Journal of Natural Sciences Research www.iiste.org
ISSN 2224-3186 (Paper) ISSN 2225-0921 (Online)
Vol.4, No.9, 2014

Woody Species Diversity and Their Preferences on Farmers' Land Holding

GETACHEW MULUGETA (Ph.D) [1*] and MESFIN ADMASSU [2]
1.Southern Agricultural Research Institute, Awassa Agricultural Research Center, P.O.Box 6 Awassa, Ethiopia
2.Amhara Regional Agricultural Bureau, Bahir Dar-Ethiopia
E-mail: getachew1968@yahoo.com

Abstract
Assessments of the available wood resources on farmers' holdings are reflections of their preferences. The study was conducted in Bahir Dar Zuriya District, Amhara-Ethiopia, with the objectives of assessing the woody species diversity and household characteristics that contribute to the woody species diversity and their preferences. This study revealed that a total of 59 tree/shrub species were recorded with the average of 21 per sampled household farms ranging from 4 – 55 species. The highest species richness was recorded at homegarden agroforestry practices.. Species composition of the three study KAs was compared and the dissimilarity in woody species composition among them calculated, hence the dissimilarity was 10%, 31% and 32% between Yobab-Chencher and Chenta Sostu; Yibab-Chencher and Kenbaba; and Chenta-Sostu and Kenbaba, respectively. Importance of individual tree/shrub species at farm-level was assessed and *Eucalyptus camaldulensis* was ranked first with mean importance value index (IVI) of 57%. Farmers at the study site have developed experiences in identifying their tree/shrub species preferences for different purposes. Therefore, farmers' woody species preference should be acknowledged and kept in touch; which will be invaluable in developing plans for researchers, development agents and any other development practitioners.
Keywords: tree/shrub, species diversity, farmers' preferences, farm, household, wealth category,

INTRODUCTION

Humans have long had a profound influence on forest ecosystems and their tree cover, and continue to do so (Schroth & Sinclair, 2003). Some activities have led to minor effects, while other have led to profound changes in the woody vegetation, or to permanent loss of tree cover (Longman & Jenik, 1987). Not all these modifications have been deleterious, but problems have been sufficiently frequent and serious to have resulted in the pace and extent of deforestation today. Deforestation of the world's tropical region, which attained the status of a 'hot topic' on the agenda of almost all environment related discussions at all levels during the 1980s, is a major environmental issue (Nair, 1993).

Although the rise in human populations has caused pronounced reductions in forest and tree cover, trees remain an important element of most human-dominated agricultural landscapes throughout the tropics. Diverse perennial vegetation (trees and shrubs) in agricultural landscapes has greater significance in nutrient cycling as compared to annual crops (Sharma, 1997), and in addition, trees provide a wide range of important products and service functions (Young, 1997; Schroth & Sinclair, 2003; Tesfaye, 2005). The pattern of distribution of various vegetation structures and the mixture with diverse tree-based farming are interesting features with regard to floristic and eco-diversity at a landscape level (Backes, 2001). Thus, woody species diversity can contribute to ecosystem productivity and sustainability under conditions of heterogeneity in species traits and environmental characteristics in agricultural landscapes (Kindt *et al.*, 2004).

Decisions by farmers to plant trees or maintain the existing trees as an agroforestry practice (AFP), is understood as a process which in the course of time is influenced by a number of agroecological, socio-economic, cultural, institutional and personal factors (Tesfaye, 1996; Solomon ,2009). Land-tenure systems that do not guarantee continued ownership and control of land are not likely to be conducive to the adoption of longer-term strategies (as also relatively short-term practices that include benefits which will only be realized in the long run) such as agroforestry (Nair, 1993). Forestry extension programs are also responsible for promoting the management of agroforestry (AF) by providing technical advice and inputs such as improved seedlings and extension activities (Salam *et al.*, 2000). Higher dependence on income from off-farm results in less labour being available to the farm to plant or manage, hence farm-level species diversity may be low (Shaxson & Tauer, 1992; Muktar, 2006). In other studies, for instance, Nair (1993) noted that increased access to labour applied by the family members in the farm results in decreased diversity of species, whereas market access encourages the production of commercial products (Scherr, 1995).

Commercialization and access to markets are among the local environments that often cause a decline in diversity of tree species, variability or both (Wiersum, 1982). Consequently, agricultural systems close to the market or towns, particularly in wealthy households, tend to emphasize on high-value cash crops instead of staple foods (Scherr, 1995). A study in Malawi by Shaxson & Tauer (1992) noted that increased access to natural resources (*i.e*. forests) is associated with decreased species diversity on farmland, since farmers can obtain some of their requirements, such as wood, medicinal plants, fruits, utensils, *etc.*, from the forest. Findings from

southern Ethiopian home garden agro forestry (AF) showed that smaller farm sizes and enhanced access to road networks decreased native and other multipurpose species (Tesfaye, 2005).

Various factors influence tree/shrub cultivation in the agricultural landscape. The socio-economic background of farmers is known to be the major factor that affects tree/shrub species diversity management (Rocheleau *et al.*, 1988). Women may prefer fruit and fodder trees close to homesteads or men may prefer timber or woodlots away from the homestead; wealthy households may prefer monocultures or poor households may prefer multi-strata gardens, to maintain diversity. Farmers with little access to resources, particularly land, may focus on the production of few staple food crops, depending on their individual comparative advantage. In addition, farm size plays a role in the choice of tree species, arrangement and density, as well as overall management practices of the system (Zebene, 2003). Inappropriate land-use practices and tenure, coupled with poor market access and absence of local institutions for farm resource management brought about a rapid decline in tree cover and loss of biological diversity. Other factors such as, exposure to information and extension input and biophysical environment conditions, are also known to affect tree species diversity management. The objectives of study were to inventory woody species diversity on farmers' landholding and assess farmers' woody species preferences.

