Challenges for Improving Forest Conditions and Forest Based Livelihoods Through Participatory Forest Management Around Bonga, Southwestern Ethiopia

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Source: International Forestry Review, 17(3):355-367.
Published By: Commonwealth Forestry Association
URL: http://www.bioone.org/doi/full/10.1505/146554815815982666

Challenges for improving forest conditions and forest based livelihoods through participatory forest management around Bonga, southwestern Ethiopia

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SUMMARY

Participatory forest management (PFM) has been considered a tool of forest conservation. Bonga forest has been under PFM project until 2010 with external support. Since 2010 PFM has continued without external support. This study aims to assess the progress of the PFM approach in improving forest condition and forest based livelihoods in Bonga National Forest Priority Area, Southwest Ethiopia. A combination of forest inventory and household surveys was employed to carry out the study. Vegetation data and socioeconomic data were collected from 53 plots and 141 households respectively. The results revealed that the regeneration of ecologically and economically important species under forest was not satisfactory. The relative forest dependency of non-PFM members is comparable and sometimes greater than PFM members. About 89% of the non-members had illegal access to the forest after the project ended. PFM has brought alienation of de facto forest use rights, and addressing forest condition and forest based livelihoods will necessitate a reconsideration of how PFM establishment is framed.

Keywords: regeneration, forest users, diversity, forest dependency, southwest Ethiopia

Défis pour améliorer la condition de la forêt et les revenus basés sur elle avec l'aide d'une foresterie participative près de Bonga, dans l'Ethiopie du sud-ouest

K. TEKALIGN, U. KABA et K. ZERIHUN

La gestion forestière participative (PFM) est considérée comme un outil pour la conservation forestière. La forêt de Bonga a été gérée par un projet PFM jusqu'en 2010, avec l'aide d'un soutien extérieur. Depuis 2010, la PFM continue, sans soutien externe. Cette étude vise à évaluer le progrès de l'approche de la PFM dans l'amélioration de la condition de la forêt et des revenus basés sur elle dans la Zone forestière prioritaire nationale de Bonga, en Ethiopie du sud-ouest. Une combinaison d'inventaire forestier et d'enquêtes dans les foyers a été employée pour effectuer cette étude. Des données végétales et socio-économiques ont été glanées de 53 parcelles de terrain et de 141 foyers, respectivement. Les résultats ont révélé que la régénération d'espèces écologiquement et économiquement importantes dans la forêt n'était pas satisfaisante. La dépendance relative à la forêt des non-membres de la PFM est comparable, et parfois supérieure à celle des membres de la PFM. Environ 89% des non-membres avaient un accès illégal à la forêt après que le projet ait été conclu. La PFM a créé une aliénation des droits dans les faits à l'utilisation de la forêt, et une prise en compte de la condition de la forêt et des revenus basés sur celle-ci va nécessiter une reconsidération de la manière dont l'établissement de la PFM est conçu.

Desafíos para mejorar el estado de los bosques y los medios de vida con base en el bosque mediante el manejo forestal participativo en torno a Bonga en Etiopía sudoccidental

T. TEKALIGN, U. KABA y K. ZERIHUN

El manejo forestal participativo (MFP) está considerado como una herramienta para la conservación de los bosques. El bosque de Bonga ha estado sujeto a un proyecto de MFP hasta 2010 que contaba con apoyo externo. Desde 2010, el MFP ha continuado sin apoyo externo. Este estudio tiene como objetivo evaluar los avances del enfoque de MFP en la mejora de las condiciones del bosque y los medios de vida con base en los bosques del Área Prioritaria del Bosque Nacional de Bonga, en el suroeste de Etiopía. Para llevar a cabo el estudio se empleó una combinación de inventario forestal y encuestas a hogares. Se recabaron datos de vegetación y datos socioeconómicos de 53 parcelas y de 141 hogares, respectivamente. Los resultados revelan que la regeneración en el sotobosque de las especies importantes desde el punto de vista ecológico y económico no fue satisfactoria. La dependencia forestal relativa de quienes no participan en el MFP es similar a la de los miembros del proyecto de MFP, y a veces mayor. Alrededor del 89% de quienes no participan accedieron ilegalmente al bosque después de que el proyecto terminó. El MFP ha entrañado una enajenación de los derechos de facto de uso de los bosques y para gestionar el estado del bosque y los medios de vida basados en el mismo se requerirá replantear el modo en que se enmarca el establecimiento del manejo forestal participativo.

INTRODUCTION

Participatory forest management (PFM) has been introduced in response to perceived deforestation and forest degradation (Nagendra *et al*. 2005, Schreckenberg and Luttrell 2009). The opinion is that local communities are the main drivers of deforestation and forest degradation due to loosely defined rights over forest resources. Slowing down deforestation and forest degradation requires that local communities take part in the use and conservation of forest resources (Campbell 2006). PFM assumes that the local communities' right to use forest resources is recognized (Tacconi 2007). The hypothesis is that the benefits which local communities perceive from the forest motivate the wise use and conservation of forest resources (Tacconi 2007). Most countries in Africa have promoted PFM since the 1990's for sustainable forest conservation (Nagendra *et al*. 2005, Rasul *et al*. 2011, Schreckenberg and Luttrell 2009, Tacconi 2007). Ethiopia is one of the countries in Africa that is introducing PFM.

Recently there has been a trend in scaling up of PFM in Ethiopia (Ameha *et al*. 2014a, Mengist *et al*. 2013). The intention is to put the remaining natural forest under PFM regimes. Doing this at large scale seems to be the success history of PFM. However, the previous study findings have given consideration to the institutional strength sustainability of the PFM arrangement. For instance, studies by Ameha *et al*. (2014b) and Belay *et al*. (2013) have shown that the introduction of PFM has divided the local communities into PFM members and non-members based on some established criteria. PFM members are organised into forest user groups to develop and use the forest resources. The PFM arrangement regulates the right of non PFM members to access the forest. The underlying premise of PFM is that of improving forest condition and the livelihoods of forest dependent communities (Mengist *et al*. 2013). Restricting the right of traditional forest users to access the forest may jeopardise the effectiveness of PFM forest user groups as a strong institution. Of equally important concern are the forest based livelihoods. Forests play a major role in the livelihoods of households. The report of Yemiru *et al*. (2010) has indicated that forests contribute 34% of household per capita income. Another study at Chilimo forest, central part of Ethiopia, shows that forest income contributes 39% of household income (Mamo *et al*. 2007). Belay *et al*. (2013) have reported that forest income accounts for 49% of household income. The dichotomy between members and non-members among traditional forest users may motivate the non-members to exploit the forest irresponsibly.

