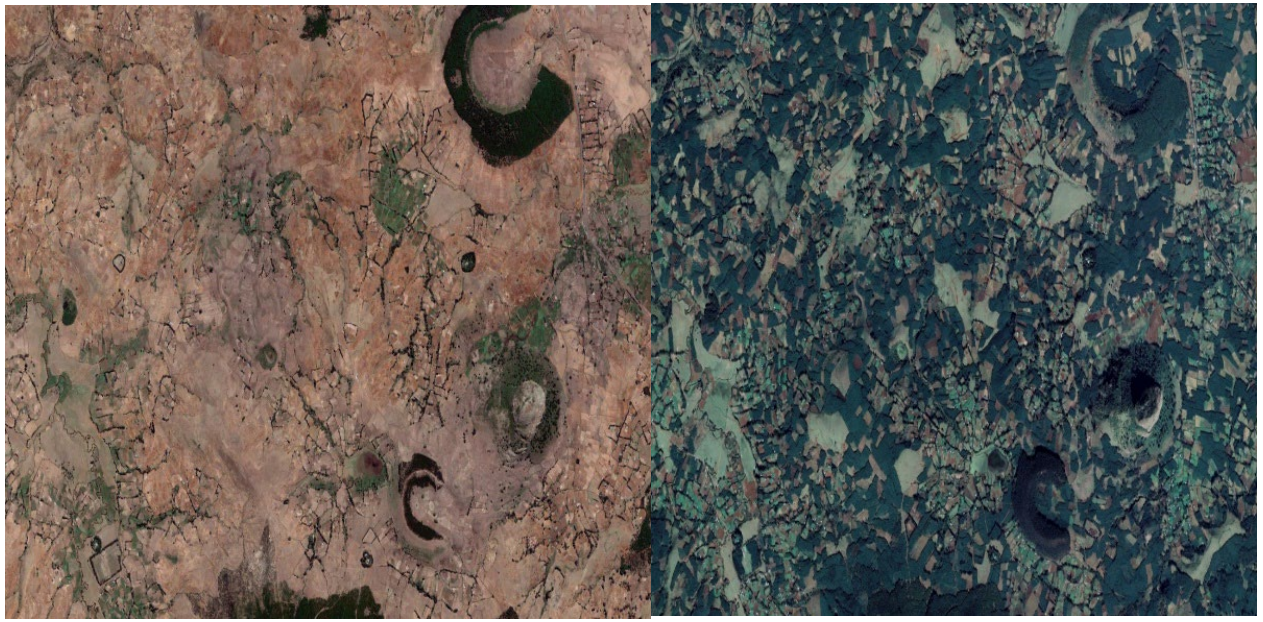
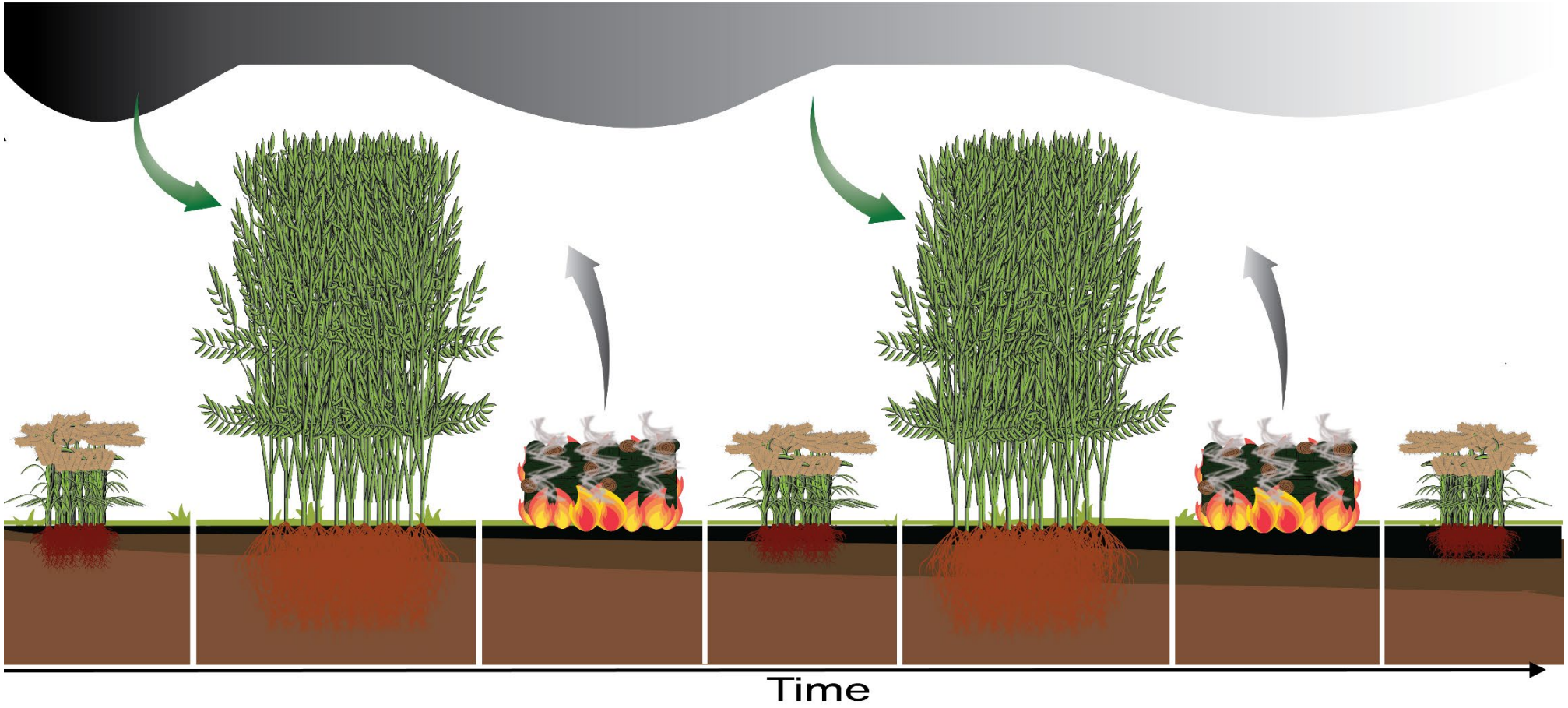
Background

