Study on the Diversity and Socio-economic Importance of Woody Trees on Farm lands, a case of North Gondar

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Abstract

Investigating the existing diversity, niches, use and socioeconomic importance of farmland trees is imperative. This underlines the objectives of this study. The study was conducted in Enfranz and Metema. The principle of functional ecological groups was the guiding rule in the data collection process. For every tree species encountered on a farm, information was collected by interviewing household members involving farm walks, and data recording using questionnaire. All answers were post-coded during data entry in the databases that were created for data analysis and storage. Several farms × species matrices were formed by inserting abundance > 0 in a specific matrix cell. Abundance > 0 was recorded for a cell in case the specific farmer (listed in rows) had communicated to use the particular species (listed in columns) for the particular use (product or service). Niche matrices were formed in an analogous way. Moreover, diversity indices were also used to calculate diversity directly from information on species' presence and absence. Six types of use groups were identified based on the purpose of species. Analysis of species by sample matrix showed, growing trees for construction has the highest frequency. It has been mentioned 876 times. The other uses were mentioned on average from 214-298, except forage use group which was mentioned 57 times. On the other hand, farm occurrences showed fuel wood is the most important use group followed by construction. Interestingly, fuel wood has the highest in species average. Moreover, analysis of species by sample matrix showed, homestead areas being the most important tree growing niches followed by trees scattered inside own farm. Live fences and farm boundary is also moderately important tree growing niches. On the other hand, degraded hills, gully, river banks, and soils conservation structures showed low species- average value. Pair wise ranking of tree growing niche by the use or function of the tree showed, homestead is the source of supply for 83% of construction, 92% of farm implement, 25% of fodder, 100% fruit, 46%fuelwood, 75%medicine, and 2% for sale. Source of seedling showed 66.70 % from government nurseries and 50.94% from their neighbor and the rest from their own. Low seedling survival due to drought and free grazing mentioned as limitations for tree growing. The most important tree management activities (in order of decreasing importance) are side pruning, lopping, hoeing, weeding, manuring, and fencing. Generally, low diversity compels diversification by means of addition of a new species or adaptation of a species performing well in similar conditions. Making more germplasm available, niches or use groups with low diversity and the socio-economic factors should be taken in to consideration to increase the diversity.

Key words: Farmland, Tree diversity, Niches, socioeconomic, Enfranz, Metema

1. Introduction

North Gondar, which was once regarded as a place of dense and diversified vegetation cover and is now losing its green cover. Patches of natural forests around places of worship are indicators of this fact. Trees in forests have been subjected to repeated man-made and natural disaster as a result it is decreasing in size and quality from time to time and land degradation and deforestation has been widespread in the area. Experience in general and observation in North Gondar zone indicates that uncontrolled removal of forests and demographic pressures have been the major causes of natural resource degradation. The rural fuel wood and fodder needs in the area are largely meeting from the forests, which do not appear to be capable of providing these increased demands. Furthermore, as a result of clearing of the forest cover, there is a very sever soil erosion. Large areas of agricultural lands are in the formation of big gullies and rock out crops. This has undoubtedly posed many social and economic problems and the need for the food, fodder, energy, biomass, and wood continues unabated.

Farmers plant or deliberately leave trees in farmland and homesteads in pursuit of their livelihood goals of income generation, risk management, household food security and optimum use of available land, labour and capital (Lengkeek, 2003). The many products, services and roles needed by people to be fulfilled by trees can not be provided by only a few species. Currently there is critical decline of tree species in conventional forests in Africa in general and Ethiopia in particular. North Gondar zone is a typical example for such occurrence. Consequently farmers are planting and deliberately leaving different tree species on agricultural land such as homesteads, farm boundaries, inside farmlands, wood lots and grazing lands in the zone. However, there is no scientific way of managing such agroforests. In some cases mono-crops are dominating the others vanishing. In most cases, only over aged trees are found in agricultural land mainly on farmlands and on grazing lands. In some cases, good structure of trees of different species is observed.