Forest degradation takes place due to over-exploitation of economically important tree species only. Forest condition is not only about controlling access to the forest. As a result, improving forest condition implies improving the regeneration of seedlings and saplings under the forest (Gobeze *et al*. 2009) and the ecosystem services provided by the forest. Tacconi (2007) argues that the notion of PFM may not necessarily result in forest conservation. Mohammed and Inoue (2012) highlight the limitation of forest conservation through PFM at grassroots level. Kassa *et al.* (2009) have reported PFM benefits in the long term. PFM is expected to address dual objectives (Gobeze *et al.* 2009). Despite about two decades of PFM experience in Ethiopia, there has been no concrete feedback about the performance of PFM in addressing both forest resources conservation and the livelihood improvement of forest user groups. Available literature is based on the study conducted during the project but the findings still show some gaps regarding the progress of PFM (Ameha *et al.* 2014a, Gobeze *et al*. 2009). Gobeze *et al*. (2009) suggest assessing progress of the PFM a few years after the project ended. To this end, it is imperative to assess the status of the pilot project after the project has ended for better success of PFM in the future.

Bonga forest is one of the forest sites where PFM was first piloted. The forest has been managed under PFM since 1995 in two phases ran by Farm Africa (Gobeze *et al*. 2009). The project ended in 2010 and since then the PFM has been running without any external support. A report from Kafa Zonal Agricultural Development Bureau for the year 2013 shows about 49 090 ha of the forest has been put under PFM. The forest has made immense ecological, cultural and economic contributions (Kelbessa and Soromessa 2008, Melaku *et al*. 2014). Ecologically, the forest is one of the remnants of Afromontane moist evergreen forest (Schmitt *et al*. 2010). Socially, it is the source of livelihoods for many people (Melaku *et al*. 2014, Stellmacher and Mollinga, 2009, Wakjira and Gole 2007). Conservation and economic interest in the forest is the tenet for putting the forest under PFM (Gobeze *et al*. 2009, Kelbessa and Soromessa 2008). On the PFM document it is stated that PFM is expected to improve the regeneration of some tree species such as *Pouteria adolfi-freiderici* (Engl.) Robyns & Gilbert, *Prunus africana* (Hook.f.) Kalkam, *Cordia africana* Lam, and to improve forest based livelihoods. Due to a lack of reference data, it is difficult to consider the previous study findings as baseline information. The interest of the paper is to assess the progress of PFM post-project based on the criteria of forest condition and forest based livelihoods. This study aims at evaluating the effectiveness of participatory forest management approach in terms of improving the forest condition and forest based livelihood in Bonga National Forest Priority Area. The paper will try to answer the following research questions:

- What is the status of the forest under PFM since the project ended?
- How strong are the forest user groups for protecting the forest?
- What are the unforeseen issues that influence the progress of PFM?

Analytical framework

The progress of PFM is evaluated based on the stated objective of the outcome of PFM. The PFM document states that PFM is expected to improve both forest condition and the livelihoods of forest user groups. For this study forest condition is explained in terms of the seedling and sapling regeneration under forest and species diversity. High species diversity and inverted J shape tree species recruitment are an indicator of good forest condition (Kelbessa and Soromessa

2008, Mengist *et al.* 2013). Only forest user groups are entitled to access the forest. For households that currently have access to the forest and their level of dependency on the forest, signs of newly cut stumps and charcoal pits are an indicator of the institutional effectiveness of the forest user groups. Forest based livelihoods are assessed based on the benefit that the local community perceive from the forest (Ameha *et al.* 2014a, Gobeze *et al*. 2009).

MATERIALS AND METHODS

Description of study area

The study was conducted in Bonga forest. The forest is found in Kafa zone, southwest Ethiopia. It is found at 453km from Addis Ababa (Melaku *et al*. 2014). Geographically, it is situated between 7°29′15″ – 7°12′54″ North and 35°59′51″ – 36°28′35″ East. The altitude of the area ranges between from 1450 m.a.s.l. to 2370 m.a.s.l. The area has long rainy season (Kelbessa and Soromessa 2008). Based on the central statistical agency, in 2013 the total population of the district was 119 958. About 89.3% of its population are rural dwellers (http://en.wikipedia.org/wiki/Ginbo). The composition of the ethnic groups in the study area was Kafficho (76.74%), Amhara (15.19%), and Oromo (4.25%). Other ethnic groups account for 3.82% of the population. Agriculture is the main source of households' economy in the area. The dominant crops grown in the area are maize, teff, sorghum, beans and wheat.

Bonga forest is one of the oldest PFM intervention sites in Ethiopia (Gobeze *et al*. 2009). Bonga forest is divided into six PFM sites. PFM members are organized into forest user groups. These forest user groups are in charge of the forest. It is permitted to use the forest only for non timber forest products such as honey, spices, and forest coffee (Gobeze *et al*. 2009). The original Bonga forest area covers about 161 424 ha (Kelbessa and Soromessa 2008, Melaku *et al*. 2014). The forest was designated as a national forest priority area in 1986. The forest is rich in biodiversity (Schmitt *et al*. 2010).

Methods of data collection

Data were collected from September 2013 to April 2014. Information was collected on forest condition and forest based livelihoods. Key variables were defined for forest condition and forest based livelihoods (Ameha *et al*. 2014a). Variables such as forest composition, regeneration and disturbance indicators were selected for forest condition assessment. Forest income, level of forest dependency and forest users' perception of being PFM members were selected for forest based livelihoods. A combination of forest inventory and household survey were the methods employed to carry out the study.

