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The Role of Traditional Agro Forestry Practices for Sustainable Land Management in Maraka District of Dawuro Zone, Southern Ethiopia

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Abstract **– The study was done to explore the constraints of traditional agro-forestry practice in sustainable land management. The research design is concurrent triangulation. The 140 households were determined using Cochran method. The respondents were selected by systematic sampling techniques. The data were analyzed using SPSS software version 20.0 excels micro software 2007 and Shanon and Soresson induces. The results indicated 108 plant species were identified from home gardens. The mean value of Simpson index is 0.35. This indicated the highest abundant and the evenness of the plant species in study area. Finally the Sorenson coefficient of similarity is 38.8%. The result of analyzed species diversity in three different agro-ecology indicated non significant difference. Traditional agro-forestry provides food, cash generate, medicinal value, keep soil fertility, cultural asset, moderate environment and construction. The most common threatening challenges were land shortage, degradation, soil erosion, mass movement, flooding hazards, bacterial wilt of enset and coffee berry wilt. Finally implementation of policy and strategic plan, the mitigation and adoption of climate change, preventing bacterial wilt and soil erosion by using indigenous knowledge were opportunities of traditional agro-forestry practices in the study area.**

Keywords **– Agro-forestry, Dawuro, Diversity, Land Management.**

I. INTRODUCTION

Agro-forestry is recently defined by the World Agro-forestry Center as dynamic, ecologically-based natural resource management practice that, through the integration of trees and other woody plants on farms and in the agricultural landscape, diversifies production for social, economic, and environmental benefits [1]. Agro-forestry is a practice that cultivation of trees and agricultural crops in intimate combination with one another. It is an ancient practice used by farmers throughout the world [2].

Agro-forestry ranges from traditional shifting cultivation to fruit trees, vines and cereals in spatial complementarity or poplar-crops systems. It is commonly practiced by integrating trees with other crops planted in a multi-storied fashion, which diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels. Also the distinctive contribution to production is to obtain tree, crop and livestock products from the farm [3]. Environmental problems associated with agricultural production have become a major concern, reducing the availability of wood products for fuel and construction, degrading range resources, and exposing vulnerable soils to degradation [4; 5].

Agro-biodiversities are influenced by different physical and socio economic factor and this will eventually influence land use sustainability. Still the land use is not static and change over time. Moreover the conversion of forest lands to agricultural lands, resulting in massive environmental degradation and a serious threat to

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sustainable land management [6]. The need to expand cultivated land and shortage of fuel bio-mass have led to removal of well adopted, nutrient additive indigenous trees, cropping areas have expanded in to marginal lands, such as steep slopes and mountainous areas, and fallow periods have been shortened [7].

Agro-forestry, now considered as a sustainable agricultural system, is being widely promoted all over the world especially in sub-Saharan Africa. In varieties of African environments, traditional agro-forestry systems sustained people for generations, the inter-cropping of trees with millet and sorghum in west-Africa is known to be successful. The systems are structurally complex and floristically diverse and can contribute significantly to the conservation of biodiversity with in fragmented landscapes, to natural forest conservation and development program [8]. Traditional agro-forestry is being practiced and which can be modernized for the purpose of adoption as an alternative to shifting cultivation and nomadism in Nigeria [9].

Agro-forestry is thought to have the potential to improve soil fertility through the maintenance or increase of soil organic matter and biological nitrogen (N_2) fixation from nitrogen fixing tree species [10]. Biologically, agro-forestry species that replenish soil fertility have the potential to reverse soil fertility decline, there by increasing crop yields. Various studies have shown potential of agro-forestry, especially in the tropics [11; 12]. Furthermore, some agro-forestry technologies provide wood for timber, pole for construction, and fuel wood forestry as an approach to sustainable agriculture production and soil management; hence they are an integral part of the household subsistence needs. Therefore, agro-forestry, now regarded as a sustainable agricultural system, is being widely promoted in most parts of Malawi. The incorporation of organic residues into the soil to enrich soil fertility is widely practiced in southern Malawi [13].

Agro-forestry technologies are complex and different from other agricultural technology such as high yielding varieties in terms of labor and other input requirements. Thus, even if women farmers were willing to adopt agro-forestry, the need for more labor would probably determine them. However, in Sub-Saharan Africa, women contribute to most of the farming and food activities [14].

Agro-forestry has been an age-old practice in the Ethiopian farming system [15]. There are numerous types of traditional agro-forestry systems in different parts of our country, in Southern Ethiopia [16; 17], South western Ethiopia, [17] and in Northern Ethiopia [15]. In Ethiopia, traditional tree managements in the form of agro-forestry have given refuges for a considerable number of native tree species on home garden and scattered (on-farm tree) agro-forestry system is one of the most obvious traditional practices across most agro-ecosystems in the highlands of Ethiopia. There are several types of traditional agro-forestry practices in different parts of Ethiopia, Coffee shade based, scattered trees on the farm-land, home gardens, woodlots, farm boundary practices, trees on grazing lands are some of the known examples of traditional agro-forestry practice [17; 18]. The economic and social developments, currently it represents one form of sustainable agricultural system managed by local communities.

The biodiversity resources of Gedeo farming system were likened to those of the natural forests [19]. The traditional agro-forests are composed of a wide range of plant and animal species that are involved in mutual benefit which sustains the healthy functioning of the system and unremitting provision of a substantial proportion of the energy and nutritive requirements of the local people. Plantation crops such as vegetables, enset, coffee, shade and fruit trees, vines, herbaceous crops, and weedy species are dominant components. Such unique diversity in plant and animal species helps them maintain dynamic equilibrium with the physical,

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biological, and social environments for millennia. Whereas the weedy species provide complete coverage for the soil, the herbaceous and woody species provide a wide variety of economic products and environmental services.

In Dawuro Zone, Traditional agro-forestry practices have the key role in sustaining land management activities. The traditional agro-forestry practices of home garden have great contribution in house-hold income, preventing land degradation, building materials, traditional medicine, and cultural, recreational and ecological value. Women have increasing the fertility of soil by depositing and felling down domesticated animals waste in their home garden and farmland.

The natural resource degradation was expanded by unofficial resettlements [20] in Dawuro. Also the high population pressure increasement leads to excessive destruction of natural resources especially forest and land. Now a day the shortage of land per hectar for farming activity can assist the mountainous area to be eroded and loses of soil fertility. To minimize loses of soil fertility the people practice traditional agro-forestry. But, still land degradation cannot solve due to low land use and management, absence of agricultural research center and knowledge for farmers.

Similarly, in the study area the high population pressure increasement in area was exposed the natural resource degradation [21]. The farmers have agricultural land scarcity because of household farmers were divided their land in hectar for their sons. The large families in certain piece of land have practicing agricultural activity without soil conserving method assisted for degradation of soil fertility.

This study was filling the knowledge gap of traditional agro-forestry practice of the farmers on sustainable land management / Gave attention for low attitude and perception towards modern agro-forestry. It assisted the farmers to know the economic, social and environmental benefit tree species.

II. The Research Methodology

2.1. *Description of the Study Area*

2.1.1. *Location and Size*

Dawuro is one of the 17 zones in the SNNPR and bounded with Hadiya Zone in the North, Kembata Tembaro Zone in the Northeast, Wolayta Zone in the East, Gamo Gofa Zone in the South, and Konta Special District in the West and Jimma Zone of Oromya Region in North West (Fig. 1). It is also bounded between Omo River from North to South and Gojeb River from Northwest to North East [22]. Dawuro have five Districts and one Town Administration. Maraka District has an area of 46,220 hectares [23]. Maraka District is located in Dawuro Zone between $6^0$35`24`` - $7^0$20`2`` N latitude and 36^0 40`48`` - $37^0$31`12`` E longitudes in Southern Nations, Nationalities and Peoples Region. Waka is the main town located at about 490kms southwest of Addis Ababa across Shashemene and Wolayta, 320 Kms away from Hawassa, town of SNNPR and 140 km from Jimma [21].

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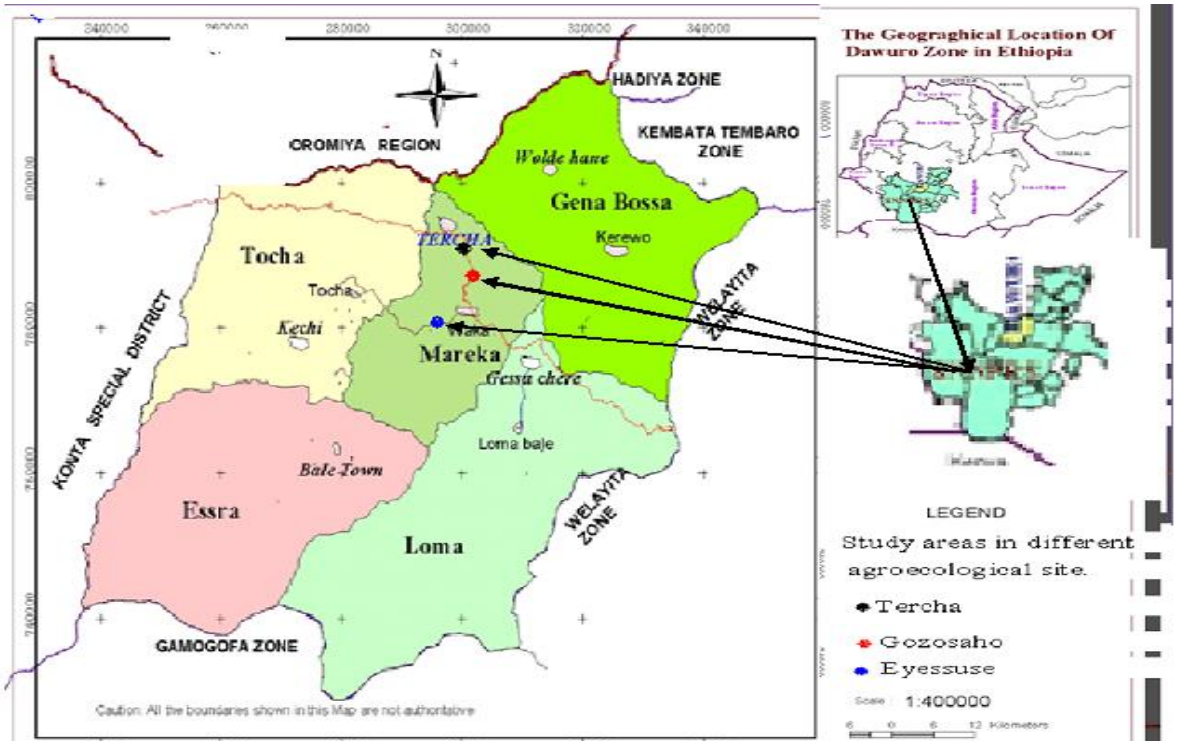

Fig. 1. Map of the study area.

2.1.2. *Climate*

The annual temperature of the study area ranges between 16°C-29°C while the meanannul temperature is 21°C. The annul range of rain fall between 900 mm-1800 mm. The study area receives the highest rain fall during summer season [22]. The altitude ranges between 1200-2374 m.a.s.l. and the agro-climate are Dega, Wayina-dega and Kola [21].

2.1.3. *Demographic Characteristics*

According to Maraka District Finance and Economy Department, 2015, the total population of Maraka Wereda was about 142,004, 73, and 573 male and 68, 431 female (Table 1). The Maraka people have unique cultural and social structure in Dawuro Zone. The word "Dawuro" means an impregnable, powerful and heroic people. Dawuro belongs to the family of the Omotic peoples in south west Ethiopia (Maraka District Culture, Tourism and Government Communication Department, 2015).

The people follow christain religion (Orthodox and Protestant) in the region [24]. Traditional Agro-forestry is the main economic activity and source of food for the people of the study area [21].

Table 1. Total Population, Area, Agro-ecology and Altitude of the Three Kebeles.

No	Kebeles	Total area	Total pop.	Agro-ecology	Altitude
1	Eyesus	459.125	2520	Daga	1800-2374m
2	Gozoshasho	855.888	4490	Woyinadega	1500-1800m
3	Tarcha Zuria	1164.122	4092	Kola	1200-1500m
Total		2479.135	11102	-	-

Source: Maraka District Agriculture Development Department (2015).

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2.1.4. *Drainage, Topography and Soil*

The study area has two main tributaries, such as Zoa and Shata meet together in Tarcha Zuria kebele. They join Gojeb River at Maraka and Genabosa District borders and also meet with Gibe River at Entelakebele in Genabosa District. Finally the two main rivers make single name of Omo River and it ends in Lake Turkana [22].

Topography of the study area from 1500-2374 masl has rugged, terrain, steep in nature and characterized by high mountains and plateaus. Gebero Mountain near to waka town has the highest elevation from sea level. It has an altitude of 2400 masl. The rugged topography particularly causes difficulties in road, irrigation and other infrastructure development. The steep slope mountainsides are not suitable for tilling and are vulnerable to soil erosion. Also the study area from 1200-1500 masl has plain, less steep, and characterized by low mountains and plateaus. Sadam Mountain near to Tarcha town has the lowest elevation from sea level. The people of Tarcha Zuria kebele which are lived in plain area near to Gojebe River are influenced by unfavorable climatic conditions, drought and prevalence of diseases such as malaria and trypanosomiasis [21].

Soil fertility is important for good production. The potential production of crops is due to the presence of suitable altitude, ample rainfall, optimum temperature and fertile soil [21]. The soil in the study area is fertile which has great potential for agricultural activities. Most of the soil in the study area has good physical properties and uniform profile, porous from clay to clay loam in texture and low base saturation and which are suitable for agriculture. Soil is one of the main factors determining the growth of plants in farm land and home garden [26]. But the steep slope areas were reduced soil fertility due to destruction of forests and erosion. Among three agro-ecology of the study area Gozo shasho kebele has low soil fertility due to un proper land use and low practice of traditional agro-forestry [21].

2.1. 5. *Vegetation*

The vegetation varies in the study area from broad-leaved evergreen forest types in dega agro-ecology of Eyesuskebele to tropical low land types in kola agro-ecology of Tarcha Zuria kebele. Also the woyinadega agro-ecological areas of Shasho kebele contain deciduous vegetations. Some of the dominant tree species are *Podocarpus* (Zigba), *Erythrina abyssinic* (Korich), *Arundinaria alpina* (Bambo). *Ficussurforssk* (Shola), *Acaciaabyssinica* (Girar), *Cordiaafricana* (Wanza), *Coffeearabica* (Coffee) and *Mangiferaindica* (Mango). Now a day the vegetation cover area has been reduced for various purposes. The vegetation have great role in land use management, wildlife habitat, recreational value and for various human needs. The population in Dawuro Zone shares a cultural identity from *Ensetventricosum* farming what is referred in Ethiopia as “Enset Culture Complex”, which is commonly characterized by high population density sustained by high yields of enset from small plot of land [21; 25].

2.1.6. *Land Use system*

The total land coverage of study area is 46, 220 hectar. Among this hectar, the land use system as follow. The arable land is 17,133 hectar, barren land is 7,395 hectar, the land which allotted for grazing 10,360.9hectar, forests cover 2,388.9 hectar and 8,942.2 hectar is unproductive. In study area, among the three kebele’s, Gozo shasho has supported by sustainable land management project because of poor land management [21; 25]).

The land in three agro-ecological zones have used for homesteadness (residence), crop cultivation, woodlots

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and grazing. The mountain area in three agro-ecology is more suitable for livestock rearing. Cattle are indispensable for households as a means of subsistence and source of cash income. The number of cattle owned and enset cultivated by a household usually determines the wealth status of the household. The main food crops grown in the area are enset, wheat, barely, maize, teff, sorghum, millet, pulses, taro, sweet potato and yam. Enset is the staple food in Dawuro, particularly in dega and woyina-dega areas, while maize and roots are the most important food crop in the kola agro-climate.

The people have practiced different animal grazing system in the study area. The domestic animals include cattle, horses, mules, donkeys, sheep, goats, and poultry. In the Eyesuskebele, herds remain at the holding or in the village through out the entire year; tide with rope, cut and carrying system of feeding.

Gozo shasho kebele have permanent settlement, their herds remain in the vicinity and send them to hillside. Tarcha Zuria kebele have permanent place and send their herds tend with herdsman. Herds in the study area are living with farmers in the home but in some tin roofed houses, it is left alone in other house with herdsman [21].

2.2. *The Research Methods*

2.2.1. *The Research Design*

The research design is concurrent triangulation, which is belongs to mixed method research. The concurrent triangulation was used to validate the finding of each elements, role, constraints and opportunities of traditional agro-forestry practice in sustainable natural resource management in three agro-ecological peasant associations with the help of qualitative and quantitative approach in a single study.

2.2.2. *Methods of Data Collection and Sampling Techniques*

2.2.2.1. *Data Sources*

The data were obtained from primary and secondary sources. Primary data were obtained from farmers, development agents (DA) and experts. Secondary data were obtained from different literatures, documents, published and unpublished materials, books, thesis, megazens and reports.

2.2.2.2. *Method of Data Collection*

A visit was made to the study area before conducting the actual data collection in selected kebele administration to get permission and introduce the purpose of the study. The discussions were held at kebele level with kebele administrators, development agents (DA) and farmers which are practicing traditional agro-forestry. Prior to collection of actual data, the questionnaire and interview were pre-tested using 21 randomly selected informants. Then necessary amendment were made to the questionnaire based on the feed back obtained from the analysis of the questionnaire. The following tools were used to collect data.

Household Survey:

For the purpose of this study, the house hold farmers were selected systematic randomly to answered structured questionnaires. The provided questionnaires which covers all issues relevant to the traditional agro-forestry practices in sustainable land management. The questionnaires were answered by 140 house hold farmers and translate into Dawurigna in study area. The three enumerators and one researcher administer the household survey.

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Focus Group Discussion (FGD):

The discussion at three peasant association with six (6) model household agro-forestry women, men and youths were carried. The discussion gave common understanding about status, role, challenges and opportunities of traditional agro-forestry practice in home garden and farmland. Focus groups from each kebele were selected by kebele chairman, manager and development agents through snow ball sampling.

Key Informant Interview:

The semi-structured interview were carried out with elder, religious and community leaders considering their knowledge and lived in study area more than 40 years in practicing the traditional agro forestry. Key informants from each kebele were selected by kebele chairman, manager and development agents through snowball sampling. Key informants were interviewed individually on the components, elements, status, role, challenges and opportunities of traditional agro-forestry practice in sustaining land managements. A total of 36 key informants were selected from three (3) kebele.

Field Observation:

It was assisted to gain abroad information about traditional agro-forestry practices in three agro-ecology through transect walk with the help of checklist. The field observation promoted the informal survey and contributed for the development of well structured questionnaires.

Structured Interview:

The structured interview were conducted at target peasant association with experts, development agents and their heads to obtain wide information about the components of traditional agro-forestry practice, constraints and police issue in sustainable resource managements. The six (6) natural resource department experts at District level and three (3) development agents (DA) living in kebele were interviewed. A total of nine (9) government employers were selected through simple random sampling.

2.2.2.3. *Sampling Techniques*

Both probability and non probability sampling techniques were used. The probability sampling of Systematic randam sampling technique was used for house hold farmers which are practicing traditional agro-forestry in sustainable land use. The experts and Development Agents were used simple random and also key informants were used by non probability sampling techniques of snow ball.

2.2.2.4. *Sampling Size Determination*

The 140 respondent from the total sample size of 908 households were selected from three agro-ecological zones. The size determined from degaagro-ecology of Eyesuskebele 408 households, woyinadega agro-ecology of Gozo shasho kebele 300 households and kola agro-ecology of Tarcha Zuria kebele 200 households respectively by using [27] the following formula:

$no = \frac{Z^2 * (P)(q)}{d^2} \rightarrow n_1 = \frac{no}{(1+no/N)}$ Where;

n_o = Desired sample size (Cochran's, 1977) when population greater than 10000.

n_1 = Finite population correction factors (Cochran's, 1977) formula less than10000.

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Z = Standard normal deviation (1.95 for 95% confidence level).

P = 0.2 (proportion of population to be included in sample i.e. 20%).

q = Is 1 – P i.e. (0.9).

N = Is total number of population.

d = Is degree of accuracy desired (0.05).

Table 2. Sample Size of Household Heads.

Kebeles	House Hold Heads	Sample Size
Eyesus	408	63
Gozo shasho	300	46
Tarcha Zuria	200	31
Total	908	140

2.2.3. *Methods of Data Analysis*

Qualitative data from participation of farmers were interpreted and analyzed. Quantitative data from household questionnaire survey were collected and coded. SPSS version 20 and excels micro software 2007 were used to organize and analyze data.

Also the species diversity, equitability, richness and similarity of home garden plant species in three agro-ecology were measured by Shannon index, Simpson Index and Sorensen index. Diversity induces can be used to assess the diversity of any species. For instance, it is used in ecology to measure biodiversity in an ecosystem Suman (2011). Shannon diversity is the very widely used index for comparing diversity between various habitats. Shannon diversity index (H^1) can be calculated as H = $-\sum_{i=1}^{s} pilnpi$

Where, H is the Index of species diversity, s is the number of species and pi is the proportion of total individual in the ith species.

Shannon Equitability (EH) can be calculated as EH = H/Hmax = H'/lnS

Where, equitability assumes the value between 0 and 1. But 1 is complete evenness.

Simpson Index (D) can be calculated as D = $\sum pi2$; D =$\sum n = 1$(ni (ni-1)/N (N-1).

Where, the latter ‘D” indicate measure of dominance and reported in the form of 1-D.

Simpson Evenness or Equitablity (E) can formulated as E = ∅/S.

Where, the value of equitablity between 0 and 1 is the highest, closer to 1 are equal abundant and closer to zero are the lowest value. Sorensen coefficient of similarity (Ss).

It is given by the formula as, Ss = 2a / 2a + b + c

Where as:

a = Number of species common to both samples.

b = Number of species in samples 1.

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c = Number of species in samples 2.

Finally the coefficient is multiplied by 100.

III. Results and Discussion

3.1. *Profile of the Respondents*

3.1.1. *Sex, Age and Marital Status of the Respondents*

The study supported to identify the sex ratio in three agro-ecology of the study area. In the study area the male number of household head is higher than female. Among the total respondents, male household head accounted (87.1%) while female house hold head accounted (12.9%).

In the study area there were different age groups from youth up to old age. But the study indicated no age group from 15-20 as house hold head. Among all age categories 41-60 were the highest. This age categories were used for practice of traditional agro-forestry in the study area. The ages restriction in study area started from 15 years up to above 60 years were identified as follows. From 15-20 (0%), 21-40(28.6%), 41-60(50%) and above 60 years (21.4%).

The mariatal status was identified from three agro-ecology of the study area. The married category is highest in number than the others. There was lowest number of single mariatal status household farmers. The marital status of the respondents were identified as follows:-single (2.9%), married (84.3%), divorced (6.4%) and widowed (6.4%).

3.1.2. *Educational Status of the Respondents*

Education is the base of development for all societies. The educational level of the respondents were identified as :- illiterate (28.6%), primary educational level from 1–4 grade (29.3%) and 5–8 grade (15.7 %), high school level from 9-10 grade (7.9%) and 11-12 grade (2.1%), certificate (2.1%), diploma holders (12.2%) and degree holders (2.1%).

3.2. *Components of Traditional Agro-forestry System*

The traditional agro-forestry systems classified in to three sub-systems based on structural, ecological and functional bases. These are Enset-tree, Coffee-tree and Banana-tree based traditional agro-forestry system.

3.2.1. *Enset-tree Based Traditional Agro-forestry System*

Enset-tree based traditional agro-forestry is highly found at altitude between 1800-2374 masl. It grown in three agro-ecology of the study area. In the dega agro-ecology, enset (*ensetventrcosum)* is combined with *Ficussur* and other trees (Table 3).

Table 3. Enset-tree based traditional agro-forestry system in the dega agro-ecology.

Trees	Frequency	Percent
Enset ventrcosum	40	63.4
Prunuspersica	3	4.8
Casimiredulis	2	3.2

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Trees	Frequency	Percent
Ficussur	10	15.9
Milettiaferruginea	2	3.2
Polysciafulva	2	3.2
Piper capense	4	6.3
Total	63	100

In the woyinadega and kola agro-ecology enset-tree combination are done Enset 75.3%, *Cardiaafricana* 93.5% and Coffee 77.9 % (Fig. 2). The enset-tree combinations are used for keeping soil fertility, economic and environmental value.

Fig. 2. Enset- tree based agro-forestry.

Nature and Characteristics of Enset plant

Most of (85.7 %) respondents as stated Enset plant cultivation occuried in dega, woyinadega and kola agro-ecology (1200-2374 masl) in study area. Enset is dominantly grown at altitude between 1800-2374 (masl) in dega agro-ecology of Eyesus Kebele. The elevation above 1800 meter is more suitable for enset cultivation. Enset is drought-tolerant plant and perennial root crop in the study area. By their nature, enset is divided into edible and unedible. The edible *Ensetventricosum* (Uutsaa) is cultivated in home garden. It is more domesticated plant species for wind breaks. Unedible enset *laurentii* (locally Erippaa) belongs to forest plant and not domesticated. There are more than 35 enset *ventricosum* species in study area. Locally *Shododdiniya* enset *ventricosum* has large width, long length, and high drought resisting capacity, high yields and wide leaves. But locally *Shashsha* enset *ventricosum* have less width and length, yields, resisting drought, broad leaves and more sweet by nature.

Enset *ventricosum* processing techniques are common in three agro-ecology. Also the same instruments such as Mayiliya and kok'aa locally prepared from bamboo and shebeko trees are used for processing enset *ventricosum*. Only women are responsible for harvesting and processing of Enset. Most of (77.9 %) of the respondant as stated the enset products as the major food in dega and co-staple food in woyinadega and kola agro-ecology of the study area. Tarcha and Gozo shasho peasant association have process enset *ventricosum* in April month to resist food shortage (locally Assurraa). But, in Eyesuskebele all year round enset *ventricosum* processing for food consumption is done. The major foods obtained from enset are:-

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Kocho (Unc'a) is the bulk of the fermented starch obtained from the mixture of decorticated (scraped) leaf sheaths and created corm. *Bulla (Ittimmaa)* is the small water-soluble starchy product that may be separated from *kocho* by the process squeezing and decanting the liquid. *Amicho (Doyissaa Uutsaa)* is the fleshly inner portion of the enset corm, which may be cooked and eaten. The enset products as the major food in dega and co-staple food in woyinadega and kola agro-ecology of the study area. Enset has economical, medical, cultural and environmental benefits. Enset plants are used for food, improve soil fertility, and improve moisture status, medicinally for humans and livestock to cure bone fractures, broken bone, child birth problems (i.e. assisting to discharge the placenta), diarrhea and birth control, protect evaporation from the ground by mulching. Fresh enset leaves are used as bread food wrappers, serving plates, bed, umbrella in rainy, generates cash and pit liners to store *kocho* for fermentation and future use. The dried petioles and midribs are used as fuel, and to make mats and tying materials for house construction. Fiber as a by product of decorticating the leaf-sheaths to tying *kocho*, tying hat's roof (in place of nails). The dried leaf sheaths are used as cattle feed and wrapping materials. Also *kocho* is widely export from Maraka District of Dawuro zone to Wolayta and Kambata Tambaro zone for cash generate.

3.2.2. *Coffee-tree based Traditional Agro-forestry System*

Coffee-tree based agro-forestry is highly found at altitude ranges of 1200 to 1800 masl. As respondents stated coffee-tree based agro-forestry *combined with Coffee Arabica*32.4%, *Cardiaafricana* 31.1%, *Acacia*21%, *Carca papaya* 10.3 % and *Enset ventrcosum* 5.2%. These trees have wide brunches of leaves which give shadow and protect high amount of incoming solar radiation for coffee tree. The mulched leaves used for increasement of soil fertility and production of coffee.

Coffee (*Coffeaarabica)*

As I observed Coffee Arabica is grown in study area from 1200-2374 masl. It is widely cultivated at altitude between1200-1800masl in Tarcha Zuria and Gozo shasho kebele. As elders stated coffee plant is originated from former Keffakifilehager (Keffa Zone). About 97.4 % respondents as stated coffee seedlings planting are done every year if there is adequate space and rain fall in March up to July months. The plating process is done by men. Farmers, who raise coffee seedling in their own nursery, have cultural practice to produce the seedlings. Naturally regenerated coffee seedlings are mostly found in coffee-trees based system.

Slashed material is spread on soil surface to serve as mulch and add up organic matter. Mulching is done in summer period forries new leaves, mulched leaves to decay and conservation of moisture. The cultivation is done April up to July months. Farmers harvest coffee in wet-red stage and at remaining red stage leaving some coffee berries to dry on the plant.

The farmers harvest wet-dry coffee from June to August and dry coffee berry from September upto November. Farmers in the study area practice sun drying processing system. Coffee drying would take one week. Most farmers in the area simply sell coffee berry without processing it to coffee beans. Farmers sell wet coffee in small market to get money in little price.

3.2.3. *Banana and Tree based Traditional Agro-forestry System*

Banana-tree based traditional agro-forestry is highly found at altitude between 1200 up to1500 masl in study

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are 93.6% respondents as stated the banana-tree based traditional agro-forestry were not known in dega agro-ecology of Eyesuskebele. The respondent stated banana-tree based traditional agro-forestry were combined with banana 64.9%, *Cardiaafricana* 63.6% and *Ficusvasta* 51.9% in woyinadega and kola agro-ecology of the study area (Fig. 3). These trees have wide brunches of leaves which give shadow and protect high amount of incoming solar radiation for banana. The mulched leaves used for increasement of soil fertility.

Fig. 3. Banana - tree based traditional agro-forestry system.

Banana (Musa paradisica)

As identified 96.8% from the respondents the banana were most cultivated at elevation between 1200 and 1500 masl in kola agro-ecology of Tarcha zuria kebele. 88.9% as interviewed banana is the same family of *Enset ventrcosum*, but it belongs to genus *musa.* Decomposing materials are mainly from ash, cow dung and domestic wastes. Banana cultivation is practiced by male. Banana fruit will reach to harvesting within 2 years. The most common types of banana in area are Abeshabanana (Abyssinian banana), and Ferje banana (*Red Canadian banana*). Farmers need to plant Abesha banana than Ferje banana. This is because Abesha banana have large amount of leaf, large fruit size but smaller in number, have good price to sell and house consumption. Also the responsibility of selling banana fruits for children and women. It is source of income for house holds. Farmers remove the dried leaves to reduce the spread of bacterial wilt disease, allow light and give adequate space for the development of root suckers.

3.3. *Status of Traditional Agro-forestry Systems*

About 88.8% as interviewed the diversified woody tree species on farm lands is declining from time to time for agricultural purpose in study area. There were high reduction of diversified indigenous tree species and expansion of exotic tree species. The farmers replaced the indigenous plant species such as Zigiba *(Podocarpus falcatus)*, Wanza *(Cordia africana)*, Dokima (Syzygium guineense), Shola *(Ficusvasta)* and Girar (*Acacia abyssinica)* by *Eucalptus globules*, Mango *(Mangiferaindica*), Avocado (*Perseaamericana)* and Kasimir (*Casimiroaedulis*) in kola and woyidega agro-ecology. Also in dega agro-ecology the plant species such as Enset *(Enset ventricosum)*, Bambo (*Arundinaria alpine)*, Koso *(Hajanaabyssinica)*,Korich (*Erythrinabrucei*), Shola *(Ficussur)*,Koki *(Prunuspersica)*, Gesho *(Rhamanusprynojes)*, Tikurenchet (*Prunus africana)* and Girar (*Acacia abyssinica)* are substituted by *Eucalptus*, Apple (*Malussylvestris)*, Giravilia (*Grevillea robusta)* and Tid (*Juniperus procera)* for economic value, ecologic value, keeping soil fertility, adoption of climate, environmental, food, animal pasture and recreation.

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About 71.4% of the respondents as stated now a day in dega agro-ecology of the study area the most common exotic tree was *Malussylvestris* mainly for economic value (Fig. 4).

Fig. 4. *Malussylvestris* of exotic tree.

About 80.6% of the respondents as stated in kola agro-ecology the most common exotic tree was *Mangoferaindinica.* The tree planted for economic and environmental value. Mango plant is one of the dominant fruit trees at altitude between 1200 to 1500 (masl) in Tarcha zuria kebele. The planting is conducted from April to July. The cultivation of mango plant always practice at younger age. The fruit harvesting and marketing responsibility belongs to women and children. Farmers have no ample knowledge to longer time storing practice.

As identified 66.7% from the discussion, the Eucalptus tree expansions were more done without considering the negative effect in soil and water resources management by farmers for house construction, serving as means of boundary line more than two neighbouring house households and source of in came. Now a day the expansion of Eucalptus tree in home garden and on farm land decreasement are occuried with the help of farmers gain education about the negative effect of planting Eucalptus trees. The development agents have great role in expansion of exotic tree species than indigenous tree species in home garden and on farm-land by sharing different knowledge, strategy and implementing policy.

The 95.8% from the total respondents were replied the present day government of Ethiopia has brought good agricultural policy and strategy to shift from agricultural development to industry lead economy (ADLI). Such transformation can achieve by integrating diversified indigenous plant species of traditional agro-forestry with diversified exotic plant species for the purpose of industrial development (textile factory, food processing factor and medical factor). The integration and transparency of stake holder's beginning from house hold farmers up to minister of agriculture have brought the change on traditional agro-forestry practice and assist for natural resource management and economic prosperity of the rural farmers.

The field observation in study area had shown the practices of traditional agro-forestry have its own weakness and advantageous on soil and water managements, environmental protection, and ecological moderation and livelihood food supply. The weakness of traditional agro-forestry were plant canopy domination, lack of knowledge about soil fertility affecting trees in home garden and on farm land and low land use system. About 88.8% as interviewed the exotic plant species planted in farmer's home garden and on farm lands with out knowledge have affected soil fertility, water quality, animal's habit and decrease staple food plant of Enset. Example: eucalyptus trees. About 85.7 % the scientific research is the base for change and adoption of

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traditional agro-forestry practice. The modern practice of agro-forestry contributed for modification of traditional agro-forestry practice of planting trees. Modem agro-forestry involves many interdependent components including alley cropping, wind breaks, and silvapasture in any or all combinations and is concerned with bio-ecological production, that is, sustainable biological production based on protective land use practice. The modern agro-forestry practice brought adoption of traditional agro-forestry practice. The introduction of modern agro-forestry practice had its own challenges, to accept and adapt new technology for local farmers. It also contributed for economic development, environmental protection, social value, food supply and natural resource managements. As respondents stated nowadays the modern agro-forestry applier become wealther and wealther.

As it was observed in the field, the study areas have change on traditional agro-forestry practice and continuity of modern agro-forestry practice with planting exotic plant species for integrated land and water management (ILWM), better economic development, social value, and food supply. The modern practice of agro-forestry also assisted by Sustainable Land Management Project (SLMP) especially in Gozo shasho peasant association. The land use and land coverage practice by Sustainable Land Management Project (SLMP) also has changed the poor management system of farmers in integrated soil and water managements. Few farmers have got knowledge of practicing modern agro-forestry in sustaining soil and water resources. They used different method of soil and water conservation. Example : - Tse'abennoowater shed management.

3.4. *Plant Species Beta, Biodiversity, Land owner ship and Role of traditional agro-forestry*

3.4.1. *Plant Species Biodiversity*

In total, 108 plant species were recorded from 45plot of land of home garden across the three agro-ecological zones with help of systematic sampling. Among them 43.5 % species were recorded from Eyesus peasant association, 3633.3 % were from the Gozo shasho peasant association and 23.2% were from the Tarcha zuria peasant association respectively. The three agro-ecological zones plant species diversity was calculated by the index of Shannon, Simpson and Sorenson coefficient of similarity. The mean value of Shannon index is 1. The mean value of 1 indicated the complete evenness of plant species diversity. Also the mean value of Simpson index is 0.35. This indicated the highest abundant and the evenness of the plant species in study area. Finally the Sorenson coefficient of similarity is 38.8%.

3.4.2. *Beta Diversity*

As recorded the plant species in three agro-ecology of the study area were no more difference of pant species. There were little difference of plant species in three agro-ecology. The beta diversity of Gozo shasho and Tarcha zuria kebeles were 11.

3.4.3. *Land ownership*

The 95% of the respondent had owned land from their elders (inherited from their family) and the rest 5% had got from government by contract. As respondents stated from three agro-ecological zones, the land in hectar are unequal distribution from house heads to house heads. The farmers had got land from their families in hectar were very small size than others. The recorded house holds land in hectar were 0-1h (55.7%), 1.5 -3h (34.3%), 4-6h (7.9%) and above 6 h (2.1%).

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3.4.4. *Roles of Traditional Agro-forestery System*

3.4.4.1. *Soil Fertility*

As respondent were identified among all plant species about 38.3%, 38.9% and 44% plant species have maintaining soil fertility by mulching in Eyesus, Gozo shasho and Tarcha zuria peasant association respectively. As identified the most common tree species in keeping soil fertility traditionally with help of mulching trees were *Enset ventricosum 32.1%, Ficussur 17.8%, Acacia abyssinica 8.6%, Cordiaafricana 14.3%, Miletti ferruguinia 9.3%, Arundinaria alpine 7.9%* and *Erythrinabrucei 10%.*

Table 4.10: Soil fertility keeping plants in different agro-ecology zone in study area

3.4.4.2. *Livelihood Improvement*

The respondent were mentioned across all agro-ecological zones of the study area, mixed farming system incorporating perennial, annual, fruit, root and vegetable crop cultivation, trees and animal-rearing is the major sources of household livelihood. On the other hand the households generate their cash income from sales of trees and fruit products in combination with crop cultivation in all agro-ecological zones. The traditional agro-forestry provides farmers to produce timber, log, charcoal and honey for market.

In the study area some of plant species are used for food, source of cash, medical value environmental value and cultural value. Examples *Enset ventrcosum, Muzaparadisica, Caricapapaya, Mangoferaindinica, Mulussylvestris, Brassicaoleracea, Prunuspersica, Persia americana, Saccharum officinarum, Citrus medica* and *Citrus synensis* are used for food, medical value and cash generation. The rest are used for shade, house construction, fencing, alchol fermentation and source of revenue. The dominant cash generating tree species in dega agro-ecology are *Enset ventricosum* (27%), *Arundinaria alpine* (15.9%), *Juniperus procera* (12.7%), *Eucalyptus* (20.6%), *Ficussur* (14.3%) and *Grevillea robusta* (9.5%). The dominant cash generating tree species in woyinadega and kola agro-ecology are *Mangiferaindica (18.2%), Cordia Africana (13%), Musaparadisica* (26%), *Arundodonox* (11.7%), *Coffeaarabica (14.3%)* and *Persea americana (16.8%).*

3.4.4.3. *Medicinal Value*

As respondents were stated in dega agro-ecology the medicinal tree species for treatment of human, cattle and domestic animal illness were *Pipercapenselif* 14.3%, *Croton macrostachyus* 9.5%, *Hajenaabssinica* 14.3%, *Enset ventricosum* 11.1%, *Milettiaferruguinia* 9.5%, *Rhamanusprynojes* 9.5%, *Pentasschimperiana* 8%, *Euphorbia candelabrum* 4.8%, *Eucalyptus* 12.7% and *Vernonia amygdalina* 6.3%. *About* 18% *of Moringastenoptela,* 26% *of Citrus aurantifolia,* 21% *of Coffee arabica,* 22% *of Carca papaya and* 13% *of Syzygium guineens* medicinal tree species were known in Woyinadega (Gozoshasho Kebele) and Kola agro-ecology (Tarcha Zuria Kebele). The traditional healers practice using the same tree species for treating different diseases of human and the domestic animals. The traditional healers in the area developed indigenous knowledge to treat different types of diseases using different types of tree species. Dried plants are kept in the house or in the pocket for immediate usage of accidental illiness similar to the study to Loma and Gena Bosa District (29). The medicinal trees are cultivated in home gardens. The same tree species used for treating different diseases of human and the domestic animal.

3.4.4.4. *Environmental Value*

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About 98% interviewed result indicated that the biodiversity in traditional agro-forestry systems are typically grow with two or more interacting plant species in study area. It creates a more complex habitat that can support a wider variety of birds, insects, and other animals. Different plant species have assisted the ecological and environmental value in study area.

The biodiversity of plant species in home garden and on farm-land have contributed to food security by restoring the soil fertility for food crops, cleaner water through reduced nutrient and soil, moderate global warming and the risk of hunger by increasing the number of drought-resistant plant (Enset *ventrcosum* plant locally), the subsequent production of fruits (*Musa paradisica, Mangiferaindica, Perseaamericana, Persikavuljaris, Caricapapaya, and Citrus auantifolia*), reducing deforestation, reducing the toxic chemicals (insecticides and herbicides), Carbon sequestration, aesthetics value, maintenance of wildlife habitat, adapt to the impacts of climate change, reduce erosion, nonpoint source pollution and damage due to flooding.

The plants such as *Acacia abyssinica, Vernonia amygdalina* and *Ficus sycomorus* are used for different purposes such as for shading, social and political meeting. In addition to all the above mentioned values the traditional believers of Gamonttoo, Awayonttoo, Ashelonttoo, Madadawu and etc are used directly the plant species such as *Podocarpus falcatus, Vernonia amygdalina* and *prunus africana* for traditional believes.

3.5. *Challenges and Opportunities in Managing Traditional Agro-forestry*

3.5.1. *Challenges in Managing Traditional Agro-forestry Practices*

As respondents stated the most common threatening challenges in study area is shortage of land. About 55.7% of the householders in three kebeles reported each households owned 0.5 to 1 hectares of land. This is mainly due to high population pressure. The growth of population and land holding systems are inversely related each other especially in dega agro-ecology of Eyesuskebele. The farmers expressed their worries over the increased unemployed male youths are claiming to share their fathers' land holding. Such an activity contributed for fragmenting the land holding size per household. Also well educated Youths cannot easily get job opportunity and they compelled to claim share of their father's land holding.

As 15.7% of the respondents stated, unproper land use has the great role of degrading rate of home garden, on-farm and woody trees. As result, soil erosion, mass movement and flooding hazards are increasing. Also the severity of seasonal drought problems increases from the higher to the lower altitudes. Such activities assisted for reduction of production in study areas. As 10.7% of the respondents stated bacterial wilt (locally woli*'uwa)* is the major problem of *enset and* banana *plants* disease in study area. The disease is caused by xanthomonas campestris and musacearum. It transmitted by infected knife used during cultivating and harvesting time. They attack at any stage of development. Moreover, mole rate and domestic animals attack corm and pseudostem plant species. The disease dries the whole plant and reduces fruit productivity in all agro-ecology. About 80%as interviewed coffee and mango trees are attacked by *kollera* disease. The disease sheds the coffee berry and mango before ripe. The remain 20% as interviewed that the insufficient rain at flowering season and too much rains shed the bloomed. Also the mango tree leaves are too thick and cannot be decomposed easily. As 4.3% of the respondents stated, the unmatured tree (nursery type) eaten by appes and domestic animals (caw, ox, goat and ship). Example : - bamboo, enset and banana. About 11.4%of the respondents as stated climate change have affected the production of crops on time and sever drough in local area.5.7% of the respondents as stated the

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multi-species tree of upper canopy in home garden and on farm land were claimed the reduction of productivity potential of the lower canopy trees and protect the incoming of solar radiation. As 14.3% of the respondents stated, the low educational status of the farmers were planted eucalyptus tree species with out scientific research were affected the soil fertility and neighbor's boundary farm in three agro-ecology of the study area. Finally 9.3% of the respondents stated that the lack of awareness affect the socio-economic development of community in study area. The local farmers were not interested to accept the modern technologies which add soil fertility. The local farmers need were only depened on nature and traditional practice.

3.5.2. *Opportunities in Managing Traditional Agro-forestry Practices*

About 8.6% of the respondents stated that, the various indigenous knowledge is preventing the bacterial wilt. Farmers have indigenous knowledge to protect the spread of the enset disease through removing infected enset from others, setting fire inside enset plant farm and planting Godere *(Collocasia esculenta)* and locally Olomuwa (Pycnostachys abyssinica) inside enset farm, fencing and controlling mole rat. More over farmers are control the banana bacteria wilt disease (woli'uwa) by cut and burn the infected plant to prevent and reduce the spread of the disease. Some of the indigenous practices to resist *kollera* disease of coffee plants are removing the infected plant, burn it and selecting clones that resist the disease.

About 15% of the respondents as stated sustainability of soil fertility were practiced by planting soil fertility increasing trees in home garden and on farm trees. The mulched tree brunches are assisting to add soil fertility. Example :- Enset *ventrcosum, Vernonia amygdalina, Cordia africana, Musa paradisica, Ficussur and etc.* Decomposing domestic animals waste materials in home garden, crop rotation and fallowing the land at least for two or three years for soil fertility agrees with the study for Loma and Gena Bosa Districts in the zone [26]. This About 10.7% of the respondents as stated the green economy is the base for control of climate change. Mitigation, adoption and carbon sequestration can assist to control the climate change.

The respondents as stated 12.9% of the environment rehabilitation, 17.8% of restoring degraded soil and 19.3% Protecting soil erosion with help of contour ploughing, terracing, mulching, intercropping and building cheekdam. About 5.7% of the respondents as stated the dense ever green trees in home garden and farm land are attract the local people to visit local area. Finally 10% of the respondents as stated implementing policy and strategy have assisted for few farmers in economic growth, changing the negative attitude of modern technology and encouraging indigenous knowledge of traditional agro-forestry in sustaining land management. The farmers in dega agro-ecology protects bamboo tree from appes and domesticated animals by keeping, fencing and cutting free from cegena locally.

3.6. *Policy on Natural Resource and the Environment*

About 88.8% as interviewed the low implementing of strategic plan and a macro economic policy affected the socio-economic development of local farmers in study area. The local farmers were not interested to accept the modern technologies which add soil fertility. The local farmers need were only depended on nature and traditional practice. Few local farmers had mentioned the various problems in discussion. Environmental sustainability was the co-operative work of government and local farmers. Farmers as mentioned lack of on time distribution of seedling, DAP and UREA were affected the traditional agro-forestry production progress.

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IV. SUMMARY, CONCLUSION AND RECOMMENDATIONS

4.1. *Summary*

The results of the study revealed that there are diverse traditional agro-forestry practices in Maraka District, Dawuro Zone. The three agro-ecological areas are rich in both home garden and on farm plant species diversity. In three agro-ecology (dega, wayinadega and kola), there were no significant variations of plant species. Shannon diversity index of three agro-ecological zones mean value indicated 1.0. This showed as complete an evenness of plant diversity in study area. Similarly Simpson indicated 0.34 which shows an evenness of plant diversity. Also 38.8% similarities of plant species in different agro-ecology were calculated by Soreson Coffecient of similarity. This showed as the richness of plant species in three agro-ecology of the study area. The mean difference of beta diversity index did not showed significant difference of plant species. Traditional agro-forestry provided food, cash generate, medicine, keep soil fertility, cultural asset, moderate environment and construction. The medicinal plants planted in the study area are more for treatment of human, cattle and other domestic animals.

The most common threatening challenges in study area are land-use systems because of the shortage of landholding for house holders. 55.7 % of the households in three peasant association were owned 0.5 to 1 hactar of land. This is caused by growing of high population density. The degradation rate of on-farm and woody trees has rise from time to time with out replacement. As a result, soil erosion, mass movement and flooding hazards are increasing. Also the severity of seasonal drought problems increases from the higher to the lower altitudes. Such activities assisted for reduction of production in study areas. The bacterial wilt (locally woli*'uwa) and kolera* are the major plants disease in study area. The opportunity for the raised problems are implementation of good governance, policy and strategic plane, the mitigation and adoption of climate change, preventing the common plants bacterial wilt (locally woli*'uwa) and kolera* disease with the help of indigenous knowledge.

4.2. *Conclusions*

The three agro-ecology of traditional agro-forestry practice were selected lack of adequate funds and wide area coverage was difficult to gather data from all kebele. The concurrent triangulation research design was used. 140 respondent from the total sample size of 908 households were selected from three agro-ecological zones by using Cochran method. The species diversity richness and similarity of home garden plant species in three agro-ecology were measured by induces. The traditional agro-forestry system were classified in to three sub-systems by using structural, ecologic and economic bases. Traditional agro-forestry provided food, cash generate medicine, keep soil fertility, cultural asset, moderate environment and construction. Challenges and opportunities of traditional agro-forestry practice were assessed.

4.3. *Recommendations*

- Promote the indigenous tree species which are sustaining the soil fertility with help of mulching the leaves of enset *ventrcosum, Milettia ferruginea and Ficus sur*.
- Promote the local medicinal trees such as *Pipercapense, Croton macrostachyus, Haejenaabssinica, Enset ventricosum, Milettiaferruguinia, Rhamanusprynojes, Pentas schimperiana, Euphorbia candelabrum, Eucalyptus globules,Vernonia amygdalina, Carca papaya, Moringa stenoptela, Syzygium guineense, Citrus*

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aurantifolia and Coffeearabica.

- Providing opportunities for challenges of traditional agro-forestry such as restoring degraded soil, environment rehabilitation, reduce upper canopy trees, use indigenous knowledge and controlling climate change.
- Encouraging modern agro-forestry such as alley cropping, silvapasture, wind break and forest farming to manage land
- Promoting the economic value of exotic trees like *persea americana, Mangifera indica and Malus sylvestris.*
- Promoting trees such as *Acacia abyssinica*, *Vernonia amygdalina* and *Fucus sycomorus* which are used for shading, social and political shade meeting and for other multipurpose.
- Increasing the conservation and production of drought and disease resisting variety tree of *enset ventrcosum* in three agro-ecology.
- Creating awareness of preventing Enset and Banana wilt disease such as protecting infected tress by cutting sharp materials, removing the infected from uninfected trees and burning the infected trees.
- Promoting the livelihood improving tree those are used for fencing, construction and etc.
- Create awareness of the sustainable utilization and management of land resource by fallowing, terracing, intercropping, mulching and building cheekdam.
- Create awareness for low implementing of strategic plan and a macro economic policy of local farmers.

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