Tree-water interactions at the farm level and implications at the landscape scale

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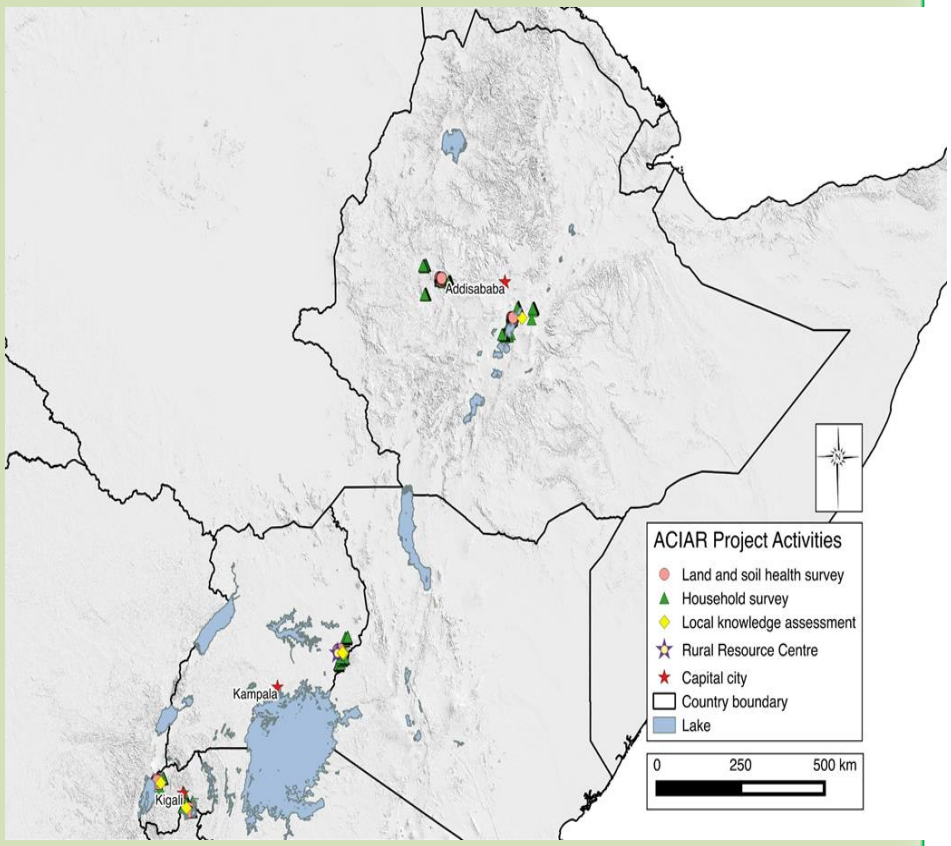
Outline

1. Why tree water interactions?
2. Context and challenges
3. Approaches and Interventions
4. Implications at landscape scale
5. Conclusions



Why Tree water interactions?

- Over 43% of the world's agricultural land >**10% tree cover** (Zomer et al. 2016,). In some tropical regions 30%.
- Water impacts productivity, livelihoods and the system
- Variability in tree species, sites and contexts
- Designing appropriate tree options for different contexts and scaling up and out
- Evidence on impact of AF on overall water productivity especially in the drylands.
- **Assumption:** Trees can enhance the efficient use of **water**

Context

Biophysical-droughts, **soils**, **policy,** markets, AEZ, **climate change,** socioeconomic, varied tree species composition/ niche---land fragmentation, **farms are systems**
Context is dynamic,