Forest inventory

Three blocks of forest under PFM were selected for the study. The study sites are the oldest PFM sites and can be seen as model sites. Table 1 shows forest blocks, total area and sampling plots. A circular plot of 314 m^2 (10 m radius) was laid along the transect line for trees and disturbance indicators. Subplots with 78.5 m^2 (5 m radius) and 19.625 m^2 (2.5 m radius) were nested within the main plot for saplings and seedlings respectively (Gobeze *et al*. 2009, Gole *et al*. 2008). Plots were laid at intervals of 450 m along the transect and transect lines were laid at an interval of 500 meters. The first plot was laid at 50 meters to avoid the forest edge effect. Definition of seedling and sapling followed Kelbessa and Soromessa (2008). Plant identification was made on the site with the help of Useful Trees and Shrubs of Ethiopia assisted by local names of plants (Bekele-Tesemma 2007). For species difficult to identify on the site, specimens were taken for identification to the Herbarium at Jimma University Biology Laboratory. The nomenclature of plant species follows the Flora of Ethiopia and Eritrea. DBH measurement was taken at 1.3 meters from the ground using calipers.

Socioeconomic survey

Samples were selected from the households living adjacent to the forest. Two stage sampling techniques were employed to select the households to be interviewed (Sapkota and Oden 2008). Households living adjacent to forest were divided into PFM members and non-PFM members. The sample size was determined using proportional probability sampling techniques. Sampled households were drawn in proportion to the total household numbers from both members and non members (Belay *et al*. 2013). Table 2 shows the total number of households and sampled households. A total of 141 households (99 members and 42 non members) were randomly drawn. A detailed structured questionnaire was prepared on variables selected for forest based livelihoods. Information was collected through face to face interview and focus group discussions. Both qualitative and quantitative data were collected. Household incomes were estimated based on the recall method (Tieguhong and Nkamgnia 2012, Yemiru *et al*. 2010). For this study the benefits in 2013 were considered for estimation.

TABLE 1 *Forest blocks, total areas and sampling plots*

	Forest blocks		
	Baka	**Matapa**	**Wacha**
Natural forest area (ha)	602	215	210
Sample plots (no)	22	16	15

TABLE 2 *Total number of households and sampled household size*

	Total Households		**Sampled Households**	
Forest blocks	**PFM-members**	**Non-members**	**PFM-member**	**Non-members**
Baka	110	34	42	13
Matapa	73	27	30	11
Wacha	64	42	27	18
Total	**247**	**103**	**99**	**42**

Data analysis

Data collected on forest condition were analyzed for species richness, Shannon-Weiner species diversity index, and Important Value Index (IVI) (Giliba *et al*. 2011, Gobeze *et al*. 2009, Senbeta and Denich 2006, Tadesse *et al*. 2014, Zegeye *et al*. 2011). The Shannon-Weiner species diversity index was computed using the formula:

$$(H') = -\sum_{1=i}^{s} \text{piln(pi)}$$

Where

H' = Shannon's diversity index

S = total number of species in the quadrate

Pi = ni/N, the number of individuals found in the i^{th} species as a proportion of the total number of individuals found in all species

In = natural logarithm to base e

Important Value Index (IVI) was computed using the formula:

$$IVI = Relative\ density + Relative\ frequency + Relative\ dominance$$

$$Relative\ Density = \frac{\text{Density of one species}}{\text{Total density}} \times 100$$

$$Relative\ Frequency = \frac{Frequency\ of\ one\ species}{Total\ frequency} \times 100$$

$$Relative\ dominance = \frac{Basal\ area\ of\ species}{Total\ basal\ area} \times 100$$

$$Basal\ area = \pi r^2$$

Socioeconomic information was analyzed descriptively using Microsoft Excel and the Statistical Package for Social Sciences (SPSS version 20). Household annual income was calculated using the formula as used by Belay *et al*. (2013), Gobeze *et al*. (2009), Masozera and Alavalapati (2004) and Tieguhong and Nkamgnia (2012).

$$Household\ Annual\ Income = \sum Forest\ income + Agricultural\ income + Other\ incomes$$

Household forest dependency was computed as total household annual forest income divided by total household annual income (Belay *et al*. 2013, Tieguhong and Nkamgnia 2012, Vedeld *et al*. 2007).

RESULTS AND DISCUSSION

Forest composition and species diversity

A total of 57 woody species representing 32 families were identified from 53 quadrants. The three forest blocks: Baka, Wacha, and Matapa, represented 45, 46 and 51 of identified woody species belonging to 25, 26, and 26 families respectively. Except for Rubiaceae (14%), all families had contributed to less than 10% of the forest composition across the three forest blocks. Of identified trees and shrubs in the forest, 54% of forest composition was dominated by trees (Appendix 1).

Canopy trees like *Pouteria adolfi-freiderici* (Engl.) Robyns & Gilbert, *Olea welwitschi* (Knobl.) Gilg & Schellenb, *Prunus africana* (Hook.f.) Kalkam, *Schefflera abyssinica* (Hochst.ex.A.Rich.) Harms, *Ekebergia capensis* Sparrm. and *Sapium ellipticum* (Hochst.) Pax were recorded. Nevertheless, these species had a lower Important Value Index (IVI) relative to the total species recorded across the forest blocks. The IVI of five ecological and economic important species, *Ekebergia capensis* Sparrm, *Prunus africana* (Hook.f.) Kalkm, *Cordia africana* Lam, *Apodytes dimidiata* E.Mey.ex Am and *Pouteria adolfi-freiderici* (Engl.) Robyns & Gilbert were computed and the result showed that *E. capensis* had 1.9, 2.2, 0.31, *P. africana* had 1.3, 1.7, 3.3, *C. africana* had 1.1,0.5,0.5*, A. dimidiata* had 0.9,0.2,0.6 and *P. adolfi-freiderici* had 0.7,2.1,1.7 at Wacha, Matapa and Baka respectively. The implication is that species with lower IVI recorded need high priority for conservation.

Table 3 shows the top ten species ranked based on IVI. The result showed that 53%, 54% and 58% of the forest composition at Baka, Matapa and Wacha were dominated by these ten species respectively. *O. welwitschii* and *C. arabica* were species with higher IVI at Baka and Matapa. IVI indicates the importance of the species. However, coffee intensification implies forest disturbance due to anthropogenic factors. The higher IVI of *C. arabica* was a sign of forest modification to coffee production.

