Resilience and Livelihood Benefits of Climate Smart Agroforestry Practices in Semi-arid Tanzania

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Introduction

The agricultural sector in Tanzania is an important driver for economic growth, poverty alleviation, food security and rural development. However, high dependence on rainfall makes the sector vulnerable to the impacts of climate change. Economic losses due to climate change are estimated at US$200 million per year. The scaling up of climate-smart agriculture practices such as agroforestry can reduce such losses, build resilience in the sector, improve productivity and farmer incomes while restoring ecosystem functions that contribute to climate change mitigation. Agroforestry technologies build a healthy agro-ecosystem and foster greater climate resilience of farm households through restoration of land productivity and diversification of production and income options. However, evidenced-based information on the resilience and livelihood benefits of semi-arid agroforestry systems as a climate smart practice is limited.

Objectives and Methods

- To assess crop yields, fuelwood supply and mitigation benefits of selected agroforestry practices
- To evaluate fuelwood consumption, gas emission and socioeconomic benefits of on-farm wood supply and use of improved cooking stoves (ICS)

Over 300 farmers in Chamwino and Kongwa districts were trained in nursery and tree planting techniques and constructions of ICS under the Trans-SEC and Africa RISING projects (Fig 1 and 2). Farmers planted trees as farm boundaries, shelterbelts, woodlots and intercropped. (Table 1). Fuelwood yield from these practices was determined using biomass equation. Household wood consumption and gas emissions under ICS and three-stone fires (3SF) were assessed using the controlled cooking test (CCT). Maize yields from experimental plots and farmer managed intercropping demonstration plots were sampled and expressed in yield per hectare at 12% moisture content.

Figure 1: (A) Community nursery at Laikala village (B), *Gliricidia sepium* harvested for fuelwood supply (C) and fodder (leaf meal) supply

Figure 2: Improved cooking stoves and three stone firewood stoves at Ilolo, Chamwino District

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On-farm Wood Supply, Maize Yield and Socio-economic Benefits

- On-farm wood supply ranged from 0.5-8 t/ha (Table 1).
- Wood was sufficient to satisfy a 5-member household for up to 11 and 34 months when using traditional 3SF and ICS, respectively (Table 1).
- Relative to 3SF, households using ICS consumed 67% less firewood, saved 50% of fuelwood collection time and reduced gas emissions (PM_{10}) by 60% (Table 2).
- ICS reduced cooking time by 31% compared to 3SF (Table 2).
- Economic impacts of ICS based on time and wood saved is estimated at USD 500 per year per household
- Maize yield was improved by *G. sepium* intercropping in the second season. Yields under farmer conditions ranged from 1.2t/ha – 3.2t/ha.

Table 1: Biomass yields of selected agroforestry practices and consumption time (months) using ICS and 3SF in Chamwino and Kongwa Districts

Agroforestry Practice	Tree species	Spacing (m)	Biomass (t/ha)	Time* With ICS	Time* Without ICS
Boundary	Acacia polyacantha	2 x 2	4.41	19.6	6.50
	Eucalyptus camadulensis	2 x 2	7.70	34.2	11.4
Woodlots	Grevillea robusta	2 x 2	2.64	11.7	3.90
	Senna siamea	3 x 3	1.01	4.50	1.50
	Melia azadarachta	4 x 4	0.84	3.70	1.20
Shelterbelt	Grevillea robusta	3 x 3	0.46	2.00	0.70
	Gliricidia sepium	1 x 2	2.08	9.20	3.10
Intercropping	Gliricidia sepium	3 x 3	1.34	6.00	2.00

*Duration it will take a 5-member household to consume the amount of wood produced on-farm. The estimate is based on the household consumption rates of 2.7t/year when using ICS and of 8.1 t/year for the three stone fire stove as determined by Sererya, (2016)

Table 2: Comparable advantages when using ICS and 3 SF technology

Stove performance variables	Type of stove: ICS	Type of stove: 3SF	Percentage reduction
Specific firewood consumption(tons/year)	2.7	8.1	67%
Total fuel wood collection time(hrs./year)	286	572	50%
Mean cooking time (min.)	133	194	31%
CO emitted (mg/Nm^3)	18.84	48.26	61%
CO_2 emitted (%)	0.02	0.05	60%
(PM_{10}) (µg/m^3)	0.0023	0.006	50%