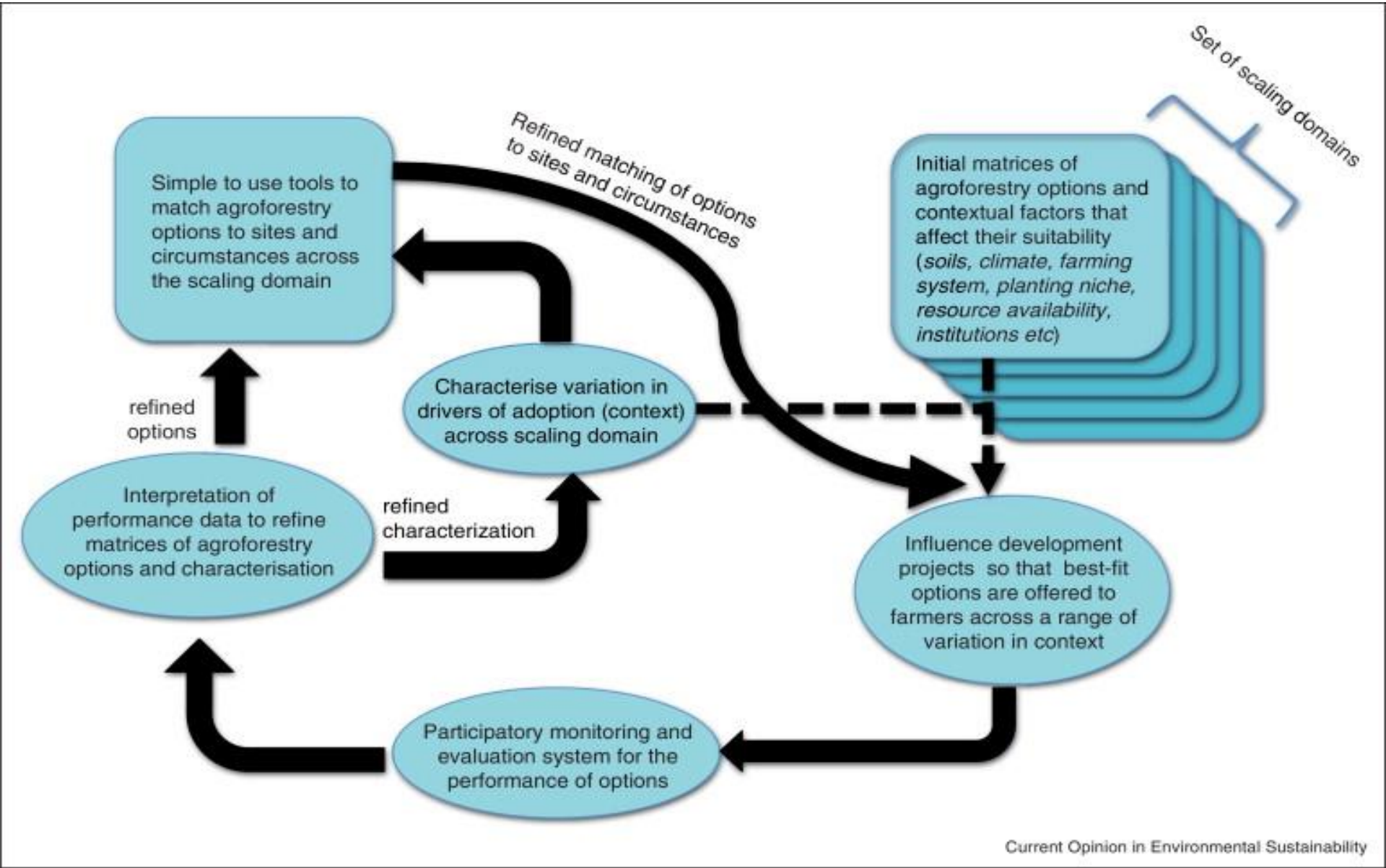





Challenges / Opportunities

Droughts, soil erosion, mud slides and flooding Communal grazing, Cultivation of steep slopes, low tree diversity, lack of quality planting materials, high demand of tree products, farmers prioritize tree products over services, training tree management required.