Previous studies have reported that PFM improves forest condition (Ameha *et al*. 2014a, Gobeze *et al.* 2009). Forest composition and tree species diversity are an indicator of forest condition (Kimaro and Lulandala 2013). This finding was comparable with the reports of a Shannon diversity of 2.98 with forest without coffee at Belete forest by Mengist *et al*. (2013). However, the figure was less than Tadesse *et al*. (2014) who reported diversity of 4.1 and 3.5 for forest and smallholder farmers' coffee at Bonga forest. Senbeta and Denich (2006) had reported a Shannon diversity of 2.8 and 0.52 evenness. Gobze *et al*. (2009) had reported a Shannon-Wiener Diversity index of 3.46 and 3.367 with PFM and non-PFM forest at Bonga. A Shannon-Wiener Diversity greater than 2 indicates medium to high species diversity (Giliba *et al*. 2011). This implies that the forest blocks are rich in species diversity. This study disagrees with Gobeze *et al*. (2009) who had reported *Schefflera abyssinica* (Hochst. ex.A. Rich.) Harms*, Ficus sur* Forrsk.*, Cassipourea malosana* (Baker) Alston, *Croton macrostachyus* Del. and *Albizia gummifera* as the five most important species of the PFM site. It also disagrees with Tadesse *et al.* (2014) who reported *Moraceae* as the dominant family in the forest of southwest Ethiopia. The difference could be due to the time of the study as most of the study was conducted during the project time.

Regeneration under forest blocks

Tree density per hectare was computed in the three forest blocks. The result showed 363 trees/ha, 387trees/ha and 448 trees/ha at Baka, Matapa and Wacha respectively. Seedling

TABLE 3 *Top ten species ranked based on Important Value Index at Baka, Matapa, Wacha Respectively*

	Botanical name	**RF**	**RD**	**RDO**	**IVI**
1	*Olea welwitschii* (Knobl.) Gilg & Schellenb.	2.98	1.09	24.28	28.4
2	*Coffee arabica* L.	2.98	18.1	5.7649	26.9
3	*Psychotria orophila* Petit	4.36	7.75	2.4641	14.6
4	*Syzygium guineese* (Wild.) Dc	3.67	0.97	9.7289	14.4
5	*Oxyanthus speciosus* DC.	5.05	5.97	2.302	13.3
6	*Vepris dainellii* (Pichi.-Serm.) Kokwaro	4.82	5.4	1.7273	11.9
7	*Teclea noblies* Del.	5.05	4.22	1.8248	11.1
8	*Rytignia neglecta* (Hiern) Robyns	4.59	4.12	1.3104	10
9	*Schefflera abyssinica* (Hochst.ex.A.Rich.) Harms	1.15	0.26	8.3537	9.76
10	*Richilia volkensilia* (Gurke) Leory	2.52	0.88	5.6331	9.03
	Botanical name	**RF**	**RD**	**RDO**	**IVI**
1	*Coffee arabica* L.	3.97	31.24	12.00	47.22
2	*Olea welwitschii* (Knobl.) Gilg & Schellenb.	1.73	0.50	19.95	22.19
3	*Dracaena fragrans* (L.) Ker-Gawl.	2.48	7.56	2.90	12.94
4	*Schefflera abyssinica* (Hochst.ex.A.Rich.) Harms	1.73	0.20	10.68	12.62
5	*Olea capensis subsp. Macrocarpa* C.A. Wright	3.97	5.96	2.56	12.50
6	*Rothmanniaur celliformis* (Hiern) Robyns	3.97	4.11	1.78	9.86
7	*Sapium ellipticum* (Hochst.) Pax	1.24	0.09	8.35	9.69
8	*Margaritaria discoidea* (Baill.) Webster	3.72	1.89	3.96	9.58
9	*Teclea noblies* Del.	3.22	2.90	1.89	8.02
10	*Millettia ferruginea* (Hoschst.) Baker	3.22	1.32	3.21	7.76
	Botanical name	**RF**	**RD**	**RDO**	**IVI**
1	*Dracaena fragrans* (L.) Ker-Gawl.	4.21	14.90	4.34	23.46
2	*Phoenix recilnata* Jacq.	4.21	8.79	7.20	20.21
3	*Olea welwitschii* (Knobl.) Gilg & Schellenb.	2.71	0.21	15.53	18.45
4	*Margaritaria discoidea* (Baill.) Webster	4.21	3.89	7.95	16.06
5	*Coffee arabica* L.	4.51	8.50	2.47	15.49
6	*Olea capensis subsp.* Macrocarpa (C.A. Wright)	4.21	7.62	2.82	14.66
7	*Schefflera abyssinica* (Hochst.ex.A.Rich.) Harms	2.41	0.11	10.89	13.41
8	*Sapium ellipticum* (Hochst.) Pax	3.01	0.49	9.21	12.71
9	*Maytenus arbutifolia* (A.Rich.) Wilczek	4.51	5.37	1.56	11.46
10	*Ocotea kenyenis* (Chiov.) Robyns & Wilcz	2.71	3.02	4.33	10.07

RF = Relative frequency; RD= Relative Density; RDO= Relative Dominance; IVI= Important Value Index.

and sapling distribution is an indicator of population structure of the forest. The assessment result showed that there were more seedlings and saplings than trees across the three forest blocks (Fig. 1). It implies a good population structure of the forest.

Seedling and sapling assessment of selected tree species showed good regeneration under the forest for certain species. The result showed that *P. adolfi-freiderici* and *E. capensis* regenerated well at Baka and Matapa respectively. *P. africana* seedlings and saplings were recorded at three forest blocks showing improvement of the forest condition. No *C. africana* seedlings across the three sites and *A. dimidiata* seedlings at Baka and Matapa forest blocks were recorded. It seems there are some differences across the forest blocks in terms of regeneration under the forest (Fig. 2).

The present study findings show more seedling and sapling density per ha under forest than in the previous Gobeze *et al*. (2009) report. The previous study reported 29 different woody species seedlings per ha with a density of 5167 seedlings per ha. However, this finding shows an average

TABLE 4 *Species richness, Evenness and Shannon Diversity across forest blocks*

Index	Forest blocks			P-value
	Baka	Matapa	Wacha	
Shannon Wiener diversity index (H`)	2.95	2.86	2.83	0.000
Species richness (S)	45	51	46	0.000
Evenness (E)	0.77	0.73	0.74	0.002
H'max	3.81	3.91	3.83	0.000

of about 9000 seedlings per ha for a few species. Kelbessa and Soromessa (2008) had reported *S. abyssinica* was one of the species without the seedling and sapling stage. *P. adolfi-friederici* and *Ekebergia capensis* were without sapling stage. The present study finding shows representation of these species with seedlings and sapling stage. It implies that regeneration of some of the desirable species takes place in the forest under PFM. The study supports the absence of a sufficient seedling and sapling stage of *C. africana*. The present study agrees with the previous study report by Kelbessa and Soromessa (2008) who reported that some species have a good regeneration capacity and others regenerate but couldn't attain the maturity stage due to an establishment problem.

