Trees for Food Security Project
A Glimpse of Ethiopia
Project overview

The Trees for Food Security Project (T4FS) is an Australian Centre for International Agricultural research (ACIAR) funded project aimed at enhancing food security for resource-poor rural people in Eastern Africa. T4FS’ research goal underpins national programmes to scale up the use of trees within farming systems in Ethiopia and Rwanda and then out-scale successes to relevant contexts in Uganda and Burundi.

Partners in Ethiopia

The Ethiopian Environment and Forest Research Institute (EEFRI), the Ethiopian Institute of Agricultural Research, the Oromia Agricultural Research Institute, the Addis Ababa University, the Mekele University, CIMMYT and World Vision Ethiopia. International scientists (from ICRAF and CSIRO) have been involved in implementing the project and supervising students. In turn, PhD and MSc students works contribute to achieve some of the project objectives.

Sites in Ethiopia

Two agro-ecologies - Initially four sites from the sub-humid (East Wollega and West Shoa) and five sites from the semi-arid (East Shoa) agro-ecologies were identified in the Oromia Region. Later, two semiarid scaling out sites were identified in Tigray.

Fig 1. Location of study sites in East Shoa, West Shoa and East Wollega Oromia, Ethiopia,
NB: the fifth site in East Shewa was dropped later and not shown in the map

Why Ethiopia?

Agriculture is Ethiopia’s most important sector accounting for more than half of the country’s GDP. A major part of the rural population is engaged in subsistence farming, often characterised by land fragmentation, land degradation associated with serious soil erosion, recurrent droughts, low agricultural productivity, and water scarcity. In addition, farmers also cite limited access to key inputs such as seeds, pesticides and extension services; a high demand for tree products e.g for fuelwood and fruit trees; and loss of tree and vegetation cover on farms and community lands. and overgrazing.
Trees for Food Security Project: A Glimpse of Ethiopia

Fig 2. Challenges to tree-based food security challenges in Ethiopia

3a: Faidherbia albida amongst teff in semi-arid Oromia

3b: Ziziphus mauritania and Acacia abysinica in maize fields semi-arid Oromia
Some outputs and achievements

Sites and farmer circumstances: understanding the target agroecologies

Understanding the barriers to, and opportunities for, adoption of trees on farm in different contexts and socio-economic characterization across the project sites is a key first step towards improving sustainable productivity. This was important to enable targeting of appropriate tree species and their management options to the farmers sites and circumstances. This project design also allowed for the results to establish a baseline for subsequent monitoring and evaluation.

Exploring socio-economic and agro-ecological patterns

A characterisation study of six hundred and eighty seven households in both the sub-humid and semiarid agroecological sites confirmed the critical importance of understanding local knowledge on the multi-dimensional utilities that farmers benefit from tree intensity on farms including from practices such as farmer managed natural regeneration (FMNR) and high value agroforestry (HVAF). Researchers used the understanding to make fine-scale recommendations of optimal mixes of species and management options rather than a wide-scale recommendation of a few iconic agroforestry practices.

Evaluating indicators of land degradation

An evaluation of site specific land health indicators found no high risk of inherent soil degradation that might limit productivity. However, it was found that the sub-humid areas in East Wollega had better soil quality for crop production and environmental services (mitigating climate change through carbon sequestration) and variability which can be better influenced by management interventions than the semiarid areas in East Shoa. The Land Degradation Surveillance Framework (LDSF), used to characterize two sentinel sites in both the sub-humid and semiarid agroecologies, further studied aspects such as average tree densities, soil organic carbon, nitrogen and other minerals.
Acquiring farmers agro-ecological knowledge

An important part of understanding sites and circumstances has also been local knowledge studies. Employing the agroecological knowledge toolkit (AKTS), designed to acquire and record farmers’ knowledge, various studies were undertaken through supported Msc and PhD programmes. Findings from historical timelines indicate that tree cover loss in Ethiopia was mainly triggered by land use change resulting from the introduction of land redistribution and villagization through government policy that began in 1974.

In East Shewa, loss of tree cover from the cropland caused by introduction of the ‘land to the tiller’ initiative saw large scale conversion of forest areas to cultivation lands; while tractor mechanized ploughing also led to uprooting of all trees from the croplands. It was also found that excessive pollarding, mainly driven by the need for tree products, heavily affected the natural regeneration of trees.

In East Wollega, some constraints to agroforestry adoption were identified as heavy browsing of seedlings by free-grazing livestock, limited land, lack of quality germplasm, and limited knowledge on both tree-crop interactions as well as the ecological suitability of trees. Farmers were also concerned about a decline in soil fertility which they blamed on continuous cultivation and soil erosion exacerbated by decreasing tree cover.