Approach- Co-learning paradigm that embeds research in development

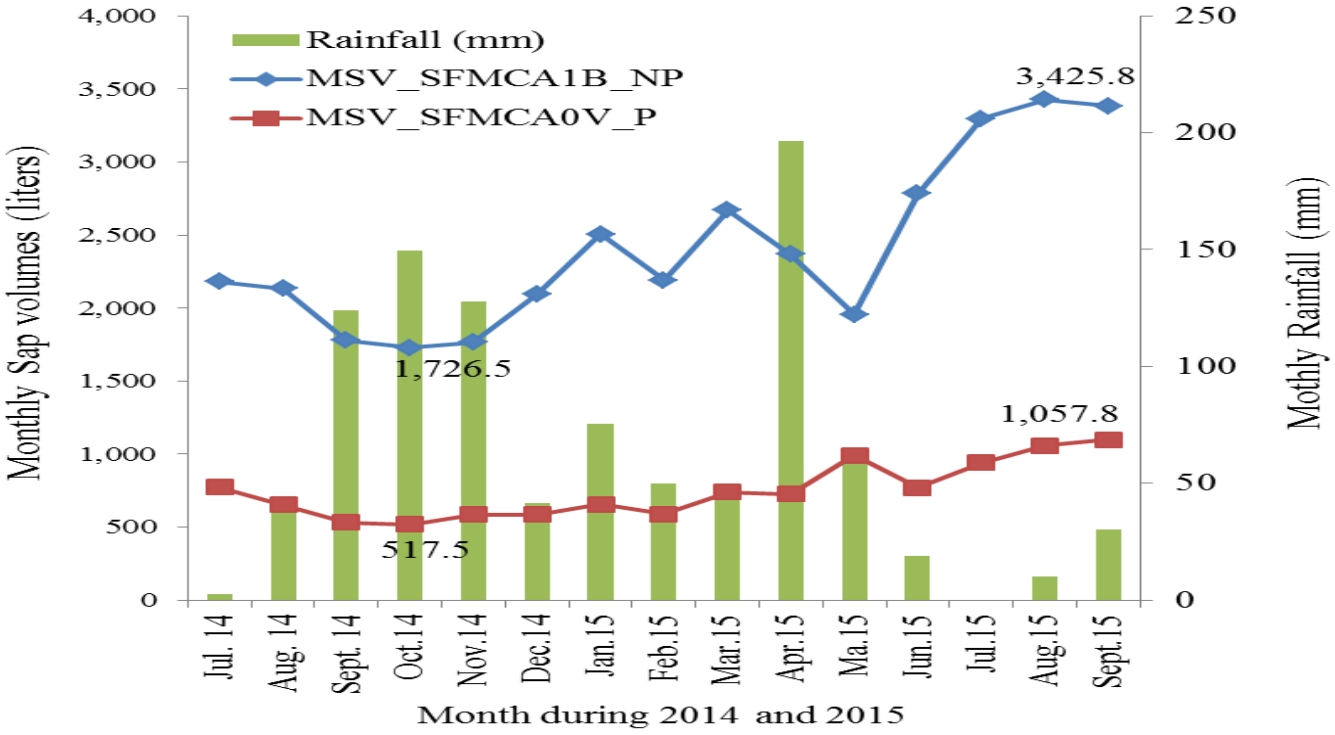


Interventions – Systems approach

- **Surveys-** understand context (Iiyama et al. 2017)
- **On farm studies, detailed biophysical and broad** farmer trials / planned comparisons-
- **Long term experiments and modelling-** *Grevillea robusta, Faidherbia albida,* Cordia africana, and *Albizia coriaria*
- **Landscape –** scaling up and out leverage on policy/ government & partnerships

Water use Competition or complementarity?