Forest Disturbance indicators

Human activities in the forest were recorded during vegetation assessment in line with prohibited PFM activities. The three forest blocks had evidence of some form of human disturbance (Fig. 3). The results of forest disturbance incidence showed that more stumps were recorded across the sites implying forest destruction resumed to some extent after the PFM project had ended (Fig. 4). New and bigger size stumps in the forest are an indication of forest use of timber. Most of the recorded stumps have confirmed the use of forest of timber tree species. The present study findings show that more forest dependent forest user groups mainly use forest for timber since the timber is better for increasing the cash income from the forest. Forest users are supposed to utilize forest for non timber forest products rather than charcoal and timber (Gobeze *et al.* 2009). These findings show a violation of some restriction of forest use under PFM.

Forest income and perception of PFM

PFM is supposed to improve the livelihoods of entitled forest users. One of forest based household livelihood improvements is through forest income. Based on the current study findings, it seems that forest income contributes a significant amount to the total income of forest user households. The survey result showed that forest income accounted for 39%, 45% and 78% of total income of the households at Baka, Matapa and Wacha respectively (Fig. 5). The dominant source of forest products were honey and spice at Baka, forest coffee and honey at Matapa, and fuelwood and charcoal at Wacha respectively (Table 5). Figure 6 shows the opinions of forest users on the benefit of being PFM members. The results showed that 46%, 56% and 26% of the respondents perceived that there were positive benefits from being a member at Baka, Matapa and Wacha respectively. However, the largest proportion of the respondents indicated that being a member of PFM made no difference to their wellbeing.

The present study findings agree with the previous study report by Mengist *et al.* (2013), Mamo *et al.* (2007) and Yemiru *et al.* (2010) who reported the relative forest income contribution accounted for 40.6%, 39% and 53% of

FIGURE 1 *Seedlings, saplings and tree density per ha across forest blocks*

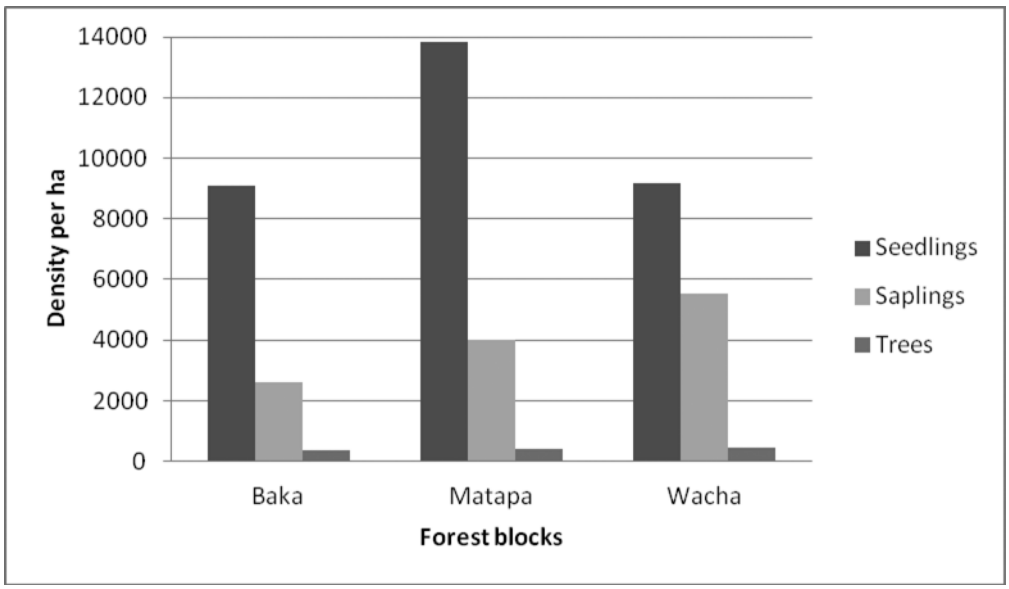
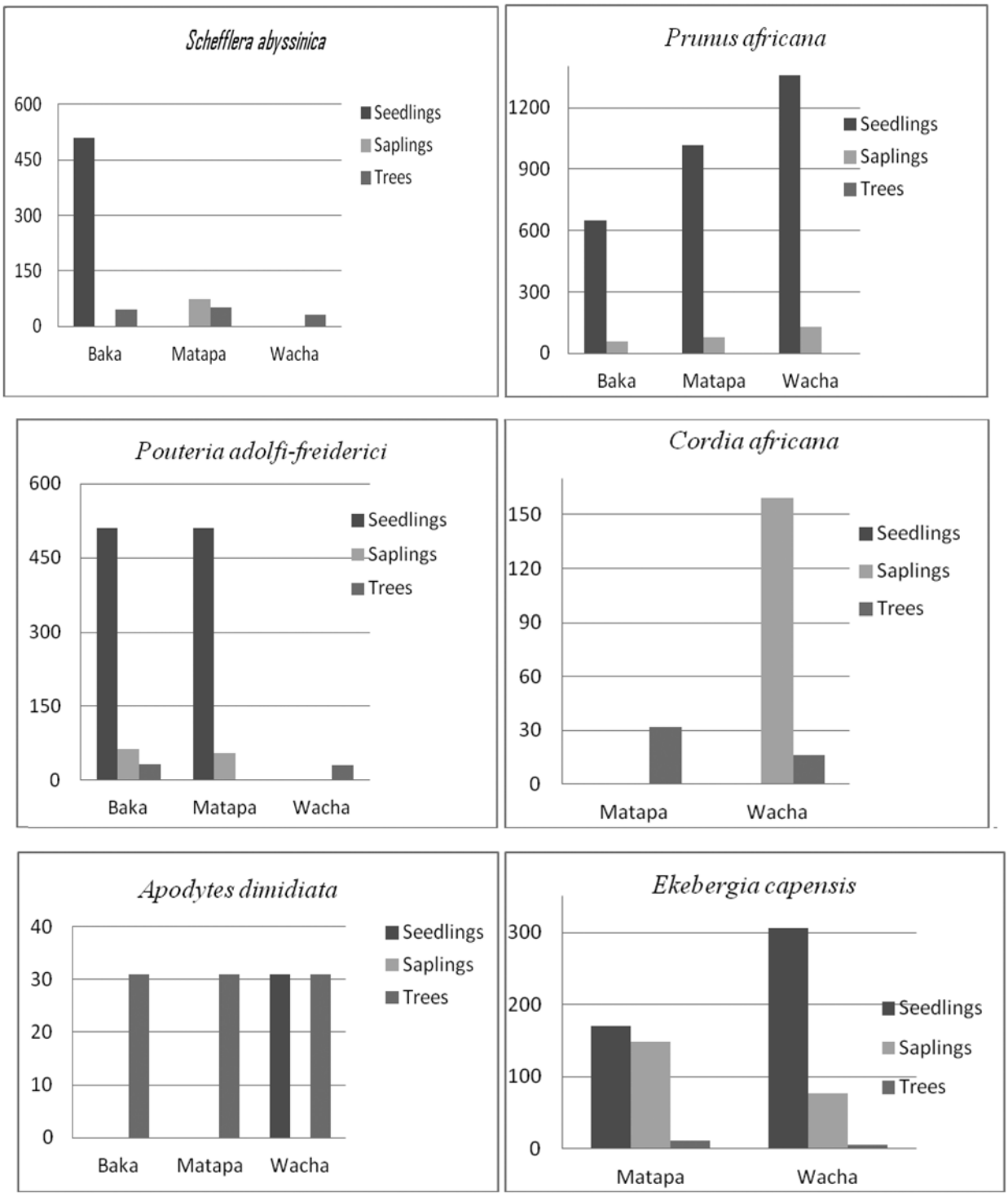


