



Review Article

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# Review of Opportunities, Challenges and Future Directions of Forestry Development



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## Abstract

This review paper basically focused on two main themes: firstly, to identify potential opportunities of forestry development and conservation in Ethiopia, secondly to identify major challenges and suggests future directions for better forestry development and conservation practice Ethiopia. Ethiopia hosts one of the richest flora resources in tropical Africa. Forest contributes to the livelihoods of millions of people in Ethiopia through provision of a great variety of timber and non-timber forest products. Moreover, it is a source of biodiversity with wide ecological values mainly as a major carbon sink regulating climate change, control erosion, maintain soil fertility, and reduce risk of natural disasters like flood and land slide. Despite the facts that forests, and trees have immeasurable values to human kind and to the environments where human beings are living, the rich forest biological resource and area coverage are highly depleting through time. Deforestation and forest degradation, overgrazing, an ever-increasing demand for forest products, forest fire and conversion of forest to farmland, etc are becoming the main challenges threatening forest development and conservation efforts in Ethiopia. These challenges in turn results in other serious ecological consequences like loss of biodiversity, soil erosion, loss of soil fertility, food insecurity and poverty. This leads to instability of ecosystem and reduced availability of various forest products and services. In other words, these challenges make the agriculture sector more challenging since the agricultural sector, which forms the backbone of the economy, is primarily dependent on forest resources. However, to overcome these challenges, and improve the forest cover in Ethiopia, there are several potential opportunities including the existence of forest policy and strategies, afforestation and reforestation programs, best enclosure practices, agroforestry practices, the presence of large land size and diversified agro-ecology as well as potentially available indigenous and exotic tree species. Therefore, efforts should be made to address the existing challenges and apply those potentials opportunities entirely so as to develop and conserve the forest resources sustainably in Ethiopia.

**Keywords:** Challenges, Conservation, Deforestation, Forest, Opportunities, Forest products

## Introduction

### Definition and Basic Concepts of Forest and Forestry

The term “forest” has many definitions in different part of the world. The definition of forest is still ambiguous [1]. However, when one contemplates about “the definition of forest”, there is one definition viewed as more official and universal, to which many national governments, institutions and other bodies and organizations adhere. This is the definition of forest developed by FAO, the Food and Agriculture Organization of the United Nations. The definition of forest should take in to account a range of important country specific value among which minimum area, crown cover and tree height are the commonest one. According to FAO [2] forest is a minimum land area of 0.05-1 ha with tree crown cover more than 10-30% and tree height of 2-5m at maturity. FAO [3] defined forest as “Land spanning more than 0.5 hectares with trees higher than 5 meters height and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ”.

It does not include land that is predominantly under agricultural or urban land use. According to FAO [4] young natural stands and all plantations established for forestry purposes which have yet to reach a crown density of 10 percent or tree height of 5m are included under forest, as are areas normally forming part of the forest area which are temporarily un stocked as a result of human intervention or natural causes but which are expected to revert to forest. Forests are determined both by the presence of trees and the absence of other predominant land uses. The trees should be able to reach a minimum height of 5 m. In Ethiopia, forest is defined as land occupied with trees (natural and planted, including bamboo) attaining a height of more than 2 meters at maturity, canopy cover of more than 20% and covering an area of more than 0.5 ha, with a minimum width of 20 meters. Therefore, forest includes natural forests and forest plantations. The term includes forests used for purposes of production, protection, multiple-use or conservation (i.e. forest in national parks, nature reserves and other protected

areas), as well as forest stands on agricultural lands (e.g. windbreaks and shelterbelts of trees with a width of more than 20 m), and rubber wood plantations and cork oak stands. The term specifically excludes trees planted in agroforestry systems as well as stands of trees established primarily for agricultural production, for example fruit tree plantations. Forestry is the science of establishing, cultivating, and managing forests and their attendant resources [5]. According to the SAF net dictionary, forestry is defined as “the science, art, and practice of creating, managing, using, and conserving forests and associated resources for human benefit and managing in a sustainable manner to meet desired goals, needs, and values” [6]. The science of forestry is practiced in plantations and natural forest stands. Generally, the modern concept of forestry embraces a broad range of concerns, in what is termed as multiple-use management including the provision of timber, fuel wood, wildlife habitat, natural water quality management, recreation, landscape and community protection, employment, aesthetically good-looking landscapes, biodiversity management, watershed management, erosion control, and preserving forests as “sinks” for atmospheric carbon dioxide. A practitioner of forestry is known as a forester.

### The Purpose of the Review

The overall objective of this review paper is to compile information on forest resources of Ethiopia, with particular emphasis;

- a. To review the contribution of forest development to food security and poverty alleviation in Ethiopia.
- b. To review the potential opportunities of forestry development and conservation in Ethiopia.
- c. To review the challenges encountered towards forestry development and conservation in Ethiopia and thereby to indicate future direction for promoting sustainable forestry development in country.

#### The Contribution of Forest Development to Food Security and Poverty Alleviation in Ethiopia

Peoples in mountainous areas rely heavily on forest resources for their livelihood and welfare [7]. With more than 90 million inhabitants [8], living in rural areas Ethiopia is primarily an agrarian country. In Ethiopia, many rural communities have for centuries lived in and around vegetation areas and they make use of timber and non-timber forest products in their livelihoods [9]. Forest provides people with food, shelter, oxygen, recreation and timber and non-timber forest products. They are the source for more than 5,000 commercially-traded products [10]. The main contributions of forest development is that it provide various types of forest products that can make to the livelihoods of the rural poor though increasing incomes, improving food security, reducing vulnerability and enhancing well-being [11]. Forestry can play significant contribution in local and national economic development in an agrarian society like Ethiopia [12]. In fact, the contribution of forestry to Ethiopia GDP has been very low as a

proportion of the whole economy and in relation to agriculture. According to CSA [13], the mean contribution of the forestry sector to the national GDP over the last ten years (2002-2011) was 4.5%. Its contribution to the GDP has been gradually declining from 6.3% in 2002 to 3% in 2011. However, a separate estimate of the contribution of the forestry sector to the national GDP puts it at 9% [12]. The economic contributions of forest products and services are underestimated in the national economic accounts of the country [9]. Partially this is due to the data gap on the actual quantities and values of timber underestimation in the national accounts statistics. On the top of this, other indirect contributions of Non-timber products such as bamboo, wood fuel, construction wood, gums and incenses, thatch grass, wild coffee and medicinal plants, etc might have not been accounted properly. Furthermore, the contribution of forestry's to employment generation in Ethiopia is undocumented. The forestry sector can also provide quite a large employment opportunity, formal and informal, as well as environmental protection services that support other economic sectors, such as the agriculture, construction, tourism and energy sectors, to operate in a sustainable manner. Most forestry operations are undertaken in rural Ethiopia and a large number of laborers are required for forest nursery operations, afforestation, reforestation and for the construction and maintenance of roads. This is a major source of income for the rural people. People also profit from forestry employment through firewood, charcoal collection and sales, incense and gum collection [14]. Fuel wood production is by far the largest employment generator accounting for nearly 50% of the total forestry employment, followed by afforestation contributing for about 34%. Forest industry employment amounted to about 2.2 % of the total work force in the country and contributed 2.8 % to employment in the agricultural sector in 1988/1989 [14]. Local communities especially the youth are being benefited from production and sale of seedlings of certain forest species. In different regions of the country, many small holder farmers, youth, women and other private seed dealers/nursery operators are engaged forest germplasm business.

Studies conducted in many parts of Ethiopia indicates that forests have contributed about 27 % of total household annual income in part of Tigray, 39 % in central Shewa, 34 % in Bale area (Table 1). These studies demonstrated that contribution of forests to the day to day lives of rural people in Ethiopia is valuable and significant. Their role in food security and poverty reduction is increasingly recognized in some part of Ethiopia. According to the study of Mamo et al., [15], forest income was more important than all other income sources combined for the poorest 40% of households and contributed more income than agriculture for 65% of the surveyed households. This forest income also reduced income inequality by 21%, thus, has an important income equalizing effect among rural households. Similar roles of forests in poverty reduction have been reported from wider geographical regions across the country such as southwest, eastern parts and central Ethiopia.

**Table 1:** Summary of studies on the contribution of forest to the total household annual income of rural people in Ethiopia.

| Study location                  | Author/s              | Contribution of major livelihood activity in Ethiopia in % |      |           |                  |          | Remark                               |
|---------------------------------|-----------------------|--|------|-----------|------------------|----------|--------------------------------------|
|                                 |                       | Forest   | Crop | Livestock | Env'tal products | Non-farm |                                      |
| Tigray (Northern Ethiopia)      | Babulo et al., [16]   | 27   | 43   | 16        | -                | -        | 40% Livestock & crop combined income |
| Central Shewa                   | Mamo et al., [15]     | 39   | -    | -         | -                | -        |                                      |
| Bale (Southern Ethiopia)        | Tesfaye et. al., [17] | 34   | 26   | 30        | 6                | 4        |                                      |
| Bonga (south western Ethiopia)  | Tsegaye et. al., [18] | 33   | 30.9 | 13.5      | -                | -        |                                      |
| Hammer (South eastern Ethiopia) | Dagim et al., [19]    | 21.4   | 15.7 | 59.7      | -                | 3.2      |                                      |

In Ethiopia the contribution of forests to local livelihoods and the national economy as a whole is significant but is largely unrecorded and hence unrecognized [20]. Forest play indispensable role in the conservation of an environment which in turn facilitates sustainable development. Forest resources of Ethiopia can serve for economic, ecological and social purposes. Their biodiversity plays a vital and diverse role to ensure food security, and sustainable livelihoods for millions of households throughout Ethiopia. Ecosystem services provided by the forest biodiversity include provisioning, regulating, supporting and cultural services.

### Potential Opportunities of Forestry Development and Conservation in Ethiopia

In Ethiopia, there are several potential opportunities for better forestry development and conservation practice. These opportunities includes: Existence of forest policies and legislations (the development and promotion of CRGE; watershed protection; increasing demand for organic forest products; involvement of NGOs and donor support for in situ conservation of biodiversity), the presence of large land size and diversified types of agroecology (extensive area for forest development (identified and demarcated), best practice on area enclosure, afforestation/ reforestation program, the presence of potential plantation species, agroforestry practices, payments for environmental services such as carbon financing from REDD+; Participatory forest management are some of them. In order to minimize various forms of threats to vegetation cover, the country has been striving for different conservation strategies like, watershed management, afforestation, and reforestation, restoration, and rehabilitation programs. These practices were found crucial to achieve better vegetation cover and contribute to improve livelihoods of local people [21].

### Existence of conducive national and international forest policies in Ethiopia

Over the last two decades, the Ethiopian government has put in place a number of policies, strategies and laws that

are designed to support sustainable development [22]. More specifically, Ethiopia has policies and strategies that support the development and utilization of forest resources in a sustainable manner. The following list provides the policies, strategies and legal instruments that are closely related to the forest genetic resources conservation and sustainable utilization: National forest policy, National Forestry Law (Act), National Environment Law (Act) [23]; Forest Development, Conservation and Utilization Policy (2007), Forest Development, Conservation and Utilization Proclamation No 542/2007, Environment Policy of Ethiopia (April 1997). The policies are reflected under various sectors including environmental protection, development of the natural resources and diversification of the domestic and export commodities. Moreover, Ethiopia is signatory to a number of multilateral agreements that have bearing on the sustainable development efforts of the country. Some of the signed and/or ratified international conventions and protocols includes: The United Nations Framework Convention on Climate Change (UNFCCC) (1994), The Convention on Biological Diversity (1994), The United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, particularly in Africa (known as the Desertification Convention -adopted in 1994), The Cartagena Protocol on Bio-safety to the Convention on Biological Diversity (known as the Bio-safety Protocol – adopted in 2000) [22].The country also has developed policy and a guide line for intellectual property rights protection of traditional medicine. These policies encourage and promote the appropriate use and protections of forest resources in Ethiopia taking in to account its potential benefit to the communities and the country at large. A wide variety of policy statements and legislative and regulatory measures have been established to protect forests in the country but need to be effectively enforced. The Government of Ethiopia launched a Climate Resilient and Green Economy Strategy (CRGE Strategy) in 2011 with the goal of achieving middle-income status for the country by 2025 while following a carbon-neutral growth path [24]. The CRGE strategy focuses on four pillars that will support Ethiopia’s developing green economy. Among them, increased GHG sequestration

in forestry, i.e., protecting and re-establishing forests for their economic and ecosystem services including carbon stocks is the one (REDD+ implementation) [25]. Furthermore, some regional governments made efforts to make forestry as a viable economic sector. For instance, the Oromia regional state and the Amhara regional state have established forest enterprises in 2007 and 2011 respectively. Besides, two UNESCO Biosphere Reserves have been established in 2010: the Yayu Coffee Forest Biosphere Reserve in Oromia [26] and the Kafa Biosphere Reserve in SNNP regional state [26]. These biosphere reserves represent the montane forest areas in southwestern Ethiopia. In addition, Sheka (2012), Lake Tana (2015) and Majang (2017) are others recently established biosphere reserves [28]. Therefore, all these efforts will contribute significantly in satisfying the demand for forest products, protecting and conserving forest genetic resources in general and forest resources in particular, and reducing soil erosion and protecting soil fertility thereby increasing agricultural production as well as sustainable development in the country.

### **The Presence of large land size and diversified types of agro-ecology in Ethiopia**

Ethiopia is located in the horn of Africa between 3° and 15° N latitude, 33° and 48° E longitude [29] and covers approximately 1.12 million km<sup>2</sup> (472,000 square miles) land surface area with variety of climate, topography and vegetation supports high endemic flora and fauna of the country that enables to attract regional and global tourists [30]. In land area it is the ninth largest country in Africa. Ethiopia is a country with different landscapes and one of the countries with the widest cultural diversities in eastern Africa [31]. The country has a diverse ecological altitude ranging from the desert of the Dankil Depression (the lowest dry land points on earth at 116 m below sea level) to Ras Dashen Mountain (the second peak and roof of Africa) at 4543 m above sea level [32]. These diversified topographic features made the country to be covered by the richest forest cover in tropical Africa [33]. Moreover, Ethiopia is a tropical country with varied macro and micro-climatic conditions [34]. The influence of high altitudes modifies mean temperatures and leads to a more moderate Mediterranean type climate in the highlands. The country is broadly divided into three major climatic zones: Cool highlands (> 2300 masl); temperate highlands (1500-2300 masl) and hot lowlands (<1500 masl) The rainfall distribution is seasonal and governed by the inter-annual oscillation of the surface position of the Inter-Tropical Convergence Zone (ITCZ) that passes over Ethiopia twice in a year [34]. Mean annual rainfall patterns range from below 200 mm to above 2800 mm. with the South western region receiving the heaviest annual rainfall that goes above 2800 mm in some areas. The central and northern central regions receive moderate rainfall that declines towards northeast and eastern Ethiopia. The southeastern and northern regions receive an annual rainfall of about 700 mm and 500 mm, respectively. This diversified topography, geology, terrain and variation in climatic conditions make the country an important center of diversity

and endemism [35]. Ethiopia holds one of the largest and most diverse plant genetic and wildlife resources in the world owing to the extreme diversities in climate, terrain, soil, topography etc. and comprising most ecological systems. Due to its large land size and diverse topography and agro-ecological zones, the country is comprised of various natural and man-made vegetation types that fulfill the definition of forest. The richness and endemism of the floral biodiversity have been reported by many researchers [36]. Mainly due to Ethiopia's diverse forest ecosystems, the country is one of the top 25 biodiversity-rich countries in the world [37] and hosts two of the world's 34 biodiversity hotspots, namely the Eastern Afromontane and the Horn of Africa hotspots [38]. A significant amount of forest resources with high biodiversity and tourism importance are designated as protected areas. It is also among the countries in the Horn of Africa viewed as major center of diversity and endemism for several plant species. According to EARO [39] the flora of Ethiopia comprises about 6500-7000 species of higher plants out of which 12% are endemic. Another author also estimated to possess about 6000 species of higher plants, of which about 10% are considered endemic [40,41]. Woody plants constitute about 1100 species [35], out of these more than 300 are trees. Historical sources indicate that, on the basis of potential climatic climax, high forests might once have covered some 35% of Ethiopia's land area. If the savanna woodland is included, two-thirds of the country was probably forest or woodland. Currently, about 12 major natural vegetation types have been identified in the country [42].

### **Best practices on area Enclosure**

The idea of area enclosure involves a protection system and exclusion of the degrading agents to allow the lands to restore itself through natural self-repairing process. Thus, area enclosures can be defined as degraded lands that have been excluded from human and livestock interference for rehabilitation [43,44]. Among the various rehabilitation techniques used, the predominant is probably area enclosure [45]. Degraded lands that almost lost their production potentials are set aside for nature-based rehabilitation. These areas, if properly managed and rehabilitated through enclosure system, allow native vegetation to regenerate [46]. Different studies revealed that establishing enclosures has emerged as a promising practice in different parts of Ethiopia. There is strong argument that Tigray region has become greener in the last few decades through area closure, soil and water conservation and tree planting activities. Successful rehabilitation and restoration activities have been also conducted in Amhara, SNNP and Oromia regions. Ecological restoration of degraded habitats is regarded as an effective response to check and reverse the negative effects of habitat loss, degradation, and fragmentation on native biological diversity and ecological processes [47]. Restoration of degraded lands reduces the loss of biodiversity. Biodiversity, which plays a critical role in overall sustainable development and poverty eradication, is essential to the human well-being and to the livelihood and cultural integrity

of people. Among the various way of overcoming environmental degradation, loss of biodiversity and deforestation problems in Ethiopia, enclosure is the most crucial and determinant measure [48]. This practice has also become very common and an important strategy for the rehabilitation of degraded areas, especially in the highlands, due to the remarkable improvement of productivity and reduction in soil erosion [49]. Studies in different part of Ethiopia indicate the presence of higher species richness of woody plants in enclosures than adjacent open areas. At Biyo-kelala, about 58 woody species were recorded inside enclosed areas as compared to only 25 recorded in an adjacent open area; at Tiya

31 species are recorded in the enclosure compared to 15 species in the open area (Table 2). Similar roles of enclosure practices have been reported from wider geographical regions in Ethiopia. This indicates that enclosures can play a paramount role for the recovery of native woody species and can change the vegetation coverage of degraded areas in a relatively short period of time. In general the higher species richness, density and diversity value in the enclosures rather than in the open area, indicate the potential of enclosures for the recovery of woody species within a short period time of protection [50,51].

**Table 2:** Summary of studies on the contribution of area enclosure practices in restoring woody vegetation compared to adjacent open areas in Ethiopia.

| Study location                       | Author/s            | Enclosure | Adjacent open area |         |          |
|--------------------------------------|---------------------|-----------|--------------------|---------|----------|
|                                      |                     | Species   | Families           | Species | Families |
| Gondar zuria, North western Ethiopia | Melkie [51]         | 43        | 24                 | 22      | 14       |
| Biyo-kelala in Central Ethiopia      | Tefera et al., [52] | 58        | 30                 | 25      | -        |
| Tiya in Northern Ethiopia            | Tefera et al., [52] | 31        | 19                 | 15      | -        |
| Aynalem, North eastern Ethiopia      | Emiru et al., [53]  | 27        | 18                 | 14      | 12       |
| Kallu, South Wello                   | Kibret [50]         | 47        | 26                 | 37      | 21       |

### The presence of potential species

Since the 1970s, Ethiopia has been implementing large scale plantation programs aimed at meeting the ever-increasing demand for industrial wood and other forest products. Moreover, Ethiopian farmers in the different agro ecological zones has been planted and continued to plant different tree/shrub species for various purposes such as fuel wood, transmission poles for income generation, construction material and for their own use [54]. As a result, fast growing exotic species were introduced mainly for plantation development and as a means for restoring the long-lasting deforestation of natural forests of the country [55]. There are huge gaps between the demand and supply of wood in Ethiopia as a result of ever-increasing human population, accelerating deforestation. In order to feel the present gap of demand for fuel wood and construction materials, plantation forest development is the only way to overcome deforestation and secure sustainable utilization [56]. In Ethiopia, there are a number of potential indigenous and exotic tree species and seed inputs that are suitable for the different agro-ecological zones. These species can satisfy the ever-increasing demands of forest and forest related products in the country. Ethiopia has one of the longest forest plantation histories in Africa. Forest plantations in Ethiopia are mainly monocultures of exotic species, such as *Eucalyptus globulus*, *Eucalyptus camaldulensis*, *Eucalyptus citrodera*, *Eucalyptus saligna*, *Eucalyptus tereticornis*, *Eucalyptus grandis*, *Cupressus lusitanica*, *Casuarina cunninghamiana*, *Pinus patula*, *Pinus radiata*, etc and the native species *Juniperus procera*. According to [57] excluding small scale tree plantations by local people, planted forests in Ethiopia are estimated to cover around 230,000 ha. These plantations are

mainly composed of the two exotic species such as *Eucalyptus species* (59.3% of industrially planted area) and *Cupressus lusitanica* (20.6%), followed by the indigenous *Juniperus procera* (5.7%). However, according to other source WBISPP [58] *Eucalyptus species* (58%) and *Cupressus* (29%) are dominant plantation species in Ethiopia. Other species include *Juniperus procera* (4%), *Pinus species* 2% and others 7 %. According to the same source today, tree plantation covers approximately 500,000 ha; out of which 133,041 ha were established as community plantation between 1978 and 1989. Among the exotic tree species *Eucalyptus* is more dominant. There are about different available species of *Eucalyptus* in Ethiopia, most of which are widely spread in many regions of the country, mainly in central highlands where there are higher population density. Planting *Eucalyptus* has been expanding from state owned forestry enterprises and projects to community woodlots, household and farm field boundaries [59]. *Eucalyptus globulus* dominates the Ethiopian afforestation and reforestation programs connected with ever increasing demand for construction, fuel wood and industrial wood production purposes. Nowadays, *Eucalyptus* plots and stands are seen all over of the Ethiopian highlands covering the range of highly sloppy and degraded areas. *Eucalyptus* tree should not be considered as ecologically hazardous species against other plants as far as proper site selection and management strategies are put in place [60].

Some research findings revealed that an increase in forest cover in *Eucalyptus* growing areas that could contribute for a slow but increasing forest covers [61]. Therefore, the use of fast-growing plantation species such as the *Eucalyptus* is foreseeable as they are

preferred to other species, because of their fast growth and useful products [62]. Many exotic species like *Eucalyptus* species have been introduced in Ethiopia for satisfying the growing demand of wood for fuel, construction material and to reduce the pressure on the remaining natural vegetation [63].

### Afforestation and reforestation programs

There is a growing recognition that deforestation and forest degradation should be reduced. In response to deforestation and ever-increasing demands for forest products afforestation/reforestation program began in Ethiopia over a century ago. During the PASDP implementation (2004/05-2009/10) alone, the forest cover of the country increased from 4.1 million ha (3.56%) to 8.8 million ha (6.0865) of the total area [64]. The Climate Resilience Green Economy strategy in Ethiopia focuses on four pillars that will support Ethiopia's developing green economy [22]. Among these, the Government of Ethiopia identified the forestry sector as one of the pillars of the green economy. This pillar basically focused on increased GHG sequestration in forestry, i.e., protecting and re-establishing forests for their economic and ecosystem services including carbon stocks. According to [25] in Mulugeta and Habtemariam [65] the government also set the following major targets for the forestry sector: afforestation on 2 million ha, reforestation on 1 million ha and improved management of 3 million ha of natural forests and woodlands. Through proper management of 5 million ha of forests and woodlands, Ethiopia hopes to achieve 50% of its total domestic greenhouse gas (GHG) emissions abatement potential by 2030. Ethiopia since 2007 undertakes massive tree-planting campaigns in different regions of the country. Most of the tree planting campaign was made in connection with the celebration of its unique Millennium in 2008. According [66] in Ethiopia, the four regions i.e. Oromia, SNNP, Amhara and Tigray claims planting in total close to 2.21 billion seedlings in 2009. The four regions had planned to plant over 7 billion seedlings in 2010 [67]. Recently, Greening Ethiopia Initiative plants 200 million seedlings on a single day, the nationwide reforestation program, also popularly known as green legacy, is aimed at recovering the trees and forests that have been lost over the years [65]. On the other hand, afforestation/reforestation activities through small-scale plantations are re-greening practices initiated and run by farmers themselves. Small-scale plantations mainly on degraded lands have become important particularly since the mid-1990s, while industrial plantations are still project-based state initiatives. The government continues to encourage industrial and peri-urban plantations to meet national industrial, construction and fuel wood demands. Small-scale plantations have expanded, especially since the 1970s when the number of farming households planting trees began increasing significantly [68]. A limited number of species from four genera (*Eucalyptus*, *Cupressus*, *Pinus* and *Acacia*) account for the majority of plantation forests in Ethiopia. *Eucalyptus*, in particular, covers more than 90% of the total planted forest area in Ethiopia [69].

Typical biological attributes that attract farmers to *Eucalyptus* include fast growth, coppicing ability, ease of management (such as non-palatability to cattle), established market demand for its wood, its ability to grow well even on degraded landscapes and its better growth performance than most indigenous tree species [70].

### Agroforestry practices

Agroforestry is not a new concept in Ethiopia. It is an age-old practice whereby farmers maintain trees in croplands [71]. The most common agroforestry practices in Ethiopia includes home gardens, parkland agroforestry (scattered trees on the farm land), hedgerow intercropping, woodlots, farm boundary practices, trees on grazing lands, riparian zone vegetation, enclosures and natural regeneration of species in woodlands and pasture, live fence and road side plantation, etc [72]. A common characteristic feature of all forms of agroforestry is that a tree component is deliberately grown or retained in an agricultural setting [73]. Population pressure, environmental degradation, particularly loss of biodiversity, calls urgently for conservation, or planting of the right tree species at the right place for the appropriate purpose [74], along with management of remnant tree resources in the form of on-farm trees, other forms of agroforestry trees in rangelands and the like [75]. Agroforestry practices have evolved overtime in the world, capturing a lot of international attention as a viable alternative to many traditional land use systems [76]. In these traditional land-management practices, trees are deliberately retained on or around farmland, to support agriculture and other livelihood systems [74]. There is enough evidence to indicate that trees and shrubs, if managed properly, can make significant contributions for maintaining biodiversity, improving fertility and overall productivity of soils in agro-ecosystems [77]. Despite the overall diminish in the extents of biodiversity of the natural forests in the highlands of Ethiopia; traditional tree managements in the form of agroforestry have given refuges for a considerable number of native woody species. It could be possible that these native tree/shrub species are still preserved as farmland tree resources and serve as major sources of biodiversity rehabilitation in the future. Parkland agroforestry (scattered on-farm tree system) is one of the most noticeable traditional practices across most agro-ecosystems in the highlands of Ethiopia. In these systems, farmers deliberately preserve several native tree/shrub species for a variety of purposes such as protection of crops and workers from the sun heat, for the supply of fodder, fuelwood or fruits and to improve soil fertility. For instance, floristic study made in the Sidama traditional agroforestry system showed the existence of more than 80 native woody species on and/or near farmlands [72]. Other study conducted by Biruk [78] on the diverse traditional agroforestry practices across different agro-ecological zones of southern eastern Ethiopia, have hosted a large number of indigenous (72 tree/shrub species) and exotic (16 trees/shrubs species) woody species (Table 3).

**Table 3:** Summary of studies on the total number of recorded woody species in traditional agroforestry system in Ethiopia.

| Study location                               | Type of AF  | Author/s              | Total woody species | Woody species |        | Average no. of species per farm |
|--|---|-----------------------|---------------------|---------------|--------|---------------------------------|
|  |   |                       |                     | Indigenous    | Exotic |                                 |
| South eastern Ethiopia (Langano)             | Combinations of home gardens, parkland, and live fences | Biruk [78]            | 88                  | 72            | 16     | 11                              |
| Southern Ethiopia, Sidama                    | homegarden  | Tesfaye et al., [79]  | 120                 | 99            | 21     | 21                              |
| Southe western Ethiopia, Midland Sidama zone | Enset-coffee based AF                                   | Abiot and Zenebe [80] | 32                  | 28            | 4      | -                               |
| Southern Ethiopia, Sidama                    | Homegarden  | Zebene [72]           | 87                  | -             | -      | 16                              |
| Southern Ethiopia, yem special district,     | d/nt AF practices                                       | Gezahegn et al., [81] | 100                 | 89            | 11     | 14                              |
| North western Ethiopia, Jabithenan           | Home garden AF  | Euketu et al., [82]   | 44                  | -             | -      | 7                               |
|  |   |                       |                     |               |        |                                 |
| South eastern rift vally                     | Enset-coffee based AF                                   | Negash et al., [83]   | 58                  | -             | -      | -                               |
|  |   |                       |                     |               |        |                                 |
| South western Ethiopia, Jimma                | -   | Buchura et al., [84]  | 60                  | -             | -      | -                               |
| South central, Ethiopia                      | Home garden   | Motuma et al., [85]   | 64                  | -             | -      | -                               |

**Table 4:** Forest area of Ethiopia (1990-2015).

| Country  | Land area (1000ha) | Forest area (1000ha) |       |       |       |       |
|----------|--------------------|----------------------|-------|-------|-------|-------|
|          |                    | 1990                 | 2000  | 2005  | 2010  | 2015  |
| Ethiopia | 109631             | 15114                | 13705 | 13000 | 12296 | 12499 |

As a form of reforestation, the human component is essential for the successful functioning of agroforestry systems. The majority of agroforestry in Ethiopia is carried out on agricultural land. In this sense agroforestry would be in addition to other reforestation efforts, greatly expanding the total area which could potentially be put into trees. The findings of these different studies certainly revealed that not only natural ecosystems but also human managed ecosystems can be used for conservation and sustainable utilization of biological diversity, especially floral diversity. In fact, the different traditional agroforestry systems vary in their potential to accommodate woody plant diversity (Table 3). Besides, it can also provide benefits in the form of direct output like wood, food, income and services watershed protection which enables people to secure stable and adequate food supply. Agroforestry permits the diversification of products and integration of trees in farms and rangelands that sustain production for augmented social, economic and environmental welfares [86], and thus play a significant role in solving deforestation and land degradation problems. The existing allocation of land to agriculture and forestry play significant role to meet the demand for food, timber, fuel, fodder, and other minor products [87].

### Challenges of Forestry Development and conservation in Ethiopia

Despite the potential opportunities, there are a number of challenges in development and conservation of forest resources in Ethiopia [88]. According to Ensermu *et al.*, [40] and Edwards [89] habitat and species are being lost rapidly as a result of the combined effects of environmental degradation, agricultural expansion, deforestation and over harvesting of species and this is further enhanced by human and livestock population increase thus hastening the overall rural livelihood impoverishment and loss of the biological diversity in Ethiopia. The decline of vegetation cover is one of the most serious challenges facing humankind today [90]. The forest resources in Ethiopia have been declining from time to time both in size as well as quality. These problems are challenging the forestry sub-sectors. Deforestation and forest degradation, livestock and free grazing system, forest fire, an increasing demand for wood and wood products, etc. appear to be the major challenges to forest development and conservation in Ethiopia that this review focused on it. Such challenges pose a significant threat to the future wellbeing of the human and animal

populations that have for generations, relied on these resources to combat various ailments.

### Deforestation and forest degradation

#### Forest degradation and its causes in Ethiopia

It is estimated that in Ethiopia, 40 percent of the land area was covered with forests at the beginning of the 19th century [91]. Despite the rich biodiversity resources and the potential benefits from biodiversity including forests, today's threats to species and ecosystems are the greatest recorded in recent history [92]. Ethiopia currently faces a number of environmental challenges. The forest resources in Ethiopia are depleting due to deforestation and forest degradation [93]. One of the major challenges facing Ethiopia in its struggle for agricultural development is environmental degradation, which is the process of progressive deterioration of biological (flora and fauna) and physical (soil, water, micro-climate, etc.) resources of the land, as well as loss of biodiversity [94]. Deforestation is the conversion of forest to an alternative permanent non-forested land use such as agriculture, grazing or urban development [95]. Deforestation is a primary concern for developing countries in the tropics as it is shrinking areas of the tropical forests [96] causing loss of biodiversity and enhancing the greenhouse effect [97]. Deforestation and conversion to permanent cultivation is the primary cause for declining tropical biodiversity in Ethiopia and the practice has already threatened a number of plant species, including the gene pool of wild populations of *Coffea arabica* L. [98]. The National Conservation Strategy of the Federal Democratic Republic of Ethiopia (FDRE) identifies deforestation as a major problem, not only in the forest sector, but also as it affects other sectors such as crops, animal husbandry, water resources, and wildlife habitat, as a result of which people are suffering from poverty and food insecurity. A significant deforestation rate (160,000 to 200,000 ha yr<sup>-1</sup>) in the country has resulted in shrinkage of high-forest cover from 16% in the 1950s to 2.7% in the early 1990s [99]. According to FAO [11], Ethiopia lost over two million hectares of forest, with an annual average loss of 140 000 hectares between 1990 and 2005.

Different studies show that land and forest degradation, often caused by deforestation, is a severe problem in Ethiopia. This degradation virtually are largely caused by directly or indirectly from human activities and mismanagement [92], aggravated by rapid population growth and the consequent increase in the need to exploit the natural resources unsustainably [100]. The forest degradation in Ethiopia is closely linked to the ongoing population growth. Biodiversity in Ethiopia is being negatively impacted by human activities [101]. It is estimated that 83% of endangered plant species loss is primary caused by human activities [102]. More people generally lead to an increasing demand on land for living and for agricultural production. Forests have become depleted at a large scale as a result of expansion of agriculture and settlement areas [14]. Population growth in highlands exerts great

pressure on the natural forests. As a result, northwestern highlands of Ethiopia have only fragments of natural forests scattered & confined to inaccessible and sacred places [103], which suggested that the highlands were once covered by high forests. With more than 90 million inhabitants, Ethiopia is the most populous nation in Eastern Africa and the second most populous country in all Africa after Nigeria [24] with 93% of the population living in rural areas and are mainly engaged in agriculture dependent on smallholder agriculture including livestock production as main economic activity. Only about 17% of Ethiopians live in urban centers and nearly half of these live in the capital, Addis Ababa. In Ethiopia, the majority of the tree plantings operations are not successful either due to technical and other constraints. Declining standard of livelihood or poverty of the farming communities and their close dependence on forests have led to clearing/burning of the forest resources for subsistent farming, cutting of trees/shrubs for fuel wood and charcoal production (both for consumption and sale). Similarly, increasing demand and rise in market value of forest products such as office and household furniture resulted in selective harvesting pressure on some forest trees particularly indigenous species such as *Cordia africana* and *Hagenia abyssinica*. Therefore, the impacts of human activities on forests have been significant, with average annual deforestation rates estimated at 85,000 ha per year [104]. The forest resources of Ethiopia's are increasingly under threat as the growing population requires more fuelwood and agricultural products, which leads to farmland expansion. Road, energy and water infrastructure construction is also accelerating deforestation and forest degradation in Ethiopia. Projections indicate that unless action is taken to change the traditional development path, an area of 9 million ha might be deforested between 2010 and 2030 [25]. Forests in general have reduced from covering 65% of the country and 90% of the highlands to 2.2% and 5.6% respectively [105]. Deforestation is major problem in Ethiopia as the people rely on biomass energy for cooking. However, large scale forest destruction at the national level is not the only change, rather major land cover changes have also occurred at the local level [106]. These local level changes play a pivotal role in affecting the health and existence of forest ecosystem [107].

#### Forest degradation and its consequences in Ethiopia

Deforestation takes place in both forests and farm woodlands and is recognized as the most severe environmental problem in Ethiopia [108]. Human interference, mainly for subsistence and economic reasons, is the most chronic force for the fast depletion and serious degradation of the forest resources in Ethiopia. Forest devastation in turn has brought adverse effects on land productivity, availability of wood products, biodiversity resources, and the tourism industry of the country [109]. The problems are causing bio-physical land resource degradation and hence hampering agricultural development in the country [45]. The problems of land degradation and low agricultural productivity in Ethiopia, resulting in food insecurity and rural

poverty, are particularly severe in the central highlands where the average soil loss from farmland was estimated to be 100 tons  $\text{ha}^{-1}\text{yr}^{-1}$  [43,106]. Moreover, deforestation coupled with improper crop production practice on the mountainous topography that dominates the highlands of Ethiopia is considered to be the root cause of the excessive soil erosion in the country [45]. In general, reduction in forest cover has number of consequences including soil erosion and reduced capacity for watershed protection with possible flooding, reduced capacity and loss of biodiversity [110]. This leads to instability of ecosystem and reduced availability of various forest products and services [111] as well as threat and decline in number and distribution of many plant species [112].

### Livestock and free grazing system

Agriculture is the foundation and dominant sector of Ethiopian economy accounting for 52% of the GDP [113], over 80% of the total export revenue, supplies around 73% of raw materials requirements of agro-based domestic industries [114] and employs about 85% of the labor force [115]. Livestock is the integral component of the agriculture on which 83% of the population depends [116]. Ethiopia has the largest livestock population in Africa with 52.1 million heads of cattle, 24.2 million sheep, 22.6 million goats and 44.9 million poultry [117,118]. In developing countries like Ethiopia, livestock play an important role in most small-scale farming systems. Majority of the rural people keep livestock as a means of livelihood or to use livestock as inputs for various activities. They provide draft power to cultivate fields, manure to maintain crop productivity, and nutritious food products for human consumption and income-generation including insurance against risks [119]. However there are many constraints in livestock production in Ethiopia. Among constraints of livestock production, inadequate livestock nutrition is a major factor affecting the development of viable livestock industries [119]. Livestock production in the tropics (including Ethiopia) is mainly sustained on free grazing as a major feed source [120]. 75% livestock population is concentrated and grazes in the highlands. The remaining 25% graze in the rangelands. Livestock feed sources in Ethiopia, ruminants and equines are mainly (80-85%) natural grazing. Animal husbandry is largely constrained by feed quality and availability due to an imbalance between animal population and pasture size and productivity. The availability of browse to animals, especially in the dry seasons is essential when grass and herbaceous legume forages are scarce [121]. In Ethiopia, livestock density and unfettered grazing patterns lead to overgrazing. Since animal yield is low due to genetic and managerial problems the natural reaction of farmers has been to increase their herds. Overstocking and overgrazing associated with poor livestock management, mainly based on the free grazing system causes biological and physical resource degradation. Overgrazing is believed to be the most important cause of soil degradation worldwide [122], sharing about 35.8% of all forms of land degradation. This showed that heavy grazing pressure significantly increased surface runoff and soil loss and reduced

infiltration capacity of the soil which in turn undermines suitability of sites for germination [123]. The natural regeneration of the forest resources is difficult due to high populations of grazing and browsing livestock within the forests [124]. Livestock can compact soil, exacerbate erosion, consume and trample tree seeds, seedlings and browse saplings, and thereby preventing forest regeneration. Though the magnitude of the reduction depends on the tree species involved [125], livestock grazing affecting regeneration of tree species [126] and healthy population forest structure [127]. The free grazing system has a negative effect on the conservation efforts, as trampling animals often damage planted seedlings in open fields as well as physical conservation structures such as stone terraces and soil bunds. According to Alemayehu [103] forests grazing clearly had a strong negative effect on germination, seedling survival and growth of seedlings although species effects are different to some extent. The lack of regeneration for a number of tree species can be related to the negative grazing impact [126]. Therefore, to achieve indigenous tree species regeneration in natural forests and plantation establishment efforts controlling livestock pressure is mandatory.

### Forest fire hazards in Ethiopia

Fires are a major tool used in clearing the forest for shifting and permanent agriculture and for developing pastures. Fire has been a constant companion of humans; we have used it to our own benefit and been threatened by it [128]. This means that fire used responsibly can be a valuable tool in agricultural and forest management but if abused it can be a significant cause of deforestation. Forest fires have varied causes, but the majority is due to human influences, while few are due to natural causes such as lightning. The traditional practice of using fire as a means to prepare land for agriculture and the enormous demographic growth intensify the impact of forest fires. In the highlands of Ethiopia, where there is rapid population growth, fires are used as the major tool to clear forest land and convert it to agricultural use. Smoking out wild bees in order to gather honey is also another cause of forest fires. Both wild and deliberate fire are frequent in some parts of the country (e.g. North Gondar, Bale, Benishangul Gumuz Regional State) and are causing serious damages on forest genetic resources [129]. More than 90% of forest fire is caused by human activity. As FRA [129] indicates, over 16,000 ha of forest area was affected by fire in Oromia Regional State alone. On the other hand, cigarette-caused fires mostly occur in areas where there is a large amount of traffic on roadsides, particularly along main trucking routes or in forest areas that must be crossed on the way to major town markets. Ethiopia is still not prepared and does not give adequate attention to efficiently protect its natural forest resources [130]. Many other fires have been caused by negligence and carelessness of those people who permit agricultural burns to get out of hand or where control burns in forests have escaped from the burn area. Fire is a major hazard to a natural forest stands especially during the dry season. When forest's litter (dead leaves and small branches on the ground) and dead stems and other

grasses are flammable, hence the forest becomes susceptible to fire. It is known that Ethiopian farmers have been using fire as a means of production or as a farming tool for a long time. Every year, just before the short rainy season, when farmers start preparing their land, it is common to see deliberately set fires. Most of the fires are attended, managed and controlled by the community members who set it. There are also fires set recklessly or accidentally. Despite inherent potential risks with fires, farmers consider it as the cheapest and most common tool used for a variety of production activities. However, there have been times when fires have broken out on a large scale and brought about serious economic, political, social and environmental shocks and devastation. Historical evidence indicates that high forests of Ethiopia remain victims of war, conflict and forest fires. Yodit/Gudit (849-897 A.C.) ordered her army and the local people to set fire to forests stretching from Tigray to Gonder and Wello in suspected hiding grounds for the soldiers of Emperor Dilnaad. Similarly, Gagn Mohamed (1527-1542 A.C.) ordered his troops to clear and burn all the forests stretching from the eastern lowlands to the central highlands to make access to battlefields easier and to destroy strategic hiding grounds of the soldiers of Emperor Libne Dingil and clergies [131]. Prior to the forest fires in 2000, the last major outbreak was in 1984 when the fires damaged approximately 308,200 ha of forests [132].

### Demand for forest products

In 2012, the Ethiopian economy is estimated to be the third fastest growing economy in the world and the first fastest growing economy in Africa [25]. The country has registered such encouraging economic performances through formulation of policies and implementation of programs and putting in place appropriate institutional arrangements. Demand for wood product is growing fast in Ethiopia mainly due to population and economic growth. The construction sector boom, growth in urbanization and urban population, and growing middle class is driving rapid growth in demand for wood and other forest products [133]. Biomass is the major source of energy [25] accounting 97% of total domestic energy consumption in Ethiopia, out of which woody biomass covers 78% [134]. According to FDRE [25] the demand for industrial wood will increase significantly. Large sized logs will be in short supply and there will be a shift to softwood logs. However, supplies of wood products are decreasing significantly [135]. The declined and continues decline in domestic supply of wood products is due to deforestation and low level of investment in plantation forests. Unsustainable harvest from natural forests and woodlands has reduced the supply of woody biomass, further widening the gap between supply and demand [25]. At national level, there is huge gap between demand and domestic sustainably produced supply of wood products [133]. This has triggered two economically unfavorable outcomes. First, it is driving unsustainable extraction of wood from the natural forests, and hence the degradation of forests and loss of biodiversity. Second, this forces the country to depend heavily on imported wood products for its wood-based industries. This in turn creates an

additional challenge for a country struggling to increase its foreign currency earnings. For instance, in 2010/11 Ethiopian Fiscal Year alone, the import bill for wood products reached Birr 1.8 Billion or US\$ 115 million [136]. Other similar works also stated that in 2015 alone, Ethiopia imported 3.006 million m<sup>3</sup> RWE of various industrial wood products worth ca. USD 182.53 million, and the trend of importation is increasing [25]. In fact, it is more than doubled between 2007 and 2015. On the other hand, as supplies of wood and other products from natural forests decline, trees grown outside forests on homesteads and communal lands become more important [135]. According to the same source, the projected demand for wood fuel based on assumed per capita requirement is on the increase and is expected to be over 202 million m<sup>3</sup> in 2030. Trends indicate an overall increase in the demand for wood fuel of about 3% a year. The potential of the forest resources to supply fuelwood on a sustainable yield basis is very low and there is an imbalance between required rural energy and the supply capacity of the forest resources. The demand therefore, is fulfilled through over exploitation of the woody vegetation. Unless actions are taken rapidly, the situation will drive further degradation of the natural forests and affect the foreign exchange reserves [136]. Reduce demand for fuelwood via the dissemination and usage of fuel-efficient stoves and/or alternative-fuel cooking and baking techniques (such as electric, LPG, or biogas stoves) leading to reduced forest degradation [22].

### Conclusions

Ethiopia is one of the centers of biodiversity in the world and it relies on its diverse biological resources mainly on forests for its national and local socio-economic development. However, these resources are now under severe pressure and the socio-economic contribution of the forestry sector is still lowest amount and not as it is expected in the country. This can be attributed to the fact that, with the focus being mainly on timber production, there is a lack of data and information derived from the informal forestry sector. This makes the contribution of the forestry sector to the national and local economy has been undervalued. Indeed, it is very difficult to get a reliable estimate on forest cover and forest cover change in Ethiopia, due to limited and conflicting data sources. In Ethiopia, there are a number of potential opportunities and challenges in forest development and conservation efforts. To increase the contribution of forestry sector for Ethiopian economy and ensure the successful implementation of sustainable forest management, appropriate understanding of the present forest resource development challenges and proper implementation of its opportunities are indispensable. Therefore, it needs continuous commitment to reduce the different challenges and use its potential opportunities so as to boost the socio-economic and ecological contribution the forestry sector in the country.

### Future Directions

The following future strategic directions are proposed for overcoming the challenges and addressing the identified issues

for the proper conservation and management of forest resources of Ethiopia: (1) Establish forest information data base since there are no reliable, consistent and comprehensive statistics about forest. (2) Improving the effectiveness of policies, regulations and agreements that are important for the development and conservation of forest resources, (3) Rehabilitating and restoring degraded ecosystems and promoting the recovery of threatened species vis scaling up best area enclosure practices, agroforestry, afforestation and reforestation programs (4) promoting forest education and training for raising awareness of local communities on the value of forest resources and ecological consequences of deforestation (5) Sustainable protection and management of the existing natural forests needed through the collaborative effort of the government, NGO and the local community for reduction of tree cutting and production of charcoal.

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### Conflict of Interest

I declare that no any conflict of interest exists.

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