MATERIALS AND METHODS

Description of the study site

Location

The study was conducted in Bahir Dar Zuriya district, west Gojam zone, Amhara regional state, Ethiopia, in North West of Ethiopia (Figure 1), about 565 km from Addis Ababa. The district is located between 11º19' - 11º52'N latitude and 37º05' - 37 º 39' E longitudes, and borders the capital city of Amhara region, Bahir Dar. It has an area of 1,283.56 km^2 and a population of 182,676 with a density of 142 persons km^{-2} (CSA, 2007). The specific study areas in the district are Kembaba,Yibab- Chencher and Chenta- Sostu Kebele Administrations (KAs)

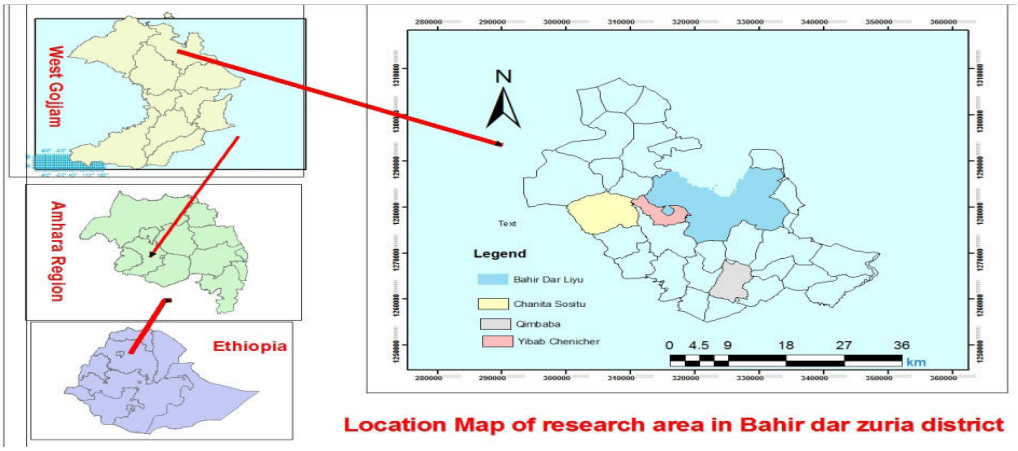

Figure 2: Location Map of Bahir Dar Zuriya district and study KAs

Climate

Climatically, the district falls within the moist *weyena dega* agroecological zone. The mean annual temperature is about 20 ºC, with a maximum temperature slightly above 28.3 ºC, and the minimum 10.2 ºC. The annual rainfall ranges between 800 – 1250 mm, with a long period of summer rain from May to September (DOoA 2009).

Topography and soil type

The topography of the area is generally characterized by flat gentle slope to undulating terrain, with an altitudinal range of 1750 - 2300 m a.s.l. The major soil types found in the district are *Merrere*, *Giracha*, and *Keyate* with the dominant colour of Black (3%), Red (93%) and Brown (4%) with heavy clay, medium clay and loam texture (MoWR, 2002).

Vegetation

The district has a vegetation cover of 12.4%, of which 41% is bush land (DOoA 2010). Forest resources in the district have decreased over time, owing to the population growth and the growing competition for resources. In spite of dwindling tree resources, the cultivation and management of woody species remains important activities in the farming systems of the district. Tree/shrub species commonly found in the district includes *Eucalyptus camaldulensis*, *Cordia africana*, *Croton macrostachyus*, *Vernonia amygdalina*, *Albizia* spp., *Rhamnus prinoides*, *Catha edulis and* fruits such as *Mangifera indica*, *Carica papaya and* other scattered indigenous trees and shrubs on farmland.

Agriculture

The land in the district is used for different farming systems. Agricultural crops constitute 59,518.8 ha (46.4%), grazing land 27, 629.4 ha (21.5%), forest 9,410.7 ha (7.3%), bush land, 6,532.3 ha (5.1%), wetland 578 ha (0.5%), hillsides (slope >15%) 4,664.4 ha (3.6%), miscellaneous 20, 022.4 ha (15.6%) (DOoA, 2010). Agriculture is the principal source of livelihood for the population. It is characterized by subsistence-level mixed farming of rain-fed crops, and livestock production together with tree plantation and management systems. In the district crops such as teff, maize, millet, bean, pea, oil crops and others are the most commonly cultivated crop types practiced by the farmers. *Teff* and *Maize* are the most widely cultivated crops for their cultural feed and drink, to prepare *Injera* and *Tella* (local beer), respectively. Others are also cultivated for feed and commercial purposes.

Research site selection

Bahir Dar Zuriya district was selected by purposive sampling among the 16 districts found in West Gojam zone. The district was selected for the study because of the presence of remnant indigenous trees/shrubs, proximity of the district to Bahir dar city, which is known to be the major forest product sink in Western Amhara , and familiarity of the researcher to the district. A reconnaissance survey was made in different Kebeles of the district, to obtain a good insight into the existence of trees and management systems, and to choose the specific study Kebeles. The selection of KAs among others was based on the existence of trees/shrubs at different AFP's (niches) and the respective distance of the KAs from Bahir dar city. Accordingly; three KAs, named by Yibab-chencher, Chenta-sostu and Kembaba were identified and selected among the 32 KAs in the district. Yibab chencher KA is about 8 km from Bahir city following the main Asphalt road to Addis Ababa, Chenta –sostu KA is found about 15km from Bahir dar city and found South-west of Yibab-chencher KA and Kimbaba is found about 30 km from Bahir Dar towards Bahir dar-Adet gravel road. Within each KAs, two villages were selected following the same criteria considered for KA selection. Accordingly, in Yibab-Chencher ; Mehal and Mertet villages; in Chenta-sostu; Chenta and Abeshma villages; and in Kembaba,Woji and Jekera villages were selected for the study. The selection of the villages was conducted based on their respective distance from the KA centre and their agroforestry potential.

Key informant selection

Key informants (KI) in this study are defined as persons who are knowledgeable about tree management practices and changes in local conditions, village households and who have continuously lived for a long period of time in the villages. The selection of the key informants was done by the snowball method. At least five farmers were asked to identify and give names of seven key informants as defined above. Then the identified key informants were ranked and the most frequently appeared top five persons were assigned as key informant in each selected village. A total of 30 key informants were selected and used in the study. The purpose of selecting KI's was to categorize villagers by wealth categories, and to provide information on agroforestry management and historical development of on-farm trees. This information was later used for developing a questionnaire for verification.

Household selection

In this study, a household (HH) is defined as a basic unit of production and consumption, made up from the persons who manage common landholdings and live under one central decision-maker, the household. To characterize HHs in each village into different social classes, wealth ranking was carried out by adapting the technique used by Crowely (1997). The purpose of wealth ranking in the study was to investigate how HHs in different social classes could understand their localities, manage and use the resources. KI's were used to categorize all individual HH's into each selected village into three main categories (rich, medium, poor). Farm size, number of cattle (particularly number of oxen and cows), money deposited in the bank, availability of house in towns, size of *Eucalyptus* plantation and size of chat farm were among the criteria used for classification of HHs into different wealth categories. To do this, the list of names of all the HH heads in the villages was taken from the local extension office and crosschecked with the KIs. Then, the KIs grouped them in to poor, medium and rich categories based on the criteria. After the KIs arranged the HHs grouped into three wealth categories, a total of 90 sample HH's were selected randomly, but proportional to their representation in respective wealth categories. (Table 1).