a) Grevillea robusta Rwanda

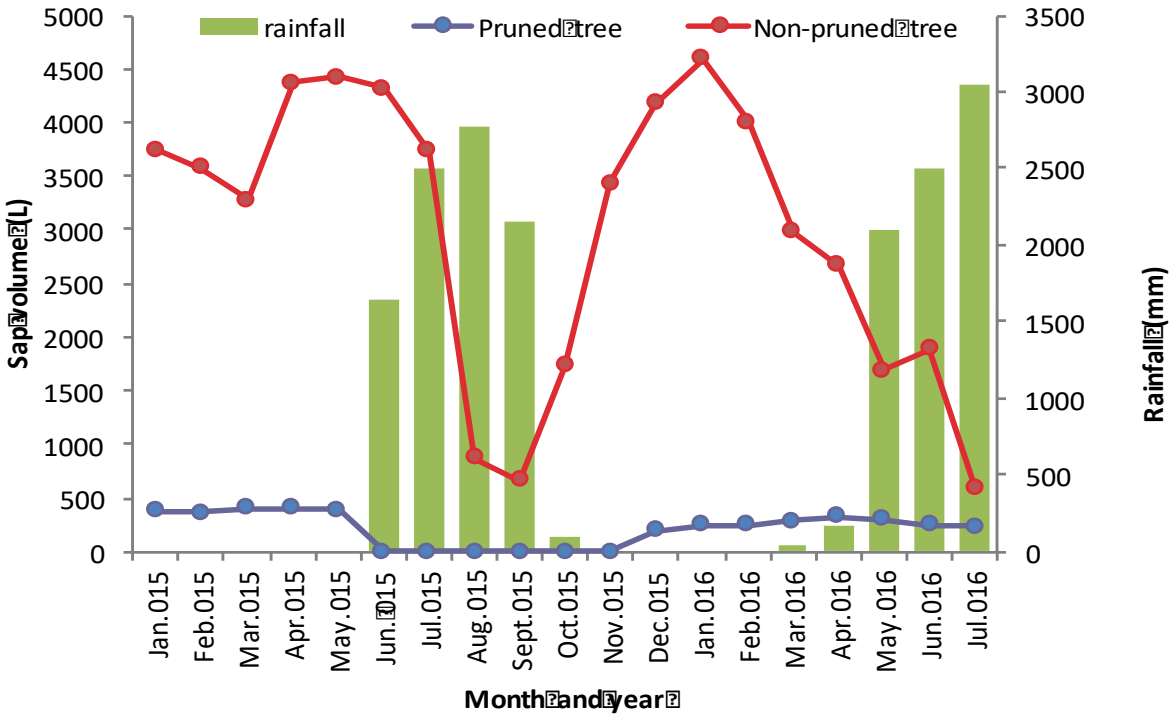


Monthly sap volumes in unprunned (NP)and prunned (P) *Grevillea* robusta in Bugesera Rwanda (Ngoga et al. in prep)

Pruning **reduces water uptake**
Increases maize yield **4. 7Kg** ha $^{-1}$ (P) against **2,8** Kg ha $^{-1}$ (NP)
Pruning provides firewood

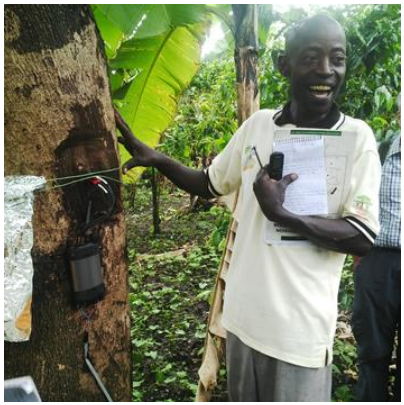
Water use Competition or complementarity?

b. *Faidherbia Albida* Ethiopia



Monthly sap volumes in unprunned (NP)and prunned (P) *F. albida* in Modjo Ethiopia