In light of the above problems, some studies on the forest resource in the area hints that species that can provide diversified benefits to the local people are disappearing gradually and this implies not only at the future fuel wood, fodder and other forest products crises but also a serious ecological disaster that the area is a heading for.

Despite the benefits that could be obtained from the proper development and utilization of the farmland tree species, knowledge on the diversity, phonology, propagation technique, characteristics and the socio economic importance of most farmland tree species is limited. As a result the species are disappearing at an alarming rate even before we have a chance to study them. There for this study is proposed to meet the following objectives;

2. Objectives

- Investigate the existing diversity of woody plants on agricultural land
- Investigate and document the Silvics, Biology, use and socioeconomic importance of farmland trees
- Recommend the possible conservation, utilization and management of woody tree diversity on farm lands.

3. Materials and methods

The study was conducted at Enfranz and Metema, North Gondar zone. For every tree species encountered on a farm, information was collected on the presence in particular on-farm niches by interviewing household members involving farm walks, and data recording using questionnaire. On-farm niches for trees refer to the location on the farm and the establishment pattern of trees at the location. The niches that were distinguished were trees in the homestead area, trees mixed in cropland, trees on contours in cropland, trees on boundaries of the farm, live fence, trees in woodlots, and trees in degraded lands.

Use-groups were defined as groups of species providing similar products or services to the farm household. Studying use-groups is similar to studying functional groups. Free responses on tree uses were obtained on a species-by-species basis. These answers were post-coded during data entry in the databases that were created for data analysis and storage.

Respondents were also requested to name the main use of the species on the farm. Information was provided by the farming household on the source of seedling or germplasm of each tree species. Origins of germplasm were post-coded in categories including the own farm, from neighbor or from government nurseries. Farmers were also interviewed to prioritize desired species and modifications in tree composition and niche.

Several farms × species matrices were formed by inserting abundance > 0 in a specific matrix cell. Use-groups (i.e. matrices) defined by species occurrence and use as recorded at individual farms. Abundance > 0 was recorded for a cell in case the specific farmer (listed in rows) had communicated to use the particular species (listed in columns) for the particular use (product or service). Niche matrices were formed in an analogous way.

Table 1. Summary of sampled watersheds and household characteristics

Location of watershed	No of HH visited	Average land holding (Ha)	N of Female HH
Enfraz	28	0.69	4
Metema	30	0.62	6

Usually ecosystem diversity is measured with species richness. Species richness (S) refers to the number of species that were encountered on a specific farm, in a specific watershed. The Shannon diversity index H, Simpson diversity index D-1 and inverse Berger-Parker index d-1, which are all values at specific scales of the Rényi series Ha were calculated directly from information on species' presence and absence. The Renyi series provides diversity profile values (Ha) based on a scale parameter value a, which varies from 0-10 (Tóthmérész 1995; Legendre & Legendre 1998; Rennols & Laumonier 2000).

4. Result and discussion

This study identified different types of use groups based on the purpose of different species for the farmers in the study area. This includes the fuelwood, Income, Honey, charcoal, shade and fertility. From the analysis of the data, it was found that the use group for fuel wood has a higher diversity value followed by income and shade (table 2). The use group income has a highest evenness value.

Table 2 result for diversity and evenness indices for the different use groups

	N2 diversity	N1 richness	N2/N1 evenness	N of species	Shannon' diversity (H)	Log (N)	H/log (N) evenness	Total
Fuel wood	7.06	9.22	0.77	17	2.22	2.83	0.78	119
Income	7.01	8.32	0.84	12	2.12	2.48	0.85	87
Honey	4.34	5.37	0.81	9	1.68	2.20	0.77	70
Charcoal	2.01	3.34	0.60	8	1.21	2.08	0.58	23
Shade	5.14	7.53	0.68	11	2.02	2.40	0.84	31
Fertility	4.17	5.12	0.82	8	1.63	2.08	0.79	41