Table 1: Determination of sample households by wealth class in the study villages

PA	Village	Poor	Medium	Rich	Total
Yibab-Chencher	Mehal	4	6	5	15
	Mertet	4	6	5	15
Chenta-Sostu	Abeshma	5	6	4	15
	Chencher	5	6	4	15
Kembaba	Jekara	4	6	5	15
	Woji	5	6	4	15
Total		27	36	27	90

Inventory and sample size

Woody species such as trees and shrubs, including woody climbers were considered in this study. In the present study, a tree is a self-supporting woody plant that grows from a single main stem (trunk), and shrubs are self-supporting multi-stemmed woody plants. Inventory of tree/shrub species were carried out on farms of sampled households. For the purpose of species richness calculations, all tree and shrub species on the farms were recorded following an approach used by Tesfaye (2005). But in counting the population (individuals) of each tree species, those trees/shrubs with a minimum Diameter at Breast Height (DBH) > 5cm at 1.3 m height from the ground were included, and their diameter was measured by calliper and diameter tape.

For woodlot plantations, 10% of the land size was sampled with 5 × 10 m sample plots with some modifications of the approach of Zebene (2003). For inventory of boundary plantations, Scherr et al. (1990) approaches were used. The length of boundary plantations was divided into 10 m sections. One section was selected for every 50 m of boundary length. When the length was less than 10 m, the actual length was considered. Inventory of homegarden trees, trees on parkland AF and on grazing lands were inventoried by taking one quadrat sample for each AFP from a HH farm based on the approaches of Nikiema et al. (2005) with some adjustments. Thus, for this study a quadrat size of 10 × 5 m, 50 × 50 m and 20 × 15 m were used for homegarden trees, AF parklands and AF grazing lands, respectively. Farm size was estimated by farmers in their local measurement unit, called "*kada*", which is equivalent to 0.25 ha.

The parameters taken during the inventory were number of tree/shrub species and DBH to estimate number of stems per farm and hectare, and the basal area per farm and hectare of the sampled household's farm area, respectively. For the identification of the farm area and the local names of tree/shrub species on the farm, the owners of the land were involved in the counting and identification of species.

For species identification local names (vernacular names) adopted by framers and different reference materials (Wolde-michael 1987; Hedberg & Edwards 1989; Azene 1993; Edwards et al. 1995; Hedberg & Edwards 1995; Edwards et al. 1997; Edwards et al. 2000; Hedberg et al. 2003) were used to identify them and their botanical name arranged and recorded.

Data collection

The information and data required for the study was collected by employing a combination of different methods. Informal survey with key informants, assessment and collection of secondary data from government offices were carried out to support the primary data. Information collected at informal interview level was used to develop questionnaires to verify the information collected during the discussion with KI, and a pre-test of the questionnaire on five farmers was carried out to verify the quality of the questionnaire in terms of its clarity and understand ability to the respondents, to avoid redundant questions and also to know how much time it needs to complete a questionnaire. Formal survey data collection was conducted on the sample households with the structured questionnaires in each selected village. Thus, information about biophysical and socio-economic aspects related to management issues *e.g.* tree/shrub species preference and types, indigenous knowledge, perception of farmers on vegetation cover change, family size, age, educational status and others were gathered. For better communication with the respondents, questionnaires were translated into the local language (Amharic) and presented to them, to evaluate clearly their understandings and knowledge. The data collection was done by employing six enumerators, two in each KA's. Prior to field work, enumerators were trained and convinced on how to handle clear information based on the questionnaire prepared and they were supervised by the researcher.

Data analysis

Both qualitative and quantitative data were analysed. The qualitative data were analysed partially during the process of data collection, to be able immediately to identify gaps to be filled through subsequent data collection. The quantitative data were first summarized, tallied and coded and processed, and was analysed by means of Statistical Package for Social Sciences (SPSS) version 16 software and with Microsoft Excel. By means of descriptive statistics, the mean, range, frequencies, percentages, minimum as well as maximum values of variables were calculated.

Diversity indices

Measurement of diversity is needed to quantify and characterize AFPs according to the degree of diversity and to examine the relationship of wealth categories and woody species diversity at the village level. Based on individual farms, the mean numbers of tree/shrub species per AFPs were estimated for each wealth category and village. Although several quantitative descriptions are available for characterizing species diversity, the Shannon-Wiener and Shannon equitability (Evenness) (Magurran, 1988; Kent & Coker, 1992) are commonly used and considered in this study. Richness and diversity of each AFP types were calculated as the number of species, Shannon and evenness indices. In addition to this importance value index (IVI) was calculated to demonstrate the importance of individual tree/shrub species on farmland. The results from the diversity indices were further subjected to ANOVA.

Shannon-Wiener index of diversity

In species diversity study, two components are important: richness and evenness. The species richness refers to

the number of species per farm while evenness refers to their relative abundance. To determine species richness of each farm, species index (S), which is simply the total number of tree/shrub species on a farm were calculated. However, this index does not indicate the relative proportion or abundance of a particular species on the farm. Hence models that incorporate both evenness and richness of relative abundance are required. Shannon index (Shannon & Wiener 1949) and Evenness measures (E) which are commonly used tools for these purposes (Magurran, 1988) were calculated.

Shannon diversity index (H^1) is high when the relative abundance of the different species in the sample is even, and decreases when few species are more abundant than the others. It is based on the theory that when there are many species with even proportions, the uncertainty that a randomly selected individual belongs to a certain species increases and thus the diversity. It relates proportional weight of the number of individuals per species to the total number of individuals for all species (Kent & Coker, 1992). The Shannon-diversity index (H^1) was calculated, to analyse the diversity of tree/shrub species per farm and it was calculated as follows:

$$H^1 = -\sum_{i=1}^{S} P_i \ln P_i$$

Pi = the proportion of individuals or abundance of the i^{th} species expressed as proportion of the total abundance *lnpi* =natural logarithm of *pi* *S*= the number of species i= 1, 2, 3…s

Evenness (equitability) index

Evenness (Shannon equitability) index (E) was calculated as follows to estimate the homogeneous distribution of tree species on farms.

$$E = \frac{H^1}{H\ \max} = \frac{H^1}{\ln S} = \frac{\sum_{i=1}^{S} pi \ln pi}{\ln S}$$

Where S = the number of species

Pi = proportion of individuals of the i^{th} species or the abundance of the i^{th} species expressed as proportion of the total abundance.