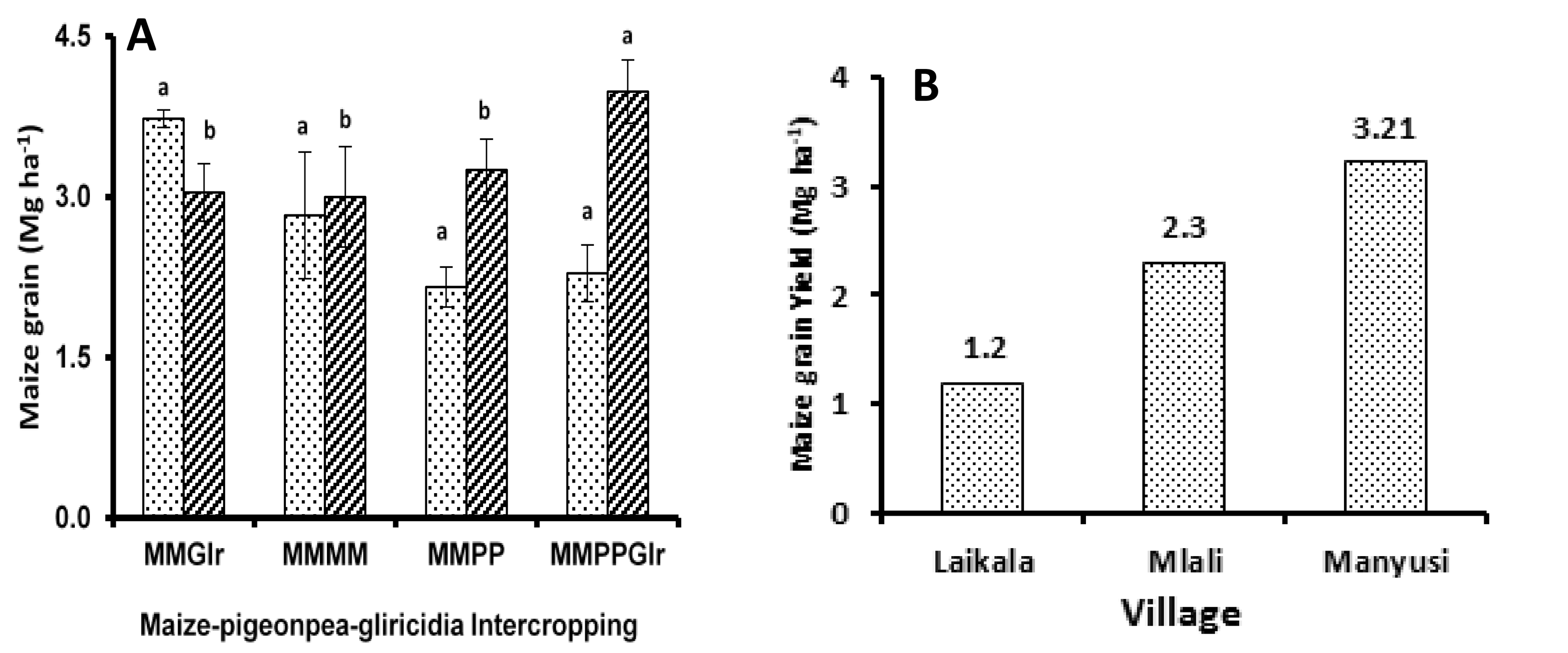

Figure 3: Maize yield in experimental (A) and farmer managed plots (B) at Manyusi, Kongwa. MMGlr=Maize+Gliricida; MMMM=Maize monoculture, MMPP = Maize+Pigeonpea, MMPPGlr=Maize+Pigeonpea+Gliricidia, PPPP=Pure pigeonpea.

Conclusion

Integrating agroforestry and ICS technologies potentially improves crop yields, meets household cooking energy demand, supplies fodder for livestock and poultry, improves household income and builds resilience to climate change.