- Rapid land use change from crop production to short-term rotation forestry has taken place in the northwestern part of Ethiopia.
- The main driver is market demand for biomass resource for energy and declining crop productivity.
- The tree species planted is *Acacia mearnsii*, native to Australia.
- By 2022, ca.50% of former cropland areas had been converted into short-rotation forestry.



April 2005 → Jan 2021

Crop – short rotation forestry cycle



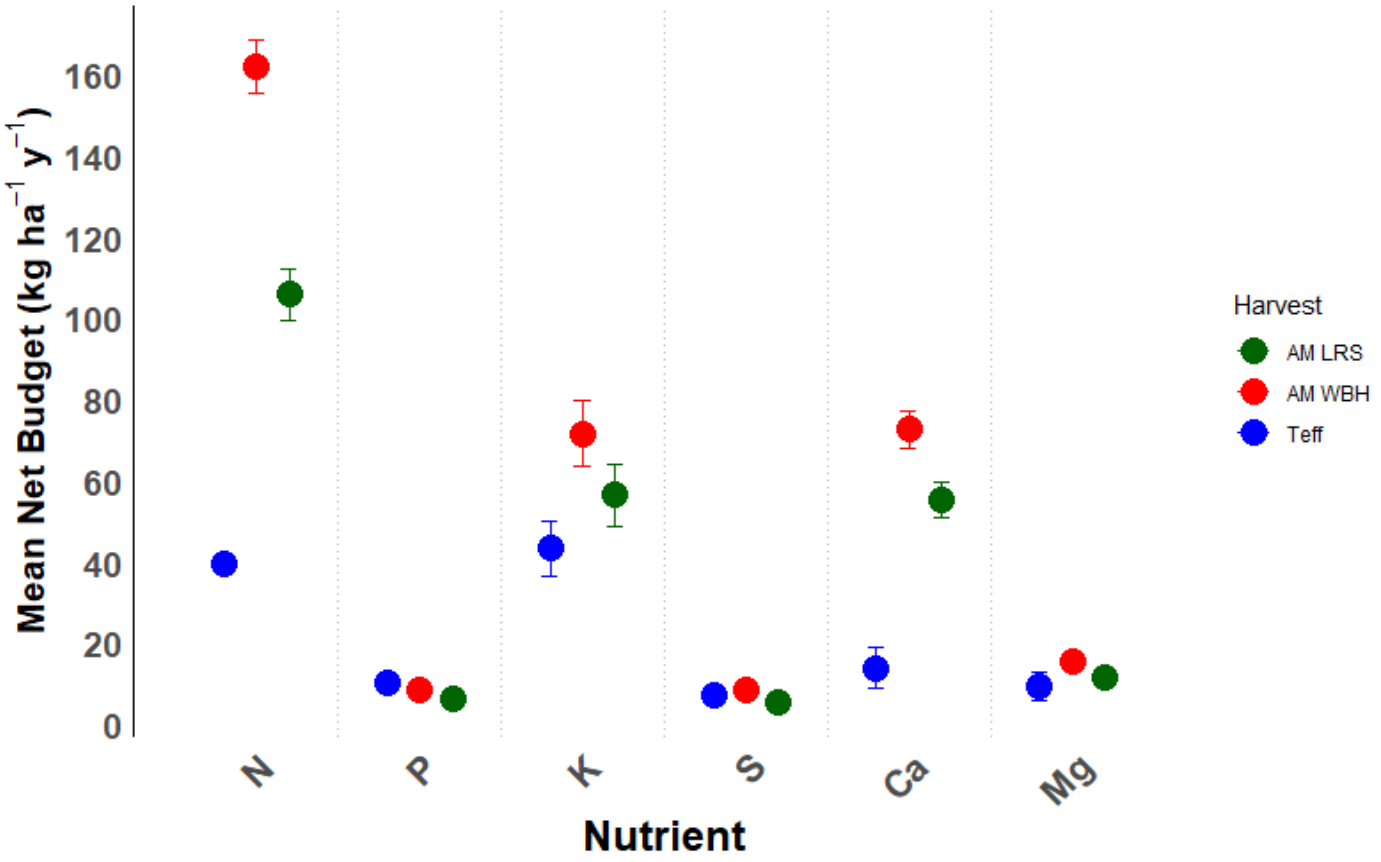
Objective:

- To examines the impact of land use change from crop production to SRF on soil nutrient balances and compare nutrient budget under AM and teff (stable food crop).

Methods

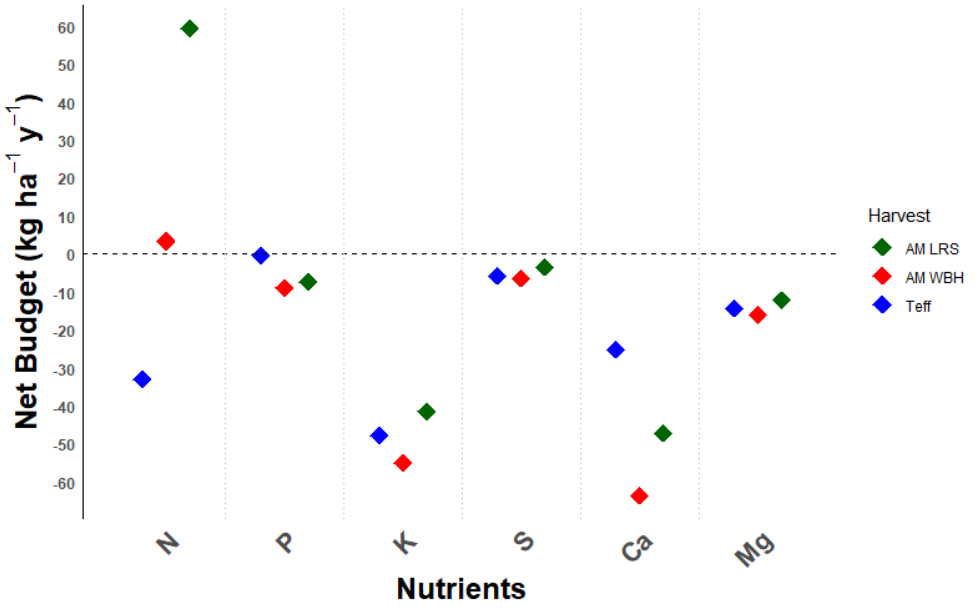
- *A. mearnsii* – soil and biomass samples.
- Stable N isotope ^{15}N:^{14}N ratio – N-fixaiton
- Soil nutrient analysis - Melich-3 extraction & then ICP-OES
- Biomass nutrient analysis – digested and ICP- SFMS
- Teff data – secondary data from published work
- Nutrient budget calculation:
  - **Inputs**: N-fixation, atmospheric deposition, fertilizers, and ash
  - **Output**: Export in biomass harvest, teff grain and straw, leaching, gaseous losses, and erosion