Thus, the measure of evenness (E) is the ratio of observed diversity to maximum possible diversity. E has values between 0 and 1, where 1 represents a situation in which all species are equally abundant. From these calculations, species richness and heterogeneity as well as density of trees/shrubs were characterized for each farm. The values obtained, were then compared across the AFPs to test for the differences in species richness and evenness of trees.

Importance value index (IVI)

The IVI indicates the importance of individual tree/shrub species in the land-use systems and was calculated with three components (Kent & Coker 1992) as follows;

$$\text{Relative frequency} = \frac{\text{Frequency of a species}}{\text{Sum of frequency of all species}} \times 100\%$$

$$\text{Relative density} = \frac{\text{Number of individuals of a species}}{\text{Total number of individuals of all species}} \times 100\%$$

$$\text{Relative dominance} = \frac{\text{Dominance of a species}}{\text{Total dominance of all species}} \times 100\%$$

IVI = Relative (density + frequency + dominance)

Similarity index

Similarity indices measure the degree to which the species composition of different systems is alike. Many measures exist for the assessment of similarity or dissimilarity between vegetation samples or quadrats. Some are qualitative and based on presence/absence data, while others are quantitative and will work on abundance data. Of the large choice available, the Sorensen similarity coefficient is applied to qualitative data and is widely used because it gives more weight to the species that are common to the samples rather than to those that only occur in either sample (Kent & Coker, 1992). The Sorensen

coefficient of similarity (S_s) is given by the formula: $$S_s = \frac{2a}{2a+b+c}$$

Where, S_s = Sorensen similarity coefficient

a = number of species common to both sites (1 and 2)

b = number of species in area 1
c = number of species in area 2

The coefficient is multiplied by 100 to give a percentage.

RESULTS AND DISCUSSIONS

Household characteristics

Farmers' settings in different houshold situations affect the management of tree/shrub species diversity in their landholdings. In this study, the demographic features of the sampled households are assessed and presented. Of the 90 households used for this study 85.6 % are male and 14.4 % female. About 78.9 % of the households were within the age range of 18 – 55 years old. The lion shares of the respondents were Orthodox followers (97.8%) and the rest 2.2% were Muslims. Education level of a HHs had a direct influence on improved way of managing agroforestry practices or in adoption of new technology. With regard to education level, most of the respondents (54.4%) were illiterate, 27.8% can read and write,12% primary second cycle,3.3% primary first cycle and the rest 2.53 above grade nine. About 68.9 % of households have family size within the range of 3 – 7 members. Agriculture was the principal occupation for all of the households and only 3.3 % of them are involved in other off farm income generating activities (petty trading, casual labor work, carpentering, guarding, *etc.*). About 30 % of the respondents were from poor categories. The average landholding size of the households at the three study KA's was 1.7 ha and there was significant difference in landholding size among the wealth categories (F-test; $P < 0.01$; Table 2).

Table 2: Landholding in ha of the respondents (n=90) corresponding to wealth categories at the study site

wealth status	Mean	N	Minimum	Maximum
rich	2.4727 ± 0.9	27	1.25	5.75
medium	1.9145 ± 0.97	36	.56	5.00
poor	.8216 ± 0.4	27	.10	1.70
Over all mean	1.7541± 1.04	90	.10	5.75

Farmers' perception on drivers of changes for woody species diversity

Formal institutional factors

Understanding of cover changes of tree/shrub species diversity and management on farmers' landholdings is so important to design and redesigning AF technology. Table 3 shows the farmers strategy and extent of woody species change, as perceived by the farmers, over the past thirty years. According to the KIs and 37.5% of the respondents, the extent of vegetation cover during the 1980's slightly reduced. The distribution and the cover of woody species on-farms have decreased during the period of before two decades but have increased within the last decade. According to KIs and the respondents, woody species change on farmland has slightly increased during the period of 20 – 11 years ago and significantly increased during the last decade.

Table 3: Households' response (n=90) in relation to the extent of woody species change around their surroundings within the past thirty years

	Age classes of past years and no. of respondents (%)		
Description	30 – 21	20 - 11	10 - 1
Significantly reduced	22.5	-[1)]	2.5
Slightly reduced	37.5	41.3	3.8
Remained the same	-	2.5	-
Slightly improved	18.8	56.3	66.3
Significantly improved	21.3	-	27.5
Total	100.0	100.0	100.0

[1)] *Indicates no respondent replied in the classified age classes*

Farmers have had a good deal of knowledge related to type of disappeared and disappearing tree/shrub species in their locality and on farmland (Table 4). They were enabled to recognize some of the very important tree/shrub species to them while the vegetation cover changes. For instance, *Ximenia americana (Enkoy)* was the most important shrub species remembered by the majority of the respondents.

On the other hand, exotics are planted and expanded to supplement native trees/shrubs. Species that are increasingly preferred and planted on farmland holdings include: *Eucalyptus camaldulensis, Cordia africana, Croton macrostachyus, Catha edulis, Mangifera indica, Acanthus polystachius, Carica papaya, Persea americana, Sesbania sesban, Coffea arabica, Psidium guajava, Entada abyssinica, Ficus sycomorus, Rhamnus prinoides, Justicia schimperiana, Vernonia amygdalina,* etc.

The absence or presence of land and tree tenure security appeared to be the major influencing factor to tree growing activities and to number of on-farm tree cover. About 94% and 95% of HH respondents (n=90) suggested that the underlining reasons for the changes in number of trees/shrubs were absence of land-tenure and tree-tenure problem, respectively. This condition motivated farmers and create confidence to plant more trees on their holdings. As a result this time more than ever before, farmers have developed interest to add value to their plot of land by implementing physical and biological soil and water conservation works. Even to the extent,

some farmers are now renting land for longer lease period, up to 25 years and planting perennial tree crops such as Eucalyptus and Catha edulis species. In the study KAs alone about 20% of the respondents rented land partly for agricultural crop production and partly for perennial crop cultivation, such as Eucalyptus woodlot establishment.

Table 4: Some of the tree/shrub species recognized by the respondents (n=90) being decreased/disappeared from the farmland at the study KAs.