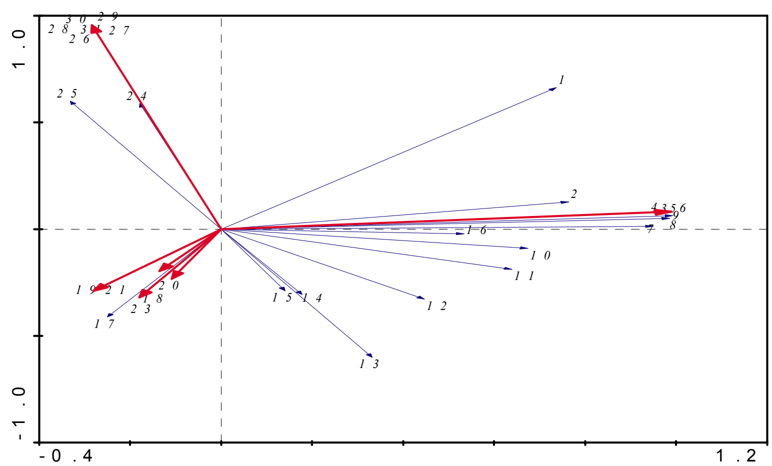

Fig 1 canonical correspondence analysis (CCA) showing the distribution of Species in use group.

Note: *1.E.camaldulensis, 2.V.amygdalina, 3. C.aurea, 4.H.revolvtum, 5.G.ferruginea, 6.D.angustifolia, 7. E.abyssinica, 8. J.procera 9.P.persica, 10.Olia africana, 11. F.toninngii, 12.M.senegalensis, 13.Serkin, 14. C.macrostachyus, 15.A. digitata, 16.A.seyal, 17.F.vasta, 18.A.indica, 19.A.albida, 20.B.adysen, 21.S.sesban, 22. B.adysen, 23.S.molle, 24.C.africana, 25.S.guineese, 26.F.sur, 27.R.prinoi, 28.Coffe, 29.C.edulis, 30.Citrus, 31.*Papaya.

Analysis of species by sample matrix by taking the occurrence of use group over species, occurrence in terms of the number of times the use was mentioned showed, growing trees for construction has the highest frequency. It has been mentioned 876 times. This may be due to many tree growers who have diverse tree species grow the trees mainly for this purpose. The other uses were mentioned on average from 214-298, except forage use group which was mentioned 57 times. On the other hand, farm occurrences, the number of households where the use was mentioned, showed fuel wood is the most important use group followed by construction. Interestingly, fuel wood has the highest result in species average, number of species per farm and per use for those farms where the use was mentioned. That means farmers have different alternative for fuel wood or diverse plant species are used as fuel wood. On the contrary extremely low species average value for forage shows, farmers have little or no alternative woody plant that can be used as fodder. That means the average number of tree species that can be used as fodder on each household is less than one and there is a possibility that fodder trees are not planted on the farm.

Table 3 Characteristics of the different use-groups

Use group	**Occurrence**[14]	**Farm occurrence**[15]	**Species average**[16]
Construction	876	139	2.69
Fuel wood	221	181	10.69
Farm implement	214	117	2.61
Fence	298	161	3.28
Market	221	124	3.63
Lumber	269	128	2.69
Forage	57	55	0.70

Analysis of species by sample matrix by taking tree growing niche and the associated plant species showed, homestead areas being the most important tree growing niches followed by trees scattered inside own farm. Live fences and farm boundary is also moderately important tree growing niches. In terms of farm occurrence, number of households where the tree growing niche was mentioned also showed homesteads being the best and preferred niches followed by live fencing and scattering trees in side own farm. Note only are homesteads important tree growing niches, they are also diverse as they have higher

[14] *Occurrence: number of times the use was mentioned;*
[15] *Farm occurrences: number of households where the use was mentioned;*
[16] *Species average: number of species per farm and per use for those farms where the use was mentioned*

species-average result, that is the number of species per farm and per niche for those farms where the niche was mentioned.