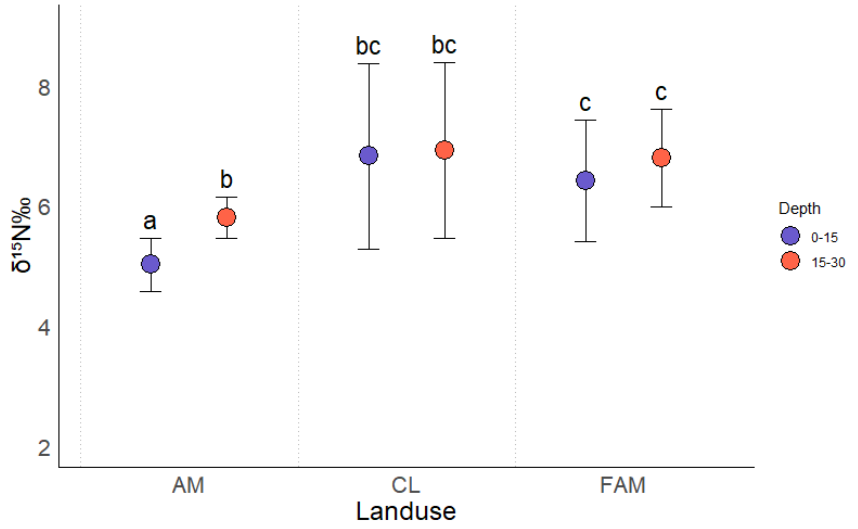
Rate of nutrient export



- Higher nutrient export rate under AM cultivation compared to teff.