No.	Local name	Botanical name	Respondents (%)	Remark
1	Sesa	*Albizia* spps.	5.5	being decreased
2	Abalo	*Combretum molle*	36.8	”
3	Warka	*Ficus vasta*	21	”
4	Gambilo	*Gardenia ternifolia*	63	”
5	Eshe	*Mimusops kummel*	22.5	”
6	Keskessie	*Nuxia congesta*	10.5	”
7	Sendel	*Albizia malacophylla*	47.36	‘’
8	Wulkefa	*Dombeya quinqueseta*	10.5	‘’
9	Digita	*Calpurnia subdecandra*	15	‘’
10	Tunjet	*Otostegia integrifolia*	15.8	‘’
11	Banba	*Ficus sycomorus*	15.8	‘’
12	Lafdi	*Piliostigma thonningii*	42	”
13	Qamo	*Rhus vulgaris*	33.6	”
14	Zana	*Stereospermum kunthianum*	15.8	”
15	Dokima	*Sizygium guineense*	15.8	”
16	Enkoy	*Ximenia americana*	68.4	‘’
17	Dengay seber	[1)]-	15	disappeared
18	Gualikokeb	[1)]-	8.5	”
19	Enjori	[1)]-	3.5	‘’

[1)] *Tree/shrub species that are disappeared from the study PAs and impossible to determine their botanical name.*

Tree/shrub species diversity

Species richness

Farmers in the study villages retain trees according to the spaces available and their compatibility with agricultural crops and household objectives. Table 5 shows tree/shrub species richness at four agroforestry practices. In general, a total of 59 species of trees and shrubs were recorded at the study site. The average number of tree/shrub per sampled household was 21 with values ranging between 4 – 58 species (Table 6). About 10 species of trees and shrubs occurred in 50% and more of the sampled farms (Table 7). *Croton macrostachyus* was the most frequent tree species, occurred in 92.5% of the sampled farms followed by *Cordia africana* ,*Eucalyptus camaldulensis*, *Rhamnus prinoides*, *Chata edulis*, etc., each occurring in sampled farms, respectively. The highest numbers of species were recorded at homegardens agroforestry practice of all villages. Slightly higher tree/shrub species richness was found in Yibab-Chencher PA (Table 6).

Table 5: Types of AFPs and number of tree/shrub species per sampled HHs at the villages

		Homegarden (n=90)	Park land (n=90)	Grazing land(n=62)	Boundary (n=62)
Yibab-Chencher	Mehal	15.6 ±8.66	4.46 ±2.44	2.78 ±1.30	1.27 ±1.27
	Mertet	19.93 ±12.40	5.2 ±3.91	3.3 ±1.64	1.6 ±1.60
Chenta-sostu	Chenta	17.4 ±9.79	3.33 ±2.19	2.44 ±1.01	1.14 ±1.14
	Abeshma	18.53 ± 9.83	4.07 ± 2.12	4 ± 2.45	2.36 ± 2.36
Kembaba	Woji	14.2 ±4.36	3.47 ±1.13	1.64 ±0.50	1.80 ±1.80
	Jekera	12.93 ±4.32	2.6 ±0.83	1.56 ±0.53	1.67 ± 1.67
Total		16.43±8.84	3.8 ± 2.41	2.70 ± 1.72	1.64 ± 0.83

Table 6: Mean, minimum and maximum number of tree/shrub species at the study PA’s

Site	Mean ± std	Minimum	Maximum
YibabChencher	24.07 ± 14.88	6	58
Chenta-Sostu	22.90 ± 12.70	4	47
Kembaba	16.73 ± 5.79	7	31
Total	21.23 ± 12.08		

Table 7: Tree/shrub species on sampled household farms (n=90) at the study site

S/N	Scientific name	Family name	Local name	Origin
1	Acacia abyssinica Hochst. ex Benth.	Mimosaceae	Yehabesha girar	I
2	Acanthus polystachius Delile	Acanthaceae	Kosheshile	I
3	Albizia malacophylla (A. Rich.) Walp.	Fabaceae	Sendel	I
4	Albizia schimperiana Oliv.	Fabaceae	Sesa	I
5	Calpurnia subdecandra (L `Hérit.) Schweick.	Papilionaceae	Digita	I
6	Capparis tomentosa Lam.	Capparidaceae	Gumero	I
7	Carica papaya L.	Caricaceae	Papaya	E
8	Carissa edulis (Forssek.) Vahl	Apocynaceae	Agam	I
9	Casuarina equisetifolia L.	Casuarinaceae	Arthelibanos	E
10	Catha edulis (Vahl) Forssk. ex Endl.	Celastraceae	Chat	I
11	Celtis africana Burm. f.	Ulmaceae	Kewot	I
12	Citrus aurantifolia (Christm.) Swingle	Rutaceae	Lomi	E
13	Citrus aurantium L.	Rutaceae	Buhero lomi	E
14	Citrus grandis (L.) Osb.	Rutaceae	Tirngo	E
15	Citrus reticulata Blanco	Rutaceae	Menderin	E
16	Citrus sinensis (L.) Osb.	Rutaceae	Birtukan	E
17	Clausena anisata (Willd.) Benth.	Rutaceae	Limich	I
18	Coffea arabica L.	Rubiaceae	Buna	I
19	Combretum molle R. Br. ex G. Don	Combretaceae	Yedega abalo	I
20	Cordia africana Lam.	Boraginaceae	Wanza	I
21	Croton macrostachyus Del.	Euphorbiaceae	Bisana	I
22	Cupressus lusitanica Mill.	Cupressaceae	Yeferenji tid	E
23	Dombeya quinqueseta (Del.) Exell	Sterculiaceae	Wulkifa	I
24	Endata abyssinica Steud. Ex A. Rich.	Mimosoideae	Kentefa	I
25	Erythrina abyssinica Lam. ex. DC.	Papilionaceae	Korch	I
26	Eucalyptus camaldulensis Dehnh.	Myrtaceae	Key bahirzaf	E
27	Euphorbia candelabrum Kotschy	Euphorbiaceae	Kulkual	I
28	Euphorbia tirucalli L.	Euphorbiaceae	Kinchib	I
29	Ficus ovata Vahl	Moraceae	Qef	I
30	Ficus sur Forssk.	Moraceae	Shola	I
31	Ficus sycomorus L.	Moraceae	Banba	I
32	Ficus thonningii Blume	Moraceae	Chibha	I
33	Ficus vasta Forssk.	Moraceae	Warka	I
34	Gardenia ternifolia Schumach. & Thonn.	Rubiaceae	Gambilo	I
35	*Grevillea robusta* R. Br.	Proteaceae	Gravilia	E
36	*Grewia ferruginea* Hochst. ex A. Rich.	Tiliaceae	Lenkuata	I
37	*Jacaranda mimosifolia* D. Don	Bignoniaceae	Yetemnja zaf	E
38	*Justicia schimperiana* (Hochst. Ex Nees)	Acanthaceae	Simiza	I
39	*Mangifera indica* L.	Anacardiaceae	Mango	E
40	*Melia azedarach L.*	Meliaceae	Nim	E
41	*Milletia ferruginea* (Hochst.) Bak.	Fabaceae	Birbira	I
42	*Mimusops kummel* A. DC	Sapotaceae	Eshe	I
43	*Nuxia congesta* Fresen.	Loganiaceae	Keskesie	I
44	*Otostegia integrifolia* Benth.	Lamiaceae	Tunjit	I
45	*Persea americana* Mill	Lauraceae	Avocado	E
46	*Phytolacca dodecandra* L `Hérit.	Phytolaccaceae	Endod	I
47	*Piliostigma thonningii* (Schumach.) Milne-Redh. Redh.	Caesalpinioideae	Lafdi	I
48	*Premna schimperi* Engl.	Verbenaceae	Chocho	I
49	*Prunus persica* (L.) Batsch	Rosaceae	Kock	E
50	*Psidium guajava* L.	Myrtaceae	Zeituna	E
51	*Rhamnus prinoides* L`Hérit.	Rhamnaceae	Gesho	I
52	*Rhus vulgaris* Meikle	Anacardiaceae	Qamo	I
53	*Sapium ellipticum* (Krauss) Pas	Euphorbiaceae	Arboje	I
54	*Securinega virosa* (Willd.) Baill.	Euphorbiaceae	Wonahe	I
55	*Sesbania sesban* (L.) Merr.	Fabaceae	Sesbania	E
56	*Syzygium guineense* (Willd.) DC.	Myrtaceae	Dokima	I
57	*Solanum giganteum* L.	Solanaceae	Dengorita	I
58	*Stereospermum kunthianum* Cham.	Bignoniaceae	Zana	I
59	*Vernonia amygdalina* Del.	Asteraceae	Girawa	I