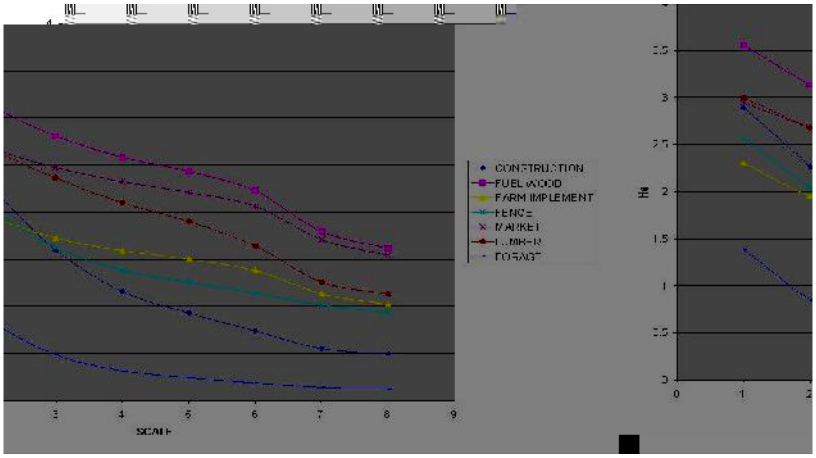

Figure 2 diversity profile values for the different use-groups

Table 4 Characteristics of tree growing niches

Tree growing niche	Occurrence[17]	Farm occurrence[18]	Species average[19]
Homestead	746	166	8.88
Live fence	279	163	3.34
Farm boundary	125	77	1.51
Scattered inside farm land	371	121	4.39
Degraded hills	63	24	0.75

[17] Occurrence: number of times the niche was mentioned;
[18] Farm occurrence: number of households where the niche was mentioned;
[19] *Species average: number of species per farm and per niche for those farms where the niche was mentioned*

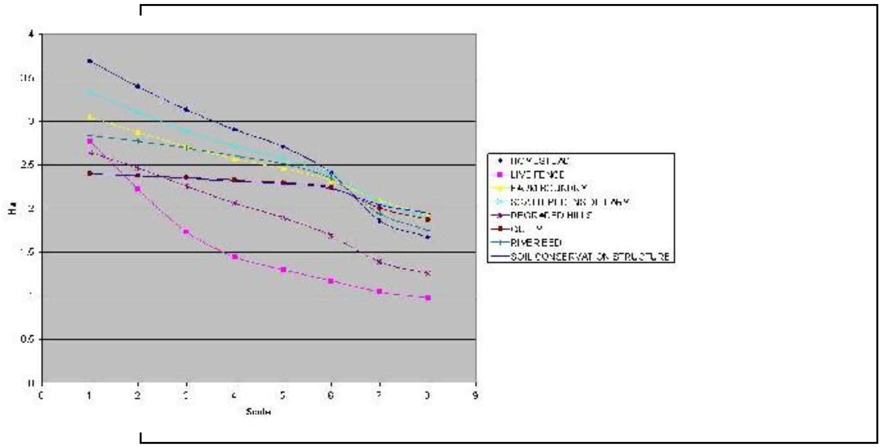

Figure 3 Diversity profile values for the different tree growing niches

On the other hand, extremely low species- average value for degraded hills, gully, river banks, and soils conservation structures; shows, these tree growing niches are not utilized for growing trees. This may be due to free grazing as these areas are common properties utilized without any regulation, or due to security problems as trees need relatively longer time before being ready for harvest, and the uncertainty during this time who will take the benefit.

Farmers get planting materials from different sources. For instance source of seedling by ownership showed 66.70 % of the respondents got their seedling from government nurseries and 50.94% from their neighbor and the rest from their own.

The most important tree management activities (in order of decreasing importance) are side pruning, lopping, hoeing, weeding, manuring, and fencing. Thinning, that is reducing the stocking number as the tree grows in size, was not mentioned as a management activity.