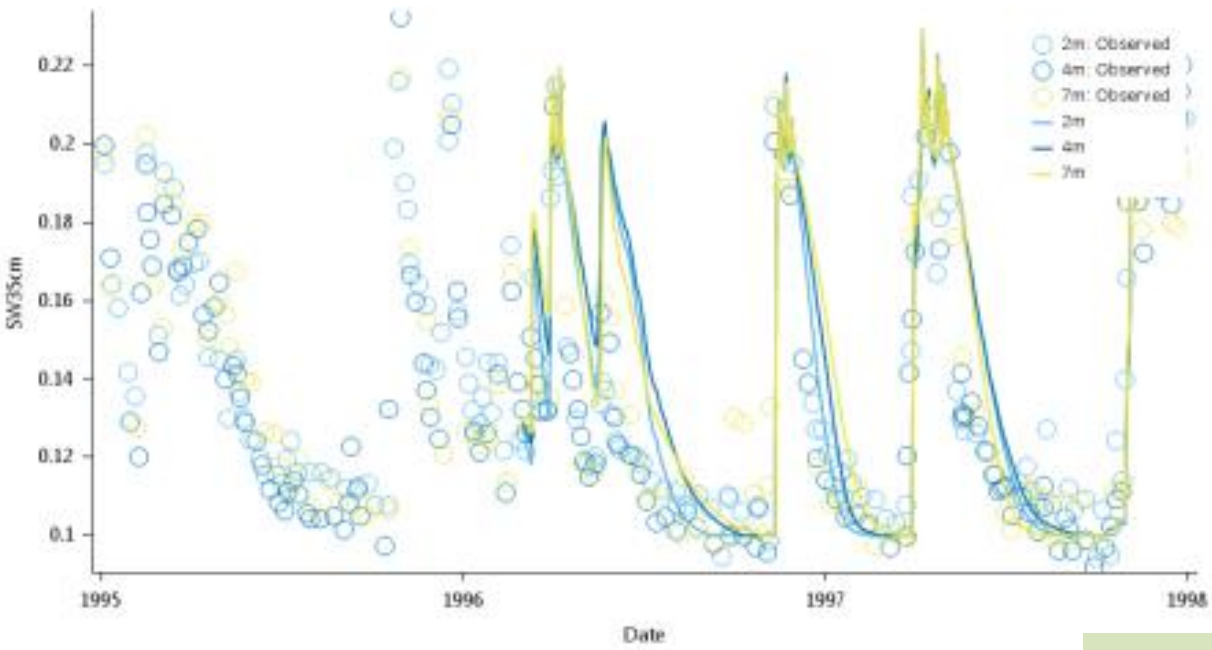
In *Faidherbia albida* pruning decreases reduces tree water uptake but increases wheat yield (Sida et al 2017, Assefa et al. in prep)



c. Uganda- *Cordia africana* and *Albizia coriaria*

In Uganda, Manafwa district, Mt Elgon area, ***C. africana* uses 12-15 Lday^{-1} and *A. coriaria*** uses 20-32 Lday^{-1}, translating to at most 450 and 960 lltres respectively. (Buyinza et al. 2018)

APSIM Agroforestry Model -Soil Water



Temporal pattern of observed and predicted soil water content at 35 cm depth at Machakos, Kenya, at 2, 4 and 7 m from Gliricidia.

Smethurst et al 2017; Luedeling E, 2016, Luedeling et al 2016

Scaling Up and Out

- **Farm-scale livelihood modelling**
- **Participatory on-farm experiments**
- **Landscape modelling (water, C, biodiversity)**
- **Virtual experiments (management, livelihoods, climate)**

Participatory Trials – at farm and landscape scales

Design workshops Participatory Trials Design Workshops

Sensitisation and training on data collection- ODK

Implementation

Different trials; Planting trees in **different niches,,** stakes for climbing beans, **green manure**, woodlots, **river bank stabilization trials, soil and water conservation structures**, fodder banks.

Monitoring and Feedback

Trials- Local knowledge -role of trees in erosion control

Farmers in the sub-humid Gishwati reported that the main cause of soil erosion was low or absent soil cover resulting from deforestation, coupled with high rainfall intensity, steep slope inclination and highly erodible soils

Farmers recognized the role played by trees in soil erosion control through soil interception and stabilization and reducing the speed of surface run-off

Heavy siltation of Karago Lake in 2013

Siltation in Lake Karago reduced through tree planting (2017)

Trials- Enhancing tree survival in East Shewa Zone

Problem: Low tree survival in East Shewa Zone Ethiopia due to water scarcity

Initial Interventions:

Soil moisture
Introduction of micro catchments

What was done

1. Farmers supported in construction of shallow wells. This enhanced survival of trees in the home orchards due to availability of water
2. Sensitization and awareness creation on tree management and tree protection
3. Enhanced capacity development through the RRCs on improved tree germplasm, appropriate management measures and suitable niches for the various tree species

Testimony: Edushe Guye's land before the construction of the well (left) and production of pawpaw trees after the well construction (right)

Findings:

1. Tree mortality remained high despite having the **SWC** especially at early stages
2. Causes of **high tree mortality**: Drought/ water scarcity; Livestock browsing; Termites
3. Farmers level of knowledge on **tree management was low**

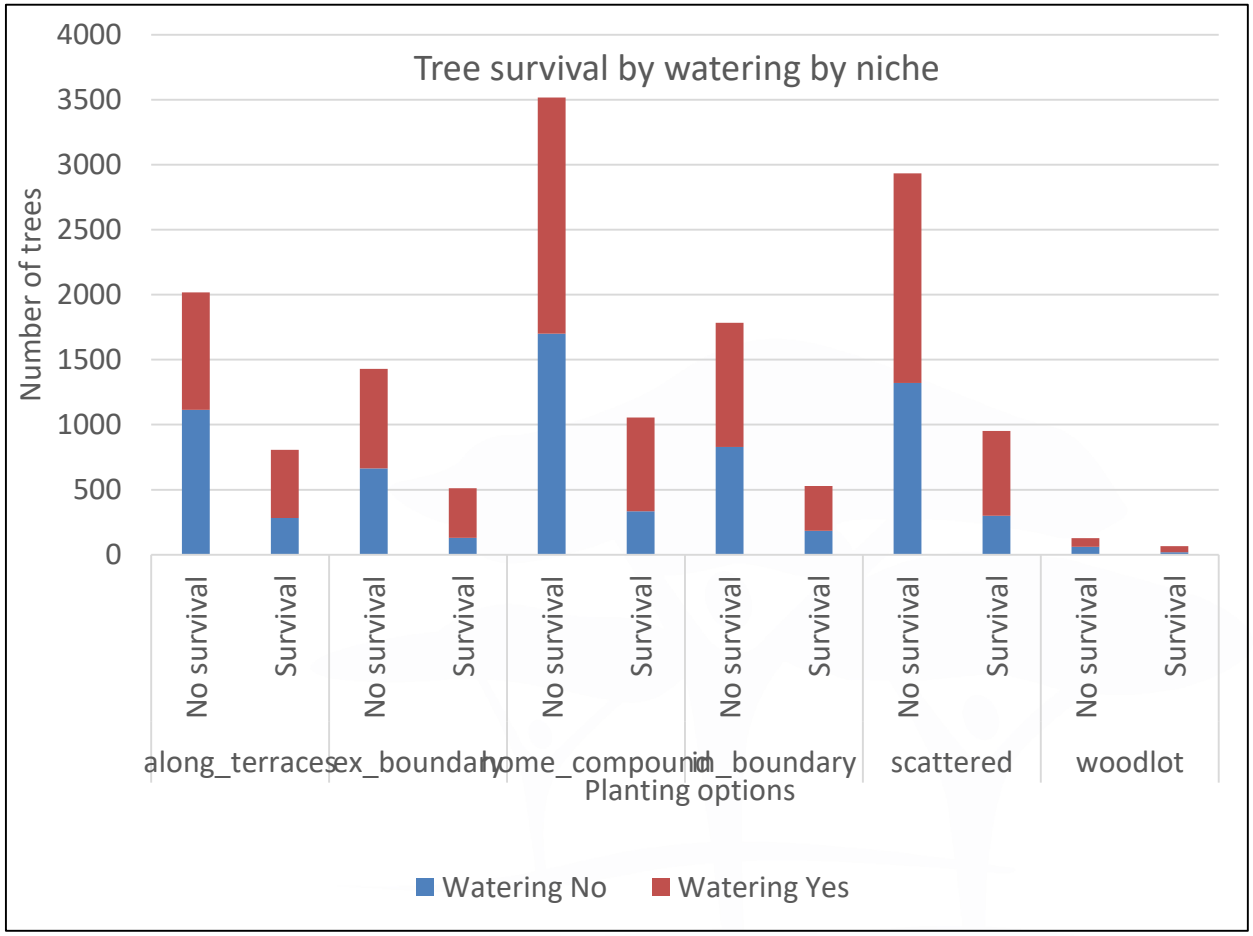
Fencing of individual fruit trees at the homesteads