FIGURE 2 *Seedlings and saplings regeneration of selected species under three forest blocks*



the total household income share at Belete forest, Chilimo forest and Adaba Dodola forest respectively. It disagrees with Gobeze *et al.* (2009) who reported forest users' livelihoods changed due to the introduction of PFM. The forest user livelihoods portfolio shows that households have been using the forest for years (Yemiru *et al.* 2010) and the only change occurred with the introduction of the PFM is that some of those forest benefits continue under the usufruct rights. Before the introduction of PFM the local communities over exploited the forest irresponsibly. The introduction of PFM recognizes the usfructuary right and imposes some restrictions on forest products use. The findings contradict Ameha *et al.* (2014a) who had reported that the introduction of PFM did not negatively affect forest income, since a large number of forest users are indifferent to the introduction of PFM.

FIGURE 3 *Charcoal pit and new stump in the forest*

Forest user and their level of dependency

The introduction of PFM has brought forest use rights to the *de facto* forest users. In the PFM arrangement, only members belonging to the PFM are entitled to use the forest. During PFM establishment the extent of forest dependency was one of the criteria for membership selection (Ameha *et al*. 2014a). The present study tried to assess the relative forest dependency of PFM and non-PFM members in their livelihoods. Computed relative forest dependency results show that the relative forest dependency of non-PFM members at Baka, Matapa and Wacha were still 23%, 44% and 60% respectively. At the moment about 39%, 9% and 89% of the non member respondents are using the forest at Baka, Matapa and Wacha respectively. The implication is that there will be a conflict of interest over the forest in the future. A large number of non-PFM members want to be PFM members - the results showed 62% at Baka, 82% at Matapa and 67% at Wacha (Table 6). Tangible benefits obtained from the forest motivates the forest users. Initially the PFM members perceive they will get more benefit from the forest. The PFM members do have different opinions about the benefits from the forest. Although the PFM members are expected to get benefit from the forest only a smaller number of PFM members feel there is equitable benefit sharing. About 64%, 73% and 100% of the respondents at Baka, Matapa and Wacha responded that there was inequitable benefit sharing among PFM members.

The present study revealed that PFM did not realize equity in benefit sharing among PFM members. Use right alienation of traditional forest users poses the question about how long