Table 5: percentage (%) of respondents as their source of wood for various purposes

	Farm	Homestead	Near Forest	Market	Neighbor	Other
construction	9.67	83.33	0	7	0	0
farm implement	3.33	91.67	3	2	0	0
fodder	72	25	3	0	0	0
fruit	0	100	0	0	0	0
fuel wood	50	46	8.30	5.70	0	0
medicine	16	75	9	0	0	0
For sale	40.01	2.09	57.9	0	0	0

Gender segregation in to male and female headed households for diversity of niche and tree species showed, male-headed households had highest species richness values than the female headed house holds. In terms of niche, homestead and scattered inside farm are important tree growing areas and live fence and boundary planting for the female headed ones. This may be related to security to farm and home.

Pair wise ranking of tree growing niche by the use or function of the tree showed, homestead is the source of supply for 83% of construction, 92% of farm implement, 25% of fodder, 100% fruit, 46%fuelwood, 75%medicine, and 2% for sale. This further substantiates our previous observation that homestead being the most diverse and important tree growing niches, followed by own farm and wood lands in the given watershed.

Homesteads are more diverse and important because they are under strong and secured ownership feeling of the household owner. Besides, they are near settlement and are always under the direct supervision of member of the household; again they will be managed well and easily as they are watched.

The most important limitations for tree growing were very low seedling survival, due to drought and free grazing. On the other hand, seedling availability has been mentioned as an obstacle for tree growing by only 7.8 % of the respondents. This may lead to the assumption that, although there is seedling supply, the quality is poor. Therefore, decentralization of nursery at the household and village level is an important intervention. This approach is important from two perspectives, first it gives flexibility to produce the desired woody species, and second quality seedlings will be produced. This can be achieved by giving training to farmers engaged in tree growing.

Pair wise comparison of a tree species against its use showed that 80 % prioritize fuel wood the most important use, followed by fruit 12%.

5. Conclusion and recommendation

In general low diversity is observed for fodder in the use group, and gully, river bank, and degraded areas in the niche analysis. Low diversity compels diversification by means of addition of a new species or adaptation of a species performing well in similar conditions. The first possibility to increase diversity might be making more germplasm available to farmers. Another possibility is that some socio-economic factors such as wealth, gender and access to information and resources, should be taken in to consideration in the form of subsidy or special program for the poor or female.

With decreasing diversity, tree diversification may become more relevant. The diversity profile values points to potential interventions. One strategy could be to increase the frequency of some tree growing niches or use-groups in the landscape where they do not occur. Groups of medium occurrence could be selected for wider distribution. A combined strategy could involve also targeting those farms with a low total number of niches or use groups and establish additional niche or use for the farms. Such interventions would increase the alpha diversity of the household; this will also increase gamma diversity provided that new species contribute to the addition.

Niches or use groups with low diversity should be targeted for diversification. The gamma diversity provides suggestions on how alpha diversity can be improved. For niches or use groups with higher gamma diversity, a wider distribution of existing species within the area would offer one method of enhancing alpha diversity. For low gamma diversity niches or use groups, for instance forage, the solution would be to introduce new species or to promote alternative uses for species that are already present. Increasing gamma diversity could also result in increased stability and productivity at the landscape level. Diversification could be targeted towards more important use-groups, rather than targeted towards those groups which have low diversity. The major emphasis should be on economic importance and importance for the household food security

The major points that need attention when a new niche and/or use is introduced should, first the quality of production of these species for a particular niche or use; second the complementarity in production in the existing land use system for instance compatibility with crops and grazing situation; and third, the characteristics of the species. The decision could be made not to promote all uses. Decreasing the number of uses per farm could result in higher profitability per farm. An analogy is the criterion introduced by Van Noordwijk et al. (1997) on the relationship between biodiversity and profitability. If initial diversity loss would result in large gains in profitability, then these authors suggest that a segregation (specialisation) approach may be more appropriate – if increment of profitability is the major goal for the landscape. Similarly, Van Noordwijk & Ong (1999) indicated that the value of diversity in agroecosystems strongly depended on the ability of farmers to derive value from a large number of components, and not from one dominating component. Reduction in the number of species for a particular niche or use-groups per farm could result in substantially greater risks to individual farmers, therefore needs great care.

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