Selecting suitable tree species

A key output from the collation of data on the two hundred and fifteen tree species identified through the various studies is the suitable tree species selection tool.

The tool, complemented with the relevant science, aims at matching agroforestry options to the sites’ biophysical context and farmers’ circumstances for both agro-ecologies.

As a key product for scaling up interventions, the tool provides three outputs; namely: a tree utility table indicating products and ecological functions of trees (including niches where trees are located), the bio-physical requirements for each species and the links to other data sources.

Integrating trees, crops and livestock in farming systems - identifying impacts and tradeoffs

In order to tailor appropriate responses to the multiple challenges faced by smallholder farmers in the management of their farms, quantitative and qualitative data on the performance of crops, tree species and management options were collected; controlled experiments conducted; and simulation models of tree and crop yield across biophysical gradients developed. The results have enabled to garner an understanding of agroforestry practices on crop productivity, water resources and nutrients, farmer decisions about adoption, adaptation and management of agroforestry practices and their impact on livelihoods.
To prune or not to prune - more wheat with less water?

A study to investigate tree-crop-soil interaction of pruned and unpruned *Faidherbia albida* trees found that there is more wheat yield and biomass under unpruned trees than under pruned trees. Pruning has been shown to reduce the sap volume taken up by the tree with highs of 200 L day⁻¹ and lows of 20 L day⁻¹ in unpruned trees compared to highs of 20 -30 L day⁻¹ and lows of below 0 L day⁻¹ (reverse flow) in pruned trees.

Tree-crop interactions - experiments on farm

On-farm experiments on tree crop interactions have been conducted by CIMMYT on microclimate, maize genotypes and crop management practices (nitrogen, and phosphorous fertilization, tillage).

Results show that the microclimatic influence of *Faidherbia albida* trees, increases aboveground biomass and grain yield of wheat right underneath the tree (by 20-25%) and decrease with increasing distance from the tree trunk.

Experiments on wheat varieties revealed complex interactions between genotype, agroforestry and tillage management. In addition, N-P trial in Faidherbia-wheat system indicated that the system improves and stabilizes yield even with low external input.
**Long term tree experiments - what has been missing out?**

**Sub-humid agroecology**

A long term trial is established at Bako Agricultural Research Center (Fig 9). Teff was grown with four tree species (*Grevillea robusta*, *Acacia abyssinica*, *Cordia africana* and *Croton macrostachyus*) planted as pure plots, mix of the four species and crop alone (control). Reports are available.

**Semiarid agroecology**

A long term trial is established in Melkassa with treatments of pure plots of four tree species, *Cordia africana*, *Moringa stenopetala*, *Acacia tortilis* and *Faidherbia albida*, a mixed plot and a crop alone (control). Soil physical and chemical properties have been characterized for Bishola together with collection of data on the survival and growth of the planted tree seedlings (Fig 10) as well as data on teff yield.

Data gathered from these experiments and trials have provided a background to evaluate tree-crop interaction under the Agricultural Production Systems Simulator (APSIM). (See Report for details)
**Farmers trying out experiments on farms**

Participatory trials involving 446 farmers were established in four semiarid and four sub-humid sites. A farmers training workshop conducted on the process of participatory trials has been instrumental for researchers, extension agents and farmers to jointly evaluate the performance of tree species under various planting niches and the effect of soil moisture retention structures and compost/manure application on the survival and growth of tree species.

Seedling distribution (Fig 11) has targeted species that have the potential to improve soil conditions. Others, such as grafted mango and avocado, as well as other fruit, timber and fodder species have also been distributed to beneficiaries (see Table 1 on following page).

Additionally, out of the tested water harvesting structures, the half-moon structure with infiltration pit significantly improved tree survival in the sub-humid agroecology. However, the survival of seedlings is challenged by drought, open grazing and by pests and diseases. (Reports on farmers’ priority species, planting niche and the survival of tree seedlings planted are available).

Nevertheless, farmers, extension agents and researchers involved in the process in a co-learning environment have enabled the research to be well embedded in the national programme, making it instrumental to scale up the use of trees within farming systems.

**Enabling environments for the adoption of trees on farms**

**Policy dialogue and policy analysis**

Large scale adoption of trees on farms requires removing barriers to adoption and so will depend on understanding the policy, socio-economic and institutional factors required for farmers to integrate trees on their farms.

Policy dialogues conducted at district and national scale in Ethiopia identified policy related challenges that inhibit the adoption of trees on farm (A Report on the dialogues is available).