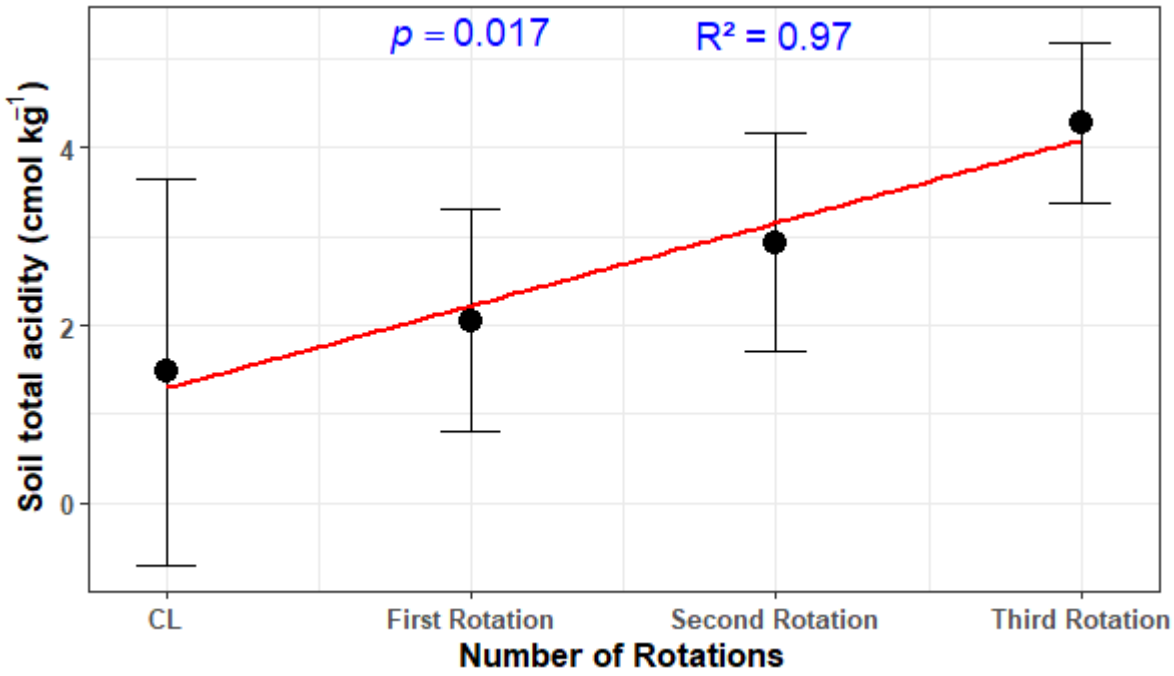
Net nutrient budget





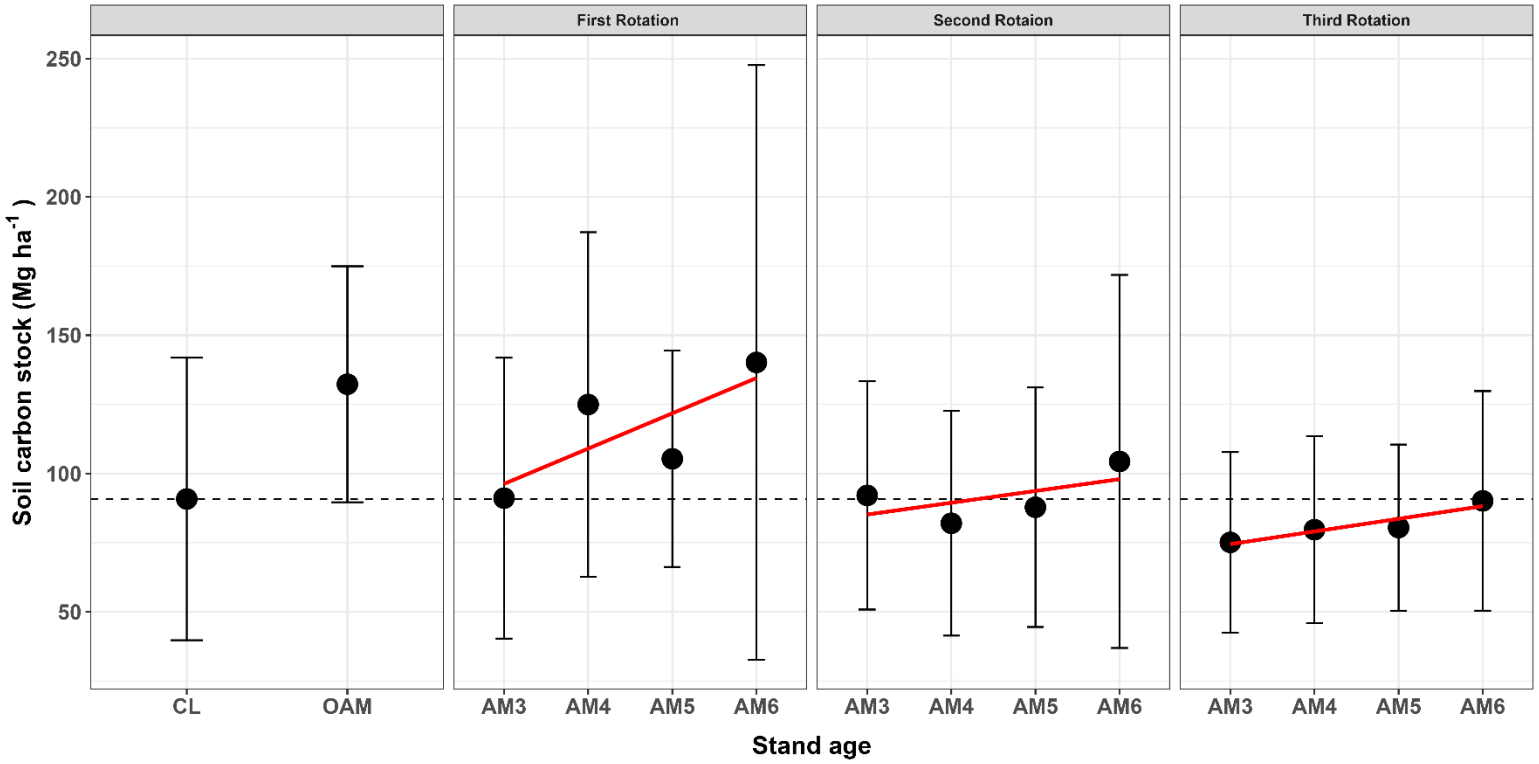
- Negative nutrient budget for both teff and AM – but higher deficit of base cations under AM.
- Positive N budget under AM due to the N-fixation by AM.

Soil total acidity



- Base cation export and nitrogen fixation likely contributed to an increasing trend in total acidity.

Soil carbon stock



- The C stock in soil tends to decrease with an increased number of rotation.
- Average C mineralization rate of 2.68 Mg ha^{-1} y^{-1} from first to third AM rotation.
- Likely due to P, S and other nutrient mining from organic sources by AM.

Conclusion

- AM cultivation is promising for C sequestration in biomass and fuelwood extraction from natural forest.
- Sustainability over multiple rotation requires management intervention.
- WBH is the most aggressive harvest scenario. Less intensive harvest can achieve ca.30% decrease in nutrient export while only resulting in a 7% decrease in biomass weight.
- Although teff cultivation also leads to negative nutrient budget, the amount is 2-3 times less than under AM cultivation.
- The calculation inevitably contains uncertainties due to the variability of input and output data and number of assumptions made.






Thank you!

Questions?