Factors influencing on-farm tree seedling survival across various contexts in the eastern drylands of Kenya

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Introduction

Trees on farms have the potential to improve the livelihoods of smallholder farmers. In addition to ecosystem services such as reducing soil erosion and enhancing soil health, they also provide opportunities for generating additional income and contributing to household nutritional requirements. Despite these benefits, there have been several challenges in tree planting in the eastern drylands of Kenya, specially characterized by low seedling survival. This is partly due to erratic rainfall, planting of ecologically-unsuitable tree species, poor quality seedlings, and poor tree seedling management practices. Tree (re)establishment in landscapes is a key approach to land restoration. However, low survival rates, especially of tree species highly valued by farmers, has remained a major bottleneck in the drylands. Understanding which trees farmers prefer, and what determines tree survival, as well as enhancing farmer knowledge of tree management is key to scaling up land restoration.

Objective

To determine how different planting and management practices influence tree seedling survival across varying farm contexts.

Materials and Methods

To support farmer learning on tree seedling survival, 1600 farmers in Kitui, Machakos and Makueni counties in Kenya conducted on-farm planned comparisons to explore the performance of different planting and management practices on survival.

Planned comparisons are an innovative way of embedding research into development by reaching a large number of farmers and ensuring high participation as options are tested with farmers, in farmers' fields. Planned comparisons aim to answer key research questions around which options work where, for whom, and facilitate rapid learning by generating good data, assessing heterogeneity and taking innovations to scale.

Options compared by farmers included tree species, hole size, manure application, mulch application and watering. The context compared included farm size, planting niche and soil health status.

Implementing partners within the Drylands Development Programme distributed seedlings of 6 tree species in November 2016 (n=14,836) and 7 species in November 2017 (n=18,106). Farmers planted between 7 and 21 seedlings on their farm, testing various management options. Survival was monitored 6 months after planting using electronic data entry. Data was analysed using R statistical software and STATA.

Monitoring the performance of options was complemented by feedback from farmers through Community of Practice (CoP) workshops. The farmers' CoP is part of the nested CoPs on restoration of degraded lands that aim to foster relationships, develop learning situated in practice and share knowledge on how to restore degraded lands.

Results

Survival was better for tree seedlings planted in 2017 compared to those planted in 2016 with variation across the counties (20% increase in Kitui, 4% in Makueni and 4% in Machakos). During CoP workshops, farmers explained that this was partly due to increased rainfall during the 2017 planting and improved farmer management of the seedlings due to practices learned during training workshops. Farmers also reported a change in perception on ownership of the tree seedlings.

Of the 7 tree species, *Moringa oleifera* seedlings had the highest survival rate in Kitui while *Carica papaya* and *Senna siamea* had the highest survival rate in Machakos and Makueni, respectively (Fig 1).

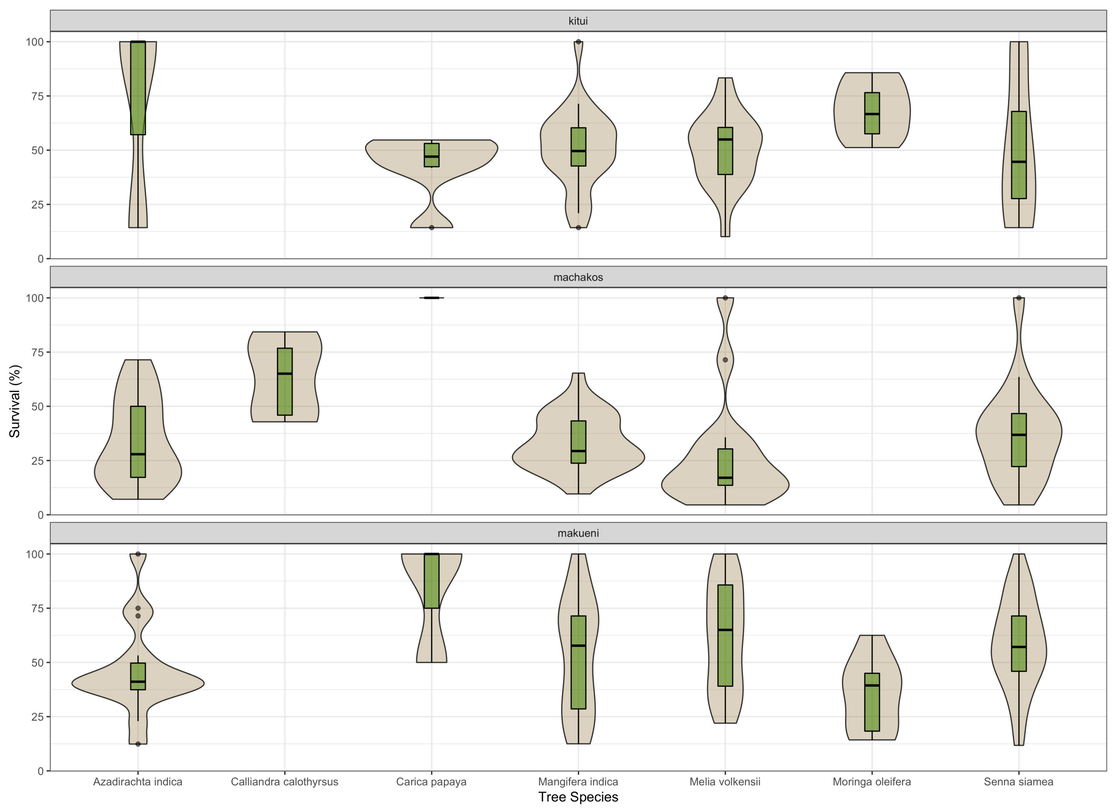

Fig 1: The boxplots show the variation in survival by species and county for seedlings planted in 2017. The black horizontal line is the median survival rate. The length of the green box illustrates the variation in survival rate for each species. For example, Mango had a median of 50% survival in Kitui County, ~27% survival in Machakos and >55% survival in Makueni. Moringa had a higher survival rate in Kitui (~65%) compared to Makueni (>38%).