Key messages

- Evidence that **high survival** due to **small scale irrigation using shallow wells, farm ponds.** Scaling up these technologies would enhance tree survival.
- **Awareness creation/ capacity development** on tree management measures especially at the early stages of tree growth is critical.

Trials DryDev tree planting planned comparisons

- 1337 farmers in eastern Kenya planting trees on various niches, applying manure, mulch and watering regimes
- Tree seedling survival influenced by manuring, watering and niche; those close to the houses do better than those further off in the woodlots



http://drydev.org/.

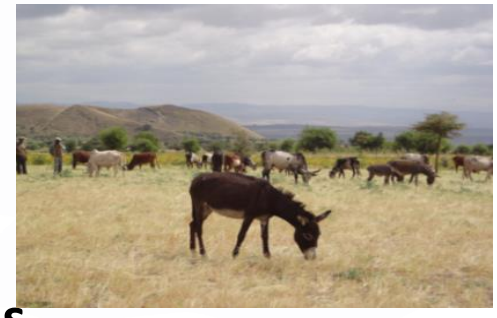
Muriuki et. al., forthcoming

Germplasm- Establishment of 6 RRCs

- **Hubs for Innovations Delivery**
- **supply of quality germplasm**
- **R**RC's can offer opportunities for, training, **peer learnings on innovations** and **income generation**

Scaling up & out / Extension methods

- Important to build on the **existing extension structures**
- Both **individual and group extension** methods are used, e.g. the use of champion farmers, farm visits, field days, demonstration plots and community meetings e.g. Umuganda (over 40,0000 farmers reached)



- **Barriers** to adoption are being addressed through:
- Engaging farmers **to formulate by-laws to control free grazing**
- Establishment of **water and soil conservation structures**

- **Diversification of tree species, soil conservation** structures, promotion of fertilizer trees, training in business skills and setting up of RRCs by the project

Conclusions

- **Context matters-** **The benefits / conditions vary in different sites**
- **Management is important in optimizing tree water interactions**
- **Multi-stakeholder engagements / relevant Partnerships / donors**
- **Co-learning paradigm with Research in Development** approach
- **Integrating the data in models for simulating impact new context**
- **Systems** approaches necessary
- **Policy support** / alignment- Need to influence Government
- **Scaling for impact possible** -Experiences from one site / country **can be scaled** to another with customized modification
- **What is the implication to rainbow water?**

Useful project resources and links

Trees for food security project webpage http://www.worldagroforestry.org/project/trees-food-security-2-developing-integrated-options-and-accelerating-scaling-agroforestry

Project webpage : http://www.worldagroforestry.org/project/trees-food-security-improving-sustainable-productivity-farming-systems-and-enhanced

Project output summary list:
http://www.worldagroforestry.org/sites/default/files/outputs/Trees%20for%20food%20security%20project%20outputs%20List_Rev_0.pdf

Trees for food security Data repository site in: Dataverse https://dataverse.harvard.edu/dataverse/T4F

Other relevant ICRAF Led Projects

IFAD Land Restoration:
1- http://www.worldagroforestry.org/project/restoration-degraded-land-food-security-and-poverty-reduction-east-africa-and-sahel-taking
2- brochure on planned comparison
http://www.worldagroforestry.org/sites/default/files/Restoration%20of%20Degraded%20Land%20Project%20Brief%20Feb%202018.pdf

3- SAIRLA
http://www.worldagroforestry.org/project/bringing-evidence-bear-negotiating-ecosystem-service-and-livelihood-trade-offs-sustainable

4- DryDev
https://drydev.org/

Thank you!