Out of the total number of tree/shrub species recorded at the study site, 55, 54 and 32 were found at

Yibab-chencher, Chenta-sostu and Kenbaba KAs, respectively.

Table 8 shows mean species richness by agroforestry practice types at the three study KAs. The overall higher mean species richness was recorded at home garden AFP than others.

Species richness per agroforestry practices and wealth status at study village is shown in Table 8. In home gardens, wealthy farmers have higher species richness compared to medium and poor HHs.

Table 8: Mean number of trees/shrubs per agroforestry practices at the three study KAs

PAs	Type of agroforestry and species richness			
	Home garden (n=90)	Park (n=90)	Grazing (n=62)	Boundary (n=62)
Yibab-Chencher	17.77	4.86	3.05	1.4
Chenta-Sostu	17.97	3.70	3.39	1.89
Kembaba	13.80	3.1	1.6	1.74
Total mean	16.51	3.88	2.68	1.67

At the study sites, farmers managed both exotic and native trees/shrubs. Of the 59 tree/shrub species recorded, 42 were indigenous while the remaining 17 species were exotics. The highest number of indigenous tree/shrub species was recorded at Mertet village as compared to the exotics.

When the overall average numbers of trees/shrubs per sampled farms of all wealth categories are compared, the values were 10.56, 20.97 and 32.89, for poor, medium and rich, respectively and the average highest proportion of tree/shrub/ species being at *Yibab* KA. In all study KA's, wealth status significantly influenced the number of tree/shrub species per farm (F-test, $P<0.05$).

Mean Shannon index and evenness of tree/shrub species of some AFPs within villages are shown on Table 9. The overall mean Shannon's diversity of home garden AFP was greater than others.

Table 9: Mean Shannon index (H1) and Evenness (E) of some AFP's at the study villages

Villages	Shannon index (H1)				Evenness index(E)			
	Homega-rden	Park land	Grazing land	Boundary	Homegarden	Park land	Graz.land	Boundary
Mehal	1.97±0.38	0.91±0.58	0.39±0.41	0.11±0.19	0.76±0.1	0.76±0.11	0.74±0.14	0.24±0.3
Mertet	0.94±0.79	1.03±0.64	0.70±0.68	0.21±0.30	0.31±0.24	0.68±0.29	0.8±0.35	0.53±0.43
Chenta	1.23±0.69	0.83±0.70	0.56±0.39	0.07±0.16	0.49±0.29	0.62±0.42	0.6±0.28	0.15±0.25
Abeshma	0.94±0.53	0.80±0.47	0.87±0.73	0.3±0.40	0.37±0.26	0.62±0.28	0.62±0.42	0.32±0.37
Woji	1.79±0.64	1.04±0.34	0.35±0.33	0.13±0.24	0.69±0.24	0.89±0.13	0.80±0. 34	0.24±0.37
Jekera	1.81±0.54	0.84±0.35	0.31±0.36	0.11±0.21	0.72±0.17	0.93±0.1	1.0±0.0	0.15±0.19
Total mean	1.44±0.73	0.9±0.52	0.54±0.55	0.16±0.27	0.55±0.28	0.72±0.33	0.28±0.34	0.75±0.27

Importance value index (IVI)

Importance value index shows the importance of individual tree/shrub species at farm-level and helps to assess the contribution of each tree/shrub species. From all sampled farms *Eucalyptus camaldulensis* ranked first followed by *Croton macrostachyus* ,*Cordia africana*, *Ficus sycomorus* and *Vernonia amygdalina* (Table 10). IVI was calculated for those tree/shrub species inventoried with a DBH of ≥ 5 cm. But some trees/shrubs with < 5 cm DBH were common and important to the farmers.

Table 10: Mean importance value of trees/shrubs (≥5cm DBH) at the study site

Species name	IVI (%)	Species name	IVI (%)
Eucalyptus camaldulensis	172.11	*Grewia ferruginea*	2.91
Croton macrostachyus	14.29	*Albizia malacophylla*	2.64
Cordia africana	13.56	*Mangifera indica*	4.44
Ficus sycomorus	13.41	*Piliostigma thonningii*	2.41
Vernonia amygdalina	7.72	*Dombeya quinqueseta*	2.15
Calpurnia subdecandra	5.96	*Persea americana*	2.04
Sesbania sesban	4.62	*Sapium ellipticum*	1.92
Acacia abyssinica	4.34	*Psidium guajava*	1.79
Gardenia ternifolia	4.22	*Combretum molle*	1.4
Albizia schimperiana	3.85	*Ficus ovata*	1.39
Melia azedarach	3.81	*Sizygium guineense*	1.25
Erythrina abyssinica	3.75	*Mimusops kummel*	1.20
Stereospermum kunthianum	3.67	*Grevillea robusta*	1.09
Ficus vasta	3.1		
Ficus thonningii	3.09		
Rhus vulgaris	2.97		

Woody species preference

At the study site, farmers' tree preference was in order of *Eucalyptus camaldulensis* > *Rhamnus prinoides* > *Catha edulis* > *Cordia africana* and so on (Table 11). Jiregna et al. (2005) also reported the choice of tree species depends on the benefit that can be drawn from keeping the tree on farm. The importance of trees in addressing these issues has been well understood by farmers through the centuries and has been clearly demonstrated in traditional tree-based agricultural farming and land-use systems (Garrity et al. 2006).

Table 11: Respondents' preference of some selected species at the study site

No.	Species	Total relative score
1	*Eucalyptus camaldulensis*	36.95
2	*Rhamnus prinoides*	14.21
3	*Croton macrostachyus*	11.91
4	*Cordia africana*	10.49
5	*Ficus sycomorus*	4.11
6	*Vernonia amygdalina*	1.14
7	*Catha edulis*	0.52
8	*Coffee arabica*	0.50
9	*Mangifera indica*	0.43
10	*Persea americana*	0.39
11	*Carica papaya*	0.23
12	*Citrus sinensis*	0.22
13	*Ficus vasta*	0.11
14	*Psidium guajava*	0.03
15	*Sizygium guineense*	0.01
16	*Grevillea robusta*	0.01

Farmers have planted or retained important tree/shrub species of their preference(Table 13). Therefore, *Croton macrostachyus, Cordia africana, Ficus sycomorus, Sapium ellipticum* and *Ficus vasta* were among the listed that were retained by majority of the farmers.

Source of seedlings

At the study site the major source of seedling production is shown in Table 12. Major source of seedlings production is done by farmers themselves. Only 11% of the respondents have got seedlings from the government nursery.

Table 12: List of some preferred tree/shrub species, source of seedlings and no. of HH respondents used the tree/shrub species and nurseries

Preferred species	Source of seedlings and number of respondents used			Total
	Self raised	GO nursery	Self &GO nursery	
Eucalyptus camaldulensis	26	7	33	66
Rhamnus prinoides	55	-[1)]	-	55
Croton macrostachyus	48	-	-	48
Cordia africana	51	1	-	52
Ficus sycomorus	12	12	9	33
Vernonia amygdalina	1	11	7	19
Catha edulis	8	1	9	18
Coffee arabica	7	-	-	7
Mangifera indica	6	-	-	6
Persea americana	12	2	-	14
Total	226 (71%)	34 (11%)	58 (18%)	318 (100%)

[1)] indicates there was no participant for the respective species at the located nursery

Table13: No. of the respondents (n=90) who planted or retained woody species in their holdings

S.N.	Species	No. of respondents (%)				Placement niche
		Planted	Retained	Planted & retained	Total	
1	*Cordia africana*	52.5	28.75	11.25	92.5	HG, PL
2	*E. camaldulensis*	91.25	-[1)]	-	91.25	HG, FB,WL
3	*Croton macrostachyus*	35	40	8.75	83.75	HG, PL
4	*Ficus sycomorus*	12.5	23.75	10	46.25	HG, PL
5	*Ficus vasta*	6.25	18.75	3.75	28.75	PL
6	*Sapium ellipticum*	-	20	2.5	22.5	GL, PL
7	*Milletia ferruginea*	15	3.75	-	18.75	HG, PL
8	*Sizygium guineense*	10	7.5	-	17.5	HG, GL, PL

Key: HG= Homegarden; FB= Farm boundary; WL= Woodlots; GL= Grazing land; PL= Parkland
[1)]indicates no respondent participated in the respective tree/shrub species planting or retaining

COCLUSION AND RECOMMENDATION

In the present study, a total of 59 species of trees/shrubs were recorded with the average of 21 per sampled household farms and diversity ranging from 4 – 55 species. The highest numbers of species were recorded at homegarden agroforestry practices.

Assessment of importance of individual tree/shrub species at farm level indicated that, *Eucalyptus camaldulensis* was ranked first with mean IVI of 57%, followed by *Croton macrostachyus* (4.76%), *Cordia africana* (4.52%), *Ficus sycomorus* (4.46%) etc.

Farmers' tree/shrub preference was in order of *Eucalyptus camaldulensis* > *Rhamnus prinoides* > *Catha edulis* > *Cordia africana* that was based on the benefits derived from woody species.

The study assessed farmers' ideas and experiences in relation to their understanding of woody species diversity and preferences, which could be considered as a big asset in designing development strategies to be implemented on their land holdings.

REFERENCES

Azene Bekele. 1993. Useful trees and shrubs of Ethiopia. Identification, propagation, and management for agricultural and pastoral communities. Regional Soil Conservation Unit, Swedish International Development

Authority, 474 pp.

Backes M.M. 2001. The role of indigenous trees for the conservation of bio-cultural diversity in traditional agroforestry land use systems: The Bungoma case study *in-situ* conservation of indigenous tree species. Agroforestry Systems 52: 119 - 132.

Crowley E.L. 1997. Rapid data collection using wealth ranking and other techniques. International centre for research in agroforestry and tropical soil biology and fertility programme, 16 pp.

CSA (Central Statistics Authority). 2007. Population census report: projected by Bureau of Finance and

Economic Development (BoFED). Bahir Dar.

DOoARD (District Office of Agriculture and Rural Development). 2009. Annual report. Bahir Dar.

DOoARD (District Office of Agriculture and Rural Development). 2010. Annual report. Bahir Dar.

Edwards S., Mesfin Tadesse & Hedberg I. (eds). 1995. Flora of Ethiopia and Eritrea, vol. 2, part 2. Addis Ababa, Ethiopia, Uppsala, Sweden, 456 pp.

Edwards S., Sebsebe Demissew & Hedberg I. (eds). 1997. Flora of Ethiopia and Eritrea, vol. 6. Addis Ababa, Ethiopia, Uppsala, Sweden, 586 pp.

Edwards S., Mesfin Tadesse, Sebsebe Demissew & Hedberge I. (eds). 2000. Flora of Ethiopia, vol. 2, part 1. Addis

Ababa, Ethiopia, Uppsala, Sweden, 532 pp.

Hedberg I. & Edwards S. (eds). 1989. Flora of Ethiopia, vol. 3. Addis Ababa and Asmara, Ethiopia, Uppsala, Sweden, 659 pp.

Hedberg I. & Edwards S. (eds). 1995. Flora of Ethiopia and Eritrea, vol. 7. Addis Ababa, Ethiopia, Uppsala, Sweden, 420 pp.

Hedberg I., Edwards S. & Sileshi Nemomissa. (eds). 2003. Flora of Ethiopia and Eritrea, vol. 4, part 1. Addis Ababa, Ethiopia, Uppsala, Sweden, 352 pp.

Kent M. & Coker P. 1992. Vegetation description and analysis: a practical approach. John Wiley & Sons, Chichester, 363 pp.

Kindt R., Noordin Q., Njui A. & Ruigu S. 2005. Biodiversity conservation through agroforestry: managing tree species diversity within a network of community-based non-governmental, governmental and research organizations in western Kenya. Paper presented at the 15th annual conference of the Eastern Africa environmental network on networking for biodiversity, 27 - 28 May, national museum of Kenya, Nairobi.

Longman K.A. & Jenik J. 1987. Tropical forest and its environment, 2nd ed. John Wiley & Sons Inc., New York, 253 pp.

Magurran A.E. 1988. Ecological diversity and its measurement. London: Croom Helm Limited, 179 pp.

MoWR (Ministry of Water Resource). 2002. Water sector development program 2002-2016, Volume II: Main

Report. Ministry of Water Resources, Federal Democratic Republic of Ethiopia, Addis Ababa, October 2002.

Muktar Reshad. 2006. Farm characteristics and tree species diversity in Arbegona district, high lands of southern Ethiopia. MSc thesis, Wondo Genet College of Forestry and Natural Resources, Report No. 2006: 83, 88 pp.

Nair P.K.R. 1993. An introduction to agroforestry. Kluwer Academic Publisher, Dordrecht, The Netherlands, 499 pp.

Nikiema A., van der Maesen L.J.G. & Hall John B. 2005. Woody species composition of Sudan savanna parklands in relation to rural land use gradients in Burkina Faso. PhD Thesis, Wageningen University, Wageningen, pp. 8 - 22.

Rocheleau D., Weber F. & Field-juma A. 1988. Agroforestry in dry land Africa: science and practice of agroforestry. ICRAF, Nairobi, Kenya, 311 pp.

Salam M.A., Noguchi T. & Koike M. 2000. Understanding why farmers plant trees in the homestead agroforestry in Bangladesh. Agroforestry Systems 50: 77 - 93.

Scherr S.J. 1995. Meeting household needs: farmer tree-growing strategies in west Kenya. In: Arnold J.E.M. & Dewees P.A. (eds), Tree management in farmer strategies: response to agricultural intensification, Oxford University Press, UK, 141 - 173 pp.

Schroth G. & Sinclair F. L. 2003. Impacts of trees on the fertility of agricultural soils. In: Schroth G. & Sinclair F.L. (eds), Trees, crops and soil fertility. CAB International, London, UK, pp.1 - 12.

Shannon C.E. & Wiener W. 1949. The mathematical theory of communication. The University of Illinois Press.

Sharma B.M. 1997. Nutrient cycling in agroforestry. In: Gupta J.P. & Sharma B.M. (eds), Agroforestry for sustained productivity in arid regions. PAWAN KUMAR scientific publishers, India, 69 - 77 pp.

Shaxson L. & Tauer L.W. 1992. Intercropping and diversity-an economic analysis of cropping patterns on smaller holder farms in Malawi. Experimental Agriculture 28: 211 - 228.

Solomon Mulu. 2009. Assessment on farmers' perception and adoption of agroforestry technologies in south Wello, north east Ethiopia. MSc thesis, Wondo Genet College of Forestry and Natural Resources, 89 pp.

Tesfaye Abebe. 2005. Diversity in homegarden agroforestry systems of Southern Ethiopia. Doctoral thesis, Wageningen University, 143 pp.

Tesfaye Teklay. 1996. Problems and prospects of tree planting by smallholder farmers: a case study in Feleghe Hiwot locality, eastern Tigray, Ethiopia. MSc thesis, Wondo Genet College of Forestry and Natural Resources, Report No.1996:7, 78 pp.

Wiersum K.F. 1982. Tree gardening and taungya on Java: examples of agroforestry techniques in the humid tropics. Agroforestry Systems 1: 53 - 70.

Wolde-michael Kelecha. 1987. A glossary of Ethiopian plant names, 4th edition, revised and enlarged. Addis Ababa, Ethiopia, 245 pp.

Young A. 1997. Agroforestry for soil management, 2nd edition. CAB International, Wallingford, UK, 319 pp.

Zebene Asfaw & Hulten H. 2003. Tree diversity management in the traditional agroforestry land-use of Sidama, southern Ethiopia. Acta Universitatis Agriculturae, SLU. SILVESTRIA 263 (1) 1 - 28.

Zemede Asfaw & Ayele Nigatu. 1995. Home-gardens in Ethiopia: characteristics and plant diversity. SINET: Ethiopian Journal of Science 18: 235 - 266.

The IISTE is a pioneer in the Open-Access hosting service and academic event management. The aim of the firm is Accelerating Global Knowledge Sharing.

More information about the firm can be found on the homepage:
http://www.iiste.org

CALL FOR JOURNAL PAPERS

There are more than 30 peer-reviewed academic journals hosted under the hosting platform.

Prospective authors of journals can find the submission instruction on the following page: http://www.iiste.org/journals/ All the journals articles are available online to the readers all over the world without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. Paper version of the journals is also available upon request of readers and authors.

MORE RESOURCES

Book publication information: http://www.iiste.org/book/

Recent conferences: http://www.iiste.org/conference/

IISTE Knowledge Sharing Partners

EBSCO, Index Copernicus, Ulrich's Periodicals Directory, JournalTOCS, PKP Open Archives Harvester, Bielefeld Academic Search Engine, Elektronische Zeitschriftenbibliothek EZB, Open J-Gate, OCLC WorldCat, Universe Digtial Library , NewJour, Google Scholar