A subsequent policy brief is currently under translation after a commissioned work further analysed agroforestry related policy provisions and the gaps in the existing national policies.
Trees for Food Security Project: A Glimpse of Ethiopia

Supporting the government agricultural extension system

Understanding the status of the extension system in Ethiopia is vital to delivering services, especially extension technologies disseminated to farmers, local innovation, community engagement, capacity and efficiency, linkage with other institutions, commercialization and marketing.

In Ethiopia, model farmers have been shown to be the most common and effective extension method.

However, other methods of extension such as individual and group extension; demonstrations at farmer training centers and on individual farms, individual farm visits, field days and mass media, face huge challenges mainly attributed to constrained budgets.

As a result most Government funded Farmer Training centers were not equipped and therefore not optimally functional. A lack of transport facilities especially for Development Agents (DA) to visit the farmers and high DA turnover due to low salaries and lack of incentives were also found to be challenges to the extension system.

In 2013, the Trees for Food Security project advised building on and strengthening the existing Government extension structure to scale up agroforestry to farmers. The Farmer Training Centres were thus subsequently complemented with Rural Resource Centres where farmers can access training, germplasm and other extension services.

Improving access to tree seeds and seedlings

A tree nurseries assessment found that high costs, insufficient government and NGO nurseries as well as lack of seed dealers are major hindrances to farmers’ tree germplasm access. Despite the popularity of tree seedlings, the challenges act as significant deterrents to many communities.

In addition, knowledge gaps exist at the grass roots level on what type of trees to plant and their management options. It was also found that the challenges encountered during seeds and seedlings distribution by the government and NGOs necessitate the establishment of more individual/group nurseries to meet community needs.

The established Rural Resource Centres have supported farmers’ access to improved germplasm and also receive various trainings (such as tree seedling establishment, record keeping, vegetative propagation and grafting methods). Currently the germplasm management capacity of nursery operators and seed dealers is also being supported in order to improve both genetic and physiological quality of seeds used in seedling production. (A related manuscript is under review in the *Forests, Trees and Livelihoods* journal).

A closer look at Rural Resource Centers

The Batu Rural Resource Centre (RRC) equipped with training hall, store, and nursery was set up in Jido Kombolcha Woreda in March 2015 in collaboration with the local Office

<table>
<thead>
<tr>
<th>Site</th>
<th>T4FS * Farmers</th>
<th>Homestead</th>
<th>Farmland</th>
<th>Soil Bund</th>
<th>Boundary</th>
<th>Coffee shade</th>
<th>Plantation</th>
<th>Total seedlings under T4FS farmers</th>
<th>Other farmers Non-T4FS farmers</th>
<th>No of seedlings</th>
<th>Number of farmers</th>
<th>Number of seedlings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ziway</td>
<td>33</td>
<td>796</td>
<td>480</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1276</td>
<td>190</td>
<td>34000</td>
<td>223</td>
<td>35276</td>
</tr>
<tr>
<td>Alemtena</td>
<td>95</td>
<td>919</td>
<td>143</td>
<td>744</td>
<td></td>
<td></td>
<td>2500</td>
<td>4306</td>
<td>205</td>
<td>31000</td>
<td>300</td>
<td>35306</td>
</tr>
<tr>
<td>Meki</td>
<td>25</td>
<td>546</td>
<td>598</td>
<td>50</td>
<td>300</td>
<td></td>
<td></td>
<td>1494</td>
<td>300</td>
<td>42500</td>
<td>325</td>
<td>43994</td>
</tr>
<tr>
<td>Mojo</td>
<td>95</td>
<td>9330</td>
<td>1974</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11304</td>
<td>50</td>
<td>3000</td>
<td>145</td>
<td>14304</td>
</tr>
<tr>
<td>Tibe</td>
<td>35</td>
<td>1355</td>
<td>4980</td>
<td>1123</td>
<td></td>
<td></td>
<td></td>
<td>7458</td>
<td>60</td>
<td>8500</td>
<td>95</td>
<td>15958</td>
</tr>
<tr>
<td>Anno</td>
<td>62</td>
<td>1658</td>
<td>17576</td>
<td>10556</td>
<td>4340</td>
<td>723</td>
<td>2000</td>
<td>36853</td>
<td>CL</td>
<td>15000</td>
<td>62</td>
<td>51853</td>
</tr>
<tr>
<td>Arjo</td>
<td>48</td>
<td>1126</td>
<td>1618</td>
<td>294</td>
<td>2168</td>
<td>1356</td>
<td>3000</td>
<td>9562</td>
<td>230</td>
<td>18000</td>
<td>278</td>
<td>27562</td>
</tr>
<tr>
<td>Uke</td>
<td>53</td>
<td>541</td>
<td>3568</td>
<td>562</td>
<td></td>
<td></td>
<td></td>
<td>4671</td>
<td>30</td>
<td>6000</td>
<td>83</td>
<td>10671</td>
</tr>
<tr>
<td>Total</td>
<td>446</td>
<td>16271</td>
<td>25957</td>
<td>16624</td>
<td>8493</td>
<td>2079</td>
<td>7500</td>
<td>76924</td>
<td>1065</td>
<td>158000</td>
<td>1511</td>
<td>234924</td>
</tr>
</tbody>
</table>