FIGURE 4 *Forest disturbance incidence across forest blocks*

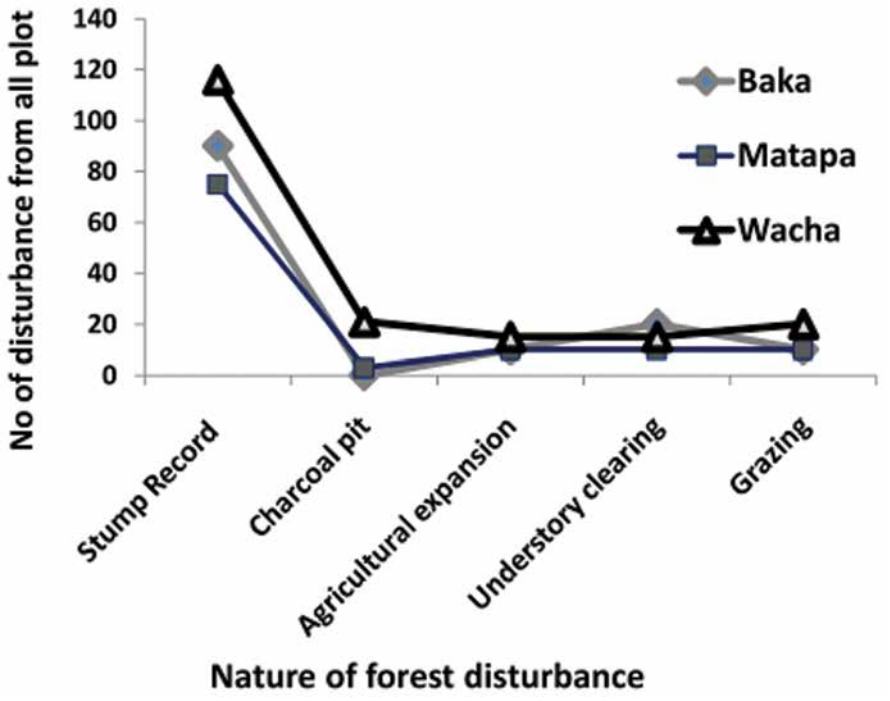


FIGURE 5 *Proportion of forest income to forest users*

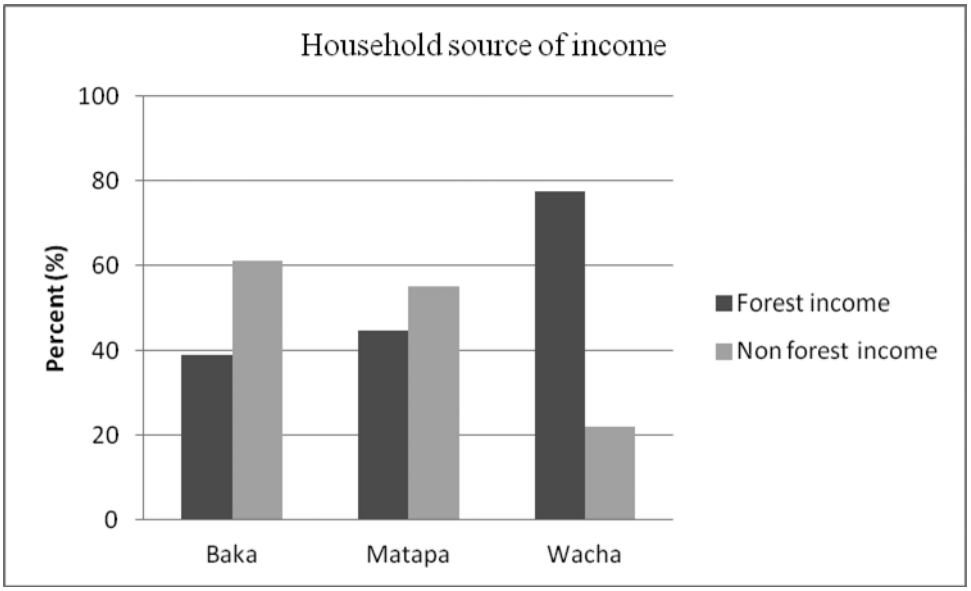


TABLE 5 *Proportion of sources of forest products to forest user groups income*

	Baka	**Matapa**	**Wacha**
Forest coffee	18	21	9
Honey	37	51	8
Spices	30	9	0.4
Poles	6	0.0	0.0
Charcoal	0.4	9	32
Fuel wood	9	10	51
Total	100	100	100

the entitled forest users remain a strong institution (Ameha *et al.* 2014a). The findings disagree with Gobeze *et al*. (2009) who reported PFM as extremely important for household livelihoods. Masozera and Alavalapati (2004) used the cut-off point of 40% to classify low and high forest dependency. The findings reveal that non-PFM members have a high forest dependency at Matapa and Wacha implying that there could be unforeseen challenges to the PFM-based forest management.

CONCLUSION

PFM has been promoted as a solution to problems associated with deforestation and forest degradation. The study findings

FIGURE 6 *Opinion of forest users on being PFM members*

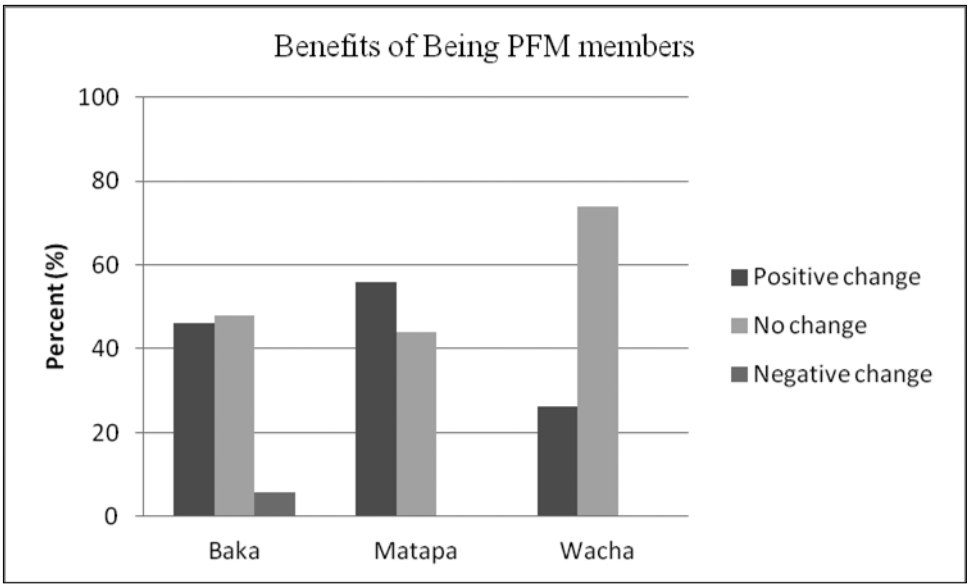


TABLE 6 *Relative forest dependency, access to forest and perception to PFM*

	Baka	Matapa	Wacha
Relative forest dependency (%)			
PFM members	39	45	80
Non PFM members	23	44	60
Access to forest after project phased out (%)			
Non PFM members	39	9	89
Feel equity in benefit sharing among PFM members (%)	36	27	nil
Want to withdraw from PFM membership (%)	2.0	7	4
Want to be PFM membership (Non PFM) (%)	62	82	67

reveal that there are few numbers of seedlings and saplings of economic and ecologically important tree species under the forest. Records of new stumps and charcoal pits show the weakness of forest user groups to protect the forest. At the moment a large proportion of PFM members are indifferent about the benefit of being a PFM member. The level of forest dependency results show that non-PFM members are more forest dependent. The distinction between traditional forest users as the members and non-members seems to overlook the traditional right to use the forest. After the PFM project ended many of the problems associated with the forest seemingly resumed. Although further research is required for a definite conclusion, the progress of the current PFM approach in Bonga forest has shown some sign of limitation. A PFM model that achieves the dual objectives (improving forest condition and forest based livelihoods) must take into account technical aspects such as inducing advance regeneration for those tree species with regeneration problems. The existing PFM approach seems to play a major role in protecting the forest from destruction rather than improving forest condition.

ACKNOWLEDGEMENT

The authors would like to thank Jimma University College of Agriculture for financing the study. The authors are also indebted to all individuals who directly or indirectly contributed to the success of the study. Special thanks go to the anonymous referees for their valuable suggestions.

