INDONESIAN JOURNAL OF INNOVATION AND APPLIED SCIENCES (IJIAS)
Journal Homepage: https://ojs.literacyinstitute.org/index.php/ijias
ISSN: 2775-4162 (Online)
Research Article

Volume 4	Issue 2	June (2024)	DOI: 10.47540/ijias.v4i2.1366	Page: 188 – 197

Review of the Properties, Acceptance, and Use of Eucalyptus as an Alternative Species in Ethiopia's Wood Industries

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ARTICLE INFO

Keywords: Alternative Species, Eucalyptus Wood, Wood Industries, Wood Properties.

Received : 14 March 2024
Revised : 21 April 2024
Accepted : 14 June 2024

ABSTRACT

The demand for forest-related goods and services has continued to grow in Ethiopia due to the increasing population, urbanization, and the boom of the construction sector. In the past, the demand was covered by indigenous timber species, which now have declined due to unwise exploitations. To narrow down the gap between supply and demand an alternative solution is promoting and utilizing fast-growing species such as *Eucalyptus* wood. To effectively utilize this species identifying its special characteristics, level of acceptance in wood industries, and utilization practices are very important. To achieve the goals of this review, a thorough search was carried out across multiple scholarly databases. Then, pertinent research, papers, and articles about the use of *Eucalyptus* in the wood industries were downloaded and reviewed. The study shows that *Eucalyptus* is widely cultivated in various regions of Ethiopia and plays a significant role in the socio-economic dimensions of many Ethiopians, providing livelihood opportunities, environmental services, and supporting sustainable development. Although it is being used as an alternative to traditional timber species in many places in the world, it is not being widely used in Ethiopia's wood industry for furniture manufacturing. This is because producers are unaware of the special properties of this species; its felling technique, sawing method, and drying behavior which demands proper attention and care. To ensure the sustainable use of *Eucalyptus* resources, better tree management techniques, innovative wood processing techniques, market development, and strengthening the capacity of relevant stakeholders are imperative.

INTRODUCTION

Human beings have used and will continue to use, forest products and services to meet their ever-growing needs (Kaba & Desalegn, 2020). In Ethiopia, the demand for forest products for construction, industry, and energy has been far higher than the supply (Sori et al, 2023). The gap between the demand and supply of wood products widened over the years since the supply from domestic production was not enough to meet domestic requirements (Girma & Abate, 2021). To satisfy the ever-increasing demand, large quantities of timber, panel, and fiber products are being imported from different countries with hard currency (Habtemariam & Zeleke, 2014). Ethiopia imported various industrial wood products totaling 3.006 million m3 worth around USD 182.53 million in 2015 alone, and the trend of imports is rising (Sori et al, 2023).

Even though Ethiopia has more than 300 indigenous and home-grown exotic tree species including *Eucalyptus* those attain timber size and therefore, are of potential economic value (Desalegn & Tadesse, 2010; Desalegn et al, 2015). The quality, suitability, and potential of lumber of these species have not yet been investigated and utilized (Desalegn et al, 2015). Currently, only a few of these species are used in the building and furniture sectors for various tasks. The choice of wood species for various applications is dependent on a variety of factors, including the wood's strength, natural durability, color, ease of machine-

and workability, cost, hardness, and availability (Kaba et al., 2018). As specified by Madalcho et al., (2019) *Eucalyptus* provides a sustainable source of timber, addressing concerns related to the depletion of well-known species in natural forests. According to Seng Hua et al., (2022) Timber extracted from the *Eucalyptus* trees has long been used for solid wood and its fibers were used for manufacturing medium-density fiberboard (Seyoum, 2012).

Moreover, *Eucalyptus* wood is known for its strength, durability, and resistance to pests and provides products like fuel wood, charcoal, poles, posts, essential oils, etc. (Birhanu & Kumsa, 2018). It has also been the basis for several industries like plywood particle board, paper, and pulp manufacture. *Eucalyptus* timber is utilized for structural framing, roofing, flooring, and joinery, owing to its strength (Seyoum, 2012). However, although it is being used as an alternative to traditional timber species in many places in the world, it is not being widely used in Ethiopia's wood industry for furniture manufacturing (Kaba et al., 2018). According to Desalegn & Tadesse (2010) even though *Eucalyptus* is mostly planted everywhere in Ethiopia, its processing and marketing are not linked well, due to a lack of knowledge and experience in sawing, drying, and processing of the various commodities produced for the wood of *Eucalyptus*. Proper utilization of these species will decrease pressure on the limited indigenous timber species and import lumber against hard currency (Desalegn & Tadesse, 2010; Sori et al, 2023). This review critically examines its acceptance level characteristics, challenges, and utilization practices in Ethiopian wood industries. By analyzing existing literature and empirical studies, this review aims to provide insights into the potential of *Eucalyptus* as a sustainable and economically viable resource for the country's growing wood demand.