Results (continued)

Tree seedlings planted with manure had a higher survival compared to those planted without manure. However, differences were observed within species and across counties and planting years (fig 2). Mulching resulted in increased seedling survival in Kitui and Makueni while in Machakos, there was no variation in the survival, with or without mulching .

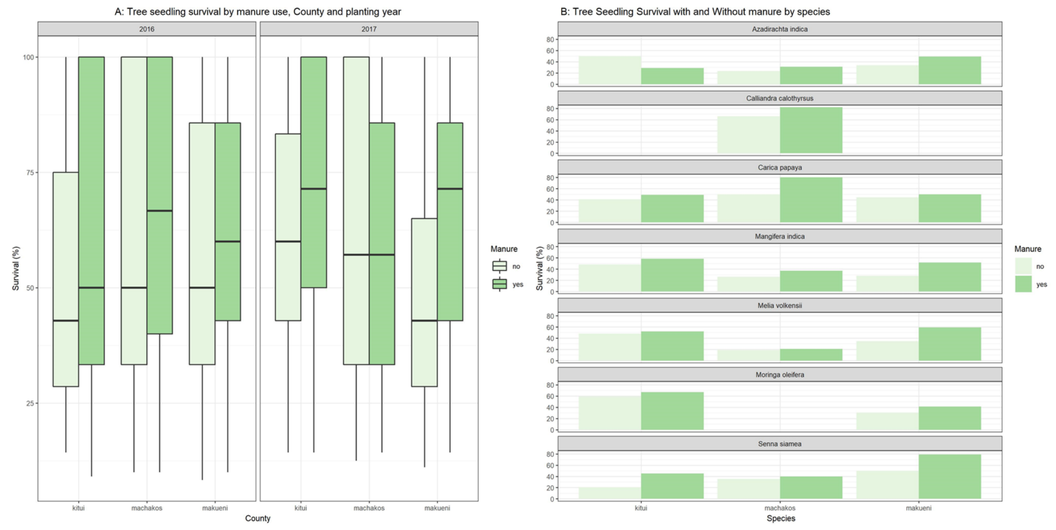

Fig 2: The graphs show the variation in seedling survival with and without manure. Graph A on the left shows the tree seedling survival across the 2 planting years with and without manure with variation across the counties, and graph B on the right shows the seedling survival with and without manure with variation within species and across counties for seedlings planted in 2017.

Statistical analysis on what leads to successful tree seedling survival indicated that watering, manure application and seedling protection by fencing positively influenced tree seedling survival. For example, application of manure increased survival by 12%, with variation at the county level. In Kitui, survival increased by 8%, in Makueni survival increased by 21% and in Machakos by 6%. The size of the planting hole did not significantly influence tree survival. However, differences were observed within species and counties. The planting niche and farm size did not have an impact on survival, with variation observed within species and across counties.

Social economic variables	Tree seedling Survival (2016) n=13,007	Chi square value (χ^2)	P value	Tree seedling Survival (2017) n=16,740	Chi square value (χ^2)	P value
Gender		9.7173***	0.002		13.227***	0.000
Male	1,258 (37%)			1,752 (44%)		
Female	3,305 (34%)			5,266 (41%)		
Age category		3.813	0.149		26.402***	0.000
< 35 years	945 (35%)			1,523 (40%)		
35-64 years	3160 (35%)			4,742 (43%)		
>65 years	458 (33%)			753 (38%)		
Education level		13.16***	0.004		59.8373***	0.000
No formal education	300 (31%)			580 (40%)		
Primary education	2691 (35%)			4117 (44%)		
Secondary education	1171 (37%)			1484 (38%)		
Tertiary education	275 (36%)			437 (49%)		
Land tenure		8.411***	0.004		3.7647*	0.052
Privately owned	4384 (35%)			6,250 (42%)		
Not privately owned	179 (30%)			498 (40%)		

Gender, age and education level of the household head had a significant impact on seedling survival with variation across the planting years. For example, the age of the household head was not significant to survival of seedlings planted in 2016, but was significant to survival of seedlings planted in 2017 (table 1).

Table 1: Some of the household socio-economic variables and their influence on tree seedling survival with variation across planting years. Gender, education level and land tenure had a significant influence on survival in both planting years, while age was only significant for seedlings planted in 2017.

Conclusion

Tree planting can have an important positive influence on environmental, social and economic realities of farmers. To scale up successful tree planting efforts, continued training on tree and nursery management for all stakeholders is necessary and beneficial. Moreover, planned comparisons have fostered farmer learning, resulting in farmers' willingness to innovate and experiment to identify options that work best for them. For example, farmers have been modifying the planting hole size from what was defined in the protocol, with varying results across species and counties.

Acknowledgements

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