Table 1. Number of seedlings planted in the participatory trials established in 2014
of Agriculture. The hub was inaugurated by the Australian Ambassador to Ethiopia H.E. Mark Sawers on 31st March 2016.

The RRC is operated by local farmers registered as a cooperative named “Magarissa”. The centre has training and agricultural technology dissemination facilities to enable farmer, extension staff, schools and local administrators conduct training and capacity building activities.

In 2015, 54,100 fruit and timber seedlings were produced and supplied to local farmers and semi-urban communities. Further, tree planting and management practices were demonstrated to 215 primary and secondary students; 247 farmers and 42 extensionists who visited the RRC. Members earned ETB 99,663 (USD$ 4,861) from sales of planting materials (seedlings, rootstock, scions) and vegetables during the year.

The cooperative has created market linkages and business opportunities with urban based tree nurseries to supply them with quality fruit rootstock and scions.

The Batu RRC plans to produce over 50,000 in seedlings of fruits (16,000); multipurpose tree species (40,220) and ornamentals (3,000) with an estimated value of ETB 525,000 (USD$ 25,609). Some of the outstanding challenges on these plans however include financial constraints to initiate satellite nurseries and to hire a technical manager on a full time basis.

The cooperative is also lobbying government to allocate good sites to set up satellite nurseries and outlets for seedlings marketing close to urban centres in line with current policy to support private tree nurseries development.

Mr Soressa of Tibe in the sub-humid agroecology planted 125 G. robusta seedlings on soil bunds and managed to get a 98% survival rate. He told his neighbors that it was a Government programme so they keep the animals away from his farm.

In addition, he also planted avocado, mango, G. robusta and M. stenopetala in his homestead area, and succeeded with a 67% survival. He uses hangs plastic bottles for watering and has fences seedlings individually.

Mr Soressa with some farm tools won for good results.

**Water harvesting and well development**

A water harvesting scheme from a lake, a river and wells is being carried out as part of an effort to improve the way Ziway lake is accessed and used in the Rural Resource Centers.

It further aims to irrigate the Melkassa long term trial from a river source and improve existing wells and dig new ones for selected project farmers in the semiarid sites. This work is led by a specialist from ICRAF.

**Fig 12. Inauguration of Batu Rural Resource Center in Ziway town**

**Fig 13. A recently developed well of a farmer in the semi arid Ziway**
SCALING UP AND SCALING OUT

To meet the T4FS project’s objective of scaling up agroforestry technologies in Ethiopia, ICRAF in partnership with World Vision Ethiopia (WVE), EEFRI and the woreda administrations has used various strategies/approaches with participatory trials, germplasm supply, Rural Resource Centers (RRC), nurseries and demonstration plots, on farm experimentation, training and capacity building, and sensitization meetings (Fig 14).

The World Vision Ethiopia (WVE) for example has supported scaling out with its own extension system and structure.

Some studies conducted on agroforestry technologies extension resulted in important outputs such as the production of materials on 1) Community by-law framework – to resolve conflicts around free grazing, 2) Community based AF extension brochure, 3) Policy brief on AF extension and 4) Community based AF extension technical reports. Currently, WVE is also engaged in scaling out activities in Eastern Tigray in two contrasting semi-arid sites.

More than 6,000 community members have been reached through the various strategies as shown:

<table>
<thead>
<tr>
<th>Scaling up approach</th>
<th>Farmers reached</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training and capacity development</td>
<td>316</td>
</tr>
<tr>
<td>Participatory Trials</td>
<td>446</td>
</tr>
<tr>
<td>RRC</td>
<td>539</td>
</tr>
<tr>
<td>Partnerships: WVE/FRC/Woreda administration and seedlings distribution</td>
<td>2238</td>
</tr>
<tr>
<td>Collective action and farmer sensitization meetings</td>
<td>2053</td>
</tr>
<tr>
<td>Farmers reached through project surveys</td>
<td>1043</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>6635</strong></td>
</tr>
</tbody>
</table>

Fig 14. Summary of the T4FS project scaling up strategy in Ethiopia

Contributors:


April 2016