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APPENDIX 1 *List of species identified in Bonga forest*

Botanical name	Family	Vernacular name		Life form	Forest blocks		
		Amharic	Kafigna		Baka	Matapa	Wacha
Albizia gummifera (J.F. Gmel) C.A.Sm	Fabaceae	Sesa	Caatoo	T	+	+	+
Allophyllus abyssinicus (Hochst.) Radlkofer	Sapindaceae	Embus	Shee'o	T	+	+	+
Pouteria adolfi-freiderici (Engl.) Robyns & Gilbert	Sapotaceae	Kerero	Qareroo	T	+	+	+
Apodytes dimidiata E.Mey.ex Am	Icacinaceae	Cheleleqa	Wundiffo	T	+	+	+
Bersama abyssinica Fresen.	Melianthaceae	Azamir	Booqqoo	ST	–	+	+
Canthium oligocarpum Hiern	Rubiaceae		Xiixi-dibo	T	+	+	+
Celtis africana Burm .f.	Ulmaceae	Kawoot	Uffoo	T	+	+	+
Clausena anisata (Wild.) Benth.	Rutaceae	Limich	Imicoo	ST	+	+	+
Coffee arabica L.	Rubiaceae	Buna	Bunnoo	ST	+	+	+
Cordia africana Lam.	Boraginaceae	Wanza	Di'oo	T	+	+	+
Croton macrostachyus Hochst.exDel.	Euphorbiaceae	Bisana	Waagoo	T	+	+	+
Cyathea manniana Hk.	Cyatheaceae		Sheeshino	S	–	–	+
Diospyros abyssinica (Hiern) F.White	Ebenaceae	elechegn	Kuro/Woraallo	T	–	+	–
Dracaena afromontane Mildbr.	Dracaenaceae	Serte	Coqimaatoo	ST	+	–	–
Dracaena fragrans (L.) Ker-Gawl.	Dracaenaceae	Itsepatos	Emoo	ST	+	+	+
Dracaena Steudneri Engl.	Dracaenaceae	Moata	Yuddo	ST	+	+	+
Ehretia cymosa Thonn.	Boraginaceae	Game	Wogaammo	ST	+	+	+
Ekebergia capensis Sparrm.	Meliaceae	ol/Samba	Orooroo	T	–	+	+
Embelia schimperia Vatke	Myrsinaceae	Enkoko	Dupho	ST	–	–	+
Euporbia ampliphyll Pax	Euphorbiaceae	Kulkual	Gachoo	T	–	+	–
Fagaropsis angolensis	Oleaceae	Siglu	Yaayo	T	+	+	–
Ficus ovata Vahl	Moraceae	Warka	Capheroo	T	+	+	+
Ficus palmata Forssk.	Moraceae		Shootoo	ST	+	+	–
Ficus Sur Forssk.	Moraceae	Shola	Caaro	T	–	+	+
Flacourtia indica (Burm.F.) Merr.	Flacourtiaceae	Ekuku	Hummoo	T	+	–	–
Galiniera saxifraga (Hochst.) Bridson	Rubiaceae	Solie/Yeioia kula	Diiddoo	ST	+	+	+
Ilex mitis (L.) Radik.	Meliaceae	Misir-gemfo	Shaahino	ST	–	+	+
Justicia schimperiana (Hochst.ex Nees) T.Anders	Acanthaceae	Sensei	Sharisharoo	S	+	–	–
Macaranga capensis (Baill.) Sim	Euphorbiaceae		Shakeroo	T	+	+	+
Maesa lanceolata Forssk.	Myrsinaceae	Kelewa	Cagoo	S	+	+	+
Margaritaria discoidea (Baill.) Webster	Euphorbiaceae		Gabo	T	+	+	+
Maytenus arbutifolia (A.Rich.) Wilczek	Celastraceae	Eshoh	Shikko/Angixo	ST	+	+	+
Millettia ferruginea (Hoschst.) Baker	Fabaceae	Birbira	Biberoo	T	+	+	+
Ocotea kenyenis (Chiov.) Robyns & Wilcz	Lauraceae		Najjoo	T	–	+	+

(*Continued*)

APPENDEX 1 (*Continued*)

Botanical name	Family	Vernacular name		Life form	Forest blocks		
		Amharic	Kafigna		Baka	Matapa	Wacha
Olea capensis subsp. Macrocarpa (C.A. Wright)	Oleaceae	Damoi weira	Shigiyoo	T	+	+	+
Olea welwitschii (Knobl.) Gilg & Schellenb.	Oleaceae	Woyira	Yahoo	T	+	+	+
Oxyanthus speciosus DC.	Rubiaceae		Opheero	ST	+	+	–
Pavetta abyssinica Fresen.	Rubiaceae		Tooshiimo	ST	–	+	–
Phoenix recilnata Jacq.	Arecaceae	Zembaba	Yeebboo	T	+	+	+
Piper capense L.f.	Piperaceae	Timiz	Turifoo	S	+	+	+
Pittosporum viridiflorum Sims.	Pittosporaceae	Kefeta	Sholloo	T	+	+	+
Polyscias flava (Hiern) Robyns	Araliaceae	Yezinjero wonber	Karesho	T	+	+	+
Prunus africana (Hook.f.) Kalkm.	Rosaceae	Xikur inchet	Oomo	T	+	+	+
Psychotria orophila Petit	Rubiaceae		Aa'i-maato	ST	+	+	+
Rhus vulgaris Meikle	Anacardiaceae	Yeregna kolo	Biceri kucoo	ST	+	+	+
Richilia volkensilia (Gurke) Leory	Meliaceae		Qettoo	T	+	–	+
Rothmanniaur celliformis (Hiern) Robyns	Rubiaceae		Diiboo	T	+	+	–
Rytignia neglecta (Hiern) Robyns	Rubiaceae		Naxaachoo	ST	+	+	–
Sapium ellipticum (Hochst.) Pax	Euphorbiacea	Boseka	Sheddo	T	+	+	+
Schefflera abyssinica (Hochst. ex.A.Rich.) Harms	Araliaceae	Geteme	Buttoo	T	+	+	+
Syzygium guineese (Wild.) Dc	Myrtaceae	Dokima	Yinnoo	T	+	+	+
Teclea noblies Del.	Rutaceae	Atesa	Shengaaro	ST	+	+	+
Trichilia dregeana Sond	Meliaceae	Bonga	Timmo	T	–	+	+
Vepris dainellii (Pichi.-Serm.) Kokwaro	Rutaceae	Atesa	Mengirexxo	ST	+	+	+
Vernonia amygdalina Del.	Asteraceae	Grawa	Graawoo	S	+	+	+
Vernonia auriculifera Hiern.	Asteraceae	Reg	Dangirattoo	S	–	+	+