METHODS

To achieve the goals of this review, a thorough search was carried out across multiple scholarly databases. Initial screening of search results was performed based on titles and abstracts to exclude irrelevant studies. Then, pertinent research, papers, and articles about the use of *Eucalyptus* in the wood industries were downloaded. To find a variety of literature on the subject, a set of keywords and phrases including "*Eucalyptus* utilization", "wood industries of Ethiopia", "*Eucalyptus* properties", "*Eucalyptus* acceptance", and "*Eucalyptus* utilization practices" were selected. The eligibility of full-text publications and reports was evaluated by the predetermined inclusion criteria. Relevant data on *Eucalyptus* wood was extracted from eligible studies and organized for analysis. A thorough summary of the characteristics, socioeconomic importance, acceptance, and application methods of *Eucalyptus* in Ethiopia's wood industries was synthesized using the retrieved data. As part of the synthesis, major themes, trends, and problems found in the literature were categorized and summarized.

RESULTS AND DISCUSSION

History of *Eucalyptus* and Its Distribution

Eucalyptus is one of the diverse genera of flowering plants in the world (Abebe & Tadesse, 2014; Bekele, 2015; Desta et al., 2023). Globally, *Eucalyptus* comprises more than 800 species and an unknown number of hybrids and varieties (Birhanu & Kumsa, 2018). Most *Eucalyptus* species occur naturally in Australia. *Eucalyptus* is one of the most planted types of trees in the world and has been grown in Africa and elsewhere for over a century (Amsalu & Yesgat, 2019). The tree was introduced to Ethiopia during the time of Emperor Minilik to satisfy the fuelwood demand of the capital and its surrounding territories (Madalcho et al., 2019). Then at the latter ages, the tree was disseminated in various highlands of the country and it has gained popularity as a result of its strong potential to adapt to various ecological settings and from fertile to degraded lands (Amsalu & Yesgat, 2019). The introduction of *Eucalyptus* species was a logical solution as they are fast-growing and thrive in marginal environments, being tolerant to severe periodic moisture stress, low soil fertility, and fire and insect attack (Debushe et al., 2015).

Eucalyptus is the most valuable and widely planted hardwood crop in the world because of its superior growth, adaptability, and wood properties (Dessie et al, 2019). In Ethiopia, *Eucalyptus* plantations constitute 58% of the total plantation cover followed by *Cupressus* (29%), *Juniperus procera* (4%), and *pines* (2%) (Seware, B. Z. et al., 2021). Today, Ethiopia has the largest area of *Eucalyptus* plantations in East Africa70 of them are

found in Kenya and nearly about 60 are cultivated in Ethiopia, with 15 species widely distributed (Jaleta et al., 2016). However, *Eucalyptus grandis, Eucalyptus saligna, Eucalyptus veminalis, Eucalyptus citiodora,* and *Eucalyptus bicostata* are among the widely distributed popular species in the country *Eucalyptus globulus* and *Eucalyptus camaldulensis* are the most dominate species and found in many rural and urban landscapes (FAO, 2009).

Table 1. Some of *Eucalyptus* species growing in Ethiopia

E. amygdlina	*E. cornuta*	*E. ficifolia*	*E. maculata*	*E. parvifolia*
E. astringens	*E. crebra*	*E. dalrympleana*	*E. melliodora*	*E. patens*
E. bosistonana	*E. globulus*	*E. gomphocephala*	*E. microcorys*	*E. pilularis*
E. botryoides	*E. deanei*	*E. planchoniana*	*E. microtheca*	*E. goniocalyx*
E. brockwayi	*E. delegatensis*	*E. grandis*	*E. nitens*	*E. regnans*
E. gunnii	*E. diversicolor*	*E. camaldulensis*	*E. obliqua*	*E. resinifera*
E,cinerea	*E. dundasii*	*E. incrassata*	*E. occidentalis*	*E. robusta*
E.citrodora	*E. dunnii*	*E. johnstonii*	*E. ovata*	*E. rubida*
E.cladocalyx	*E. fastigata*	*E. largiflorens*	*E. paniculata*	*E. saligna*
E. cloeziana	*E. wandoo*	*E. transcontinentalis*	*E. tereticornis*	*E. leucoxylon*
E. saubris	*E. sideroxylon*	*E. salmonophloia*	*E. torelliana*	*E. viminalis*

Source: Jaleta et al., 2016.

Socio-Economic Importance of *Eucalyptus* in Ethiopia

Eucalyptus trees play a significant role in Ethiopia's socioeconomic dimensions of many Ethiopians, providing livelihood opportunities, and environmental services, and supporting sustainable development (Alemu, 2016). For many years, Ethiopians have been attached to it as it served by being the prime source of construction material for houses (Mekonnen, 2010). *Eucalyptus* plays a role in mitigating climate change by sequestering carbon dioxide from the atmosphere and acting as carbon sinks (Daba, 2016). The shade provided by *Eucalyptus* trees helps moderate temperatures and create microclimates that support biodiversity and ecosystem resilience (Madalcho & Tefera, 2016). The fast growth rate of *Eucalyptus* trees allows for quick replenishment of wood resources, meeting the high demand for timber in both urban and rural areas for construction, furniture making, and various woodworking industries (Bekele, 2015). *Eucalyptus* wood also serves as a readily available source of fuelwood for cooking and heating, particularly in rural communities where access to alternative energy sources is limited (Madalcho et al., 2019). In Ethiopia, where above 90% of the population's energy demand comes from biomass (Yadeta et al., 2021), *Eucalyptus* plays a crucial role in the supply of much-needed energy, and in rural areas, 78% of the firewood and 20% of charcoal are from *Eucalyptus* (Jaleta et al., 2016).

The cultivation, harvesting, and processing of *Eucalyptus* trees create employment opportunities for a significant number of people in Ethiopia (Derbe et al., 2018). Different socioeconomic studies on *Eucalyptus* production have shown that *Eucalyptus* provides additional income for smallholder farmers and landowners, particularly in areas where agricultural productivity is low (Dessie et al., 2019). As stated by Birhanu & Kumsa. (2018), The income from *Eucalyptu*s can account for as much as 72% of the total household yearly cash income for poor households in the central highland of Ethiopia. According to various sources, Ethiopia earns foreign exchange by exporting *Eucalyptus* pols to the neighboring countries. Alem (2015) pointed out that in the years 2005–2013, the country earned a total of US$21,206,392.5 from the export of Eucalypts logs. The average income generated from the export of *Eucalypts* logs was increased by US$357,365.6 annually as mentioned by Haileab (2010). *Eucalyptus* wood serves as a raw material in the wood products industry sub-sectors, i.e., sawn wood, panels, and joinery (Seyoum, 2012). The availability of this tree supports the growth of these industries, contributes to economic development, and stimulates investment in value-added wood products.

Eucalyptus trees contribute to soil conservation and erosion control efforts in Ethiopia, particularly in degraded and vulnerable landscapes (Amsalu & Yesgat, 2019). The deep root systems of

Eucalyptus trees help stabilize soil, reduce water runoff, and enhance water infiltration, leading to improved soil fertility and moisture retention (Seware et al., 2021). *Eucalyptus* trees are used in the construction of rural infrastructure such as bridges, fences, and poles, improving access to essential services and facilitating socio-economic development in remote areas (Alemayehu & Melka, 2022). *Eucalyptus* plantations provide shade, windbreaks, and aesthetic value in urban and rural landscapes, enhancing the quality of life for communities and contributing to social well-being (Tadesse & Tafere, 2017).

Eucalyptus and the Need for Alternative Timber Species

Ethiopia's wood industries play a crucial role in the country's economy, providing employment opportunities, contributing to national income, and meeting the demand for various wood-based products (Daba, 2016). However, the traditional reliance on a limited number of timber species poses challenges in terms of sustainability, biodiversity conservation, and meeting growing market demands (Kaba, G., et al., 2018). This section discusses the detailed need for alternative timber species in Ethiopia's wood industries, emphasizing the importance of diversifying the timber supply to address these challenges effectively.

Traditionally majority of end users and wood industries in Ethiopia select indigenous timber species grown in natural forests for most of their furniture requirements (Kaba et al., 2018). According to Bekele, T., (2015) Ethiopia's natural forests are under pressure due to deforestation, land degradation, and unsustainable harvesting practices. As pointed out by Zelalem et al (2014) commercially valuable Indigenous species are indiscriminately and increasingly exploited and what is remaining is found mostly in unusable sizes and inaccessible areas. Limited availability of well-known timber species in natural forests such as Cordia africana and others poses risks to the stability and resilience of Ethiopia's wood industries. Most wood industries close to major cities today use imported timber and composite wood products including *Eucalyptus* species (Habtemariam & Zeleke, 2014). Due to this Ethiopia's import value of forest products against hard currency could grow dramatically to 2.877 billion dollars by importing 3.67 million tons of forest products after 19 years, in 2035 (Desalegn et al, 2015).

Ethiopia's growing population, urbanization, and expanding middle class drive the demand for wood-based products, including furniture, construction materials, and paper (Girma & Abate, 2021). Alternative timber species that are fast-growing, commercially viable, and suitable for various applications can help meet the increasing market demand, stimulate economic growth, and create employment opportunities in the wood industries (Desalegn & Tadesse, 2010). Furthermore, Diversifying the timber supply with alternative species ensures a more resilient and adaptable wood industry, reducing vulnerability to fluctuations in the availability and prices of specific timber species (Girma & Abate, 2021). Alternative timber species with unique properties, colors, and grain patterns offer opportunities for diversifying wood products and meeting consumer preferences in domestic and international markets (Lahr et al, 2018). It also encourages the innovation of wood industries in product development, design, and manufacturing processes (Seyoum, 2012). Therefore, according to Sori et al., (2023), it is unwise to rely solely on imported timbers and alternative sources have to be sought to meet this increasing timber demand. Hence, while our short-term timber requirements are satisfied by the imported species, it is essential to plan for the local fast-growing tree species like *Eucalyptus* to supply the required timber essential for the construction and furniture industries.

Acceptability of _Eucalyptus_ in Furniture Industries of Ethiopia

Eucalyptus, a fast-growing and versatile timber species, has gained widespread acceptability in the world's wood-based industries due to its availability, affordability, and favorable properties (Bekele, 2015; Kaba & Desalegn, 2020). In Ethiopia, it is not being used as expected in various industries, especially in the furniture industry for many reasons (Kaba et al, 2018). This section delves into the main factors contributing to the acceptability of *Eucalyptus* in furniture manufacturing within Ethiopia, highlighting its role in meeting the diverse needs of the furniture market and supporting the growth of the industry.

Eucalyptus trees are widely cultivated in various regions of Ethiopia, offering a readily available and accessible source of timber for fuel wood construction as well as in the limited amount for furniture production (Alemu, 2016). *Eucalyptus* wood is known for its affordability and accessibility compared to other hardwood species. Furthermore, the relatively low cost of *Eucalyptus* wood might be able to help furniture producers maintain competitive pricing in the market, appealing to a broad range of consumers with varying budget constraints. Despite its affordability, *Eucalyptus* wood offers sufficient strength and durability for various furniture applications (Seng Hua et al., 2022). Furniture made from *Eucalyptus* wood exhibits adequate structural integrity, ensuring longevity and reliability in everyday use (Kaba & Desalegn, 2020). *Eucalyptus* wood is used as raw materials in some wood industries such as chipboards, hard boards, and plywood factories in Ethiopia (Seyoum, 2012). Studies have found that in Ethiopia the availability of sawn *Eucalyptus* wood is limited on the market. Due to this, its wood in solid form has not yet gained a distinct utilization share in furniture factories (Kaba et al, 2018). There are different species of *Eucalyptus* suitable for furniture production, including chairs, tables, beds, cabinets, parquet, and decorative items (Desalegn. et al., 2015). According to the result of the study in 2018, the lack of information about *Eucalyptus* wood and product type significantly influences the use of *Eucalyptus* wood in furniture factories (Kaba et al, 2018).

Challenges in Wood Furniture Industries to Use *Eucalyptus* Wood

Using *Eucalyptus* wood in the furniture industry presents several challenges that need to be addressed (Ghani & Lee, 2021). Addressing these challenges requires a combination of specialized knowledge, equipment, and techniques to effectively utilize *Eucalyptus* wood in furniture making while ensuring quality, durability, and sustainability. *Eucalyptus* wood is known for its high density and hardness, which can make it difficult to work with using traditional and simple woodworking tools (Kaba et al, 2018). Specialized equipment may be required to cut, shape, and sand *Eucalyptus* wood effectively (Sori et al., 2023). *Eucalyptus* wood tends to dry unevenly, leading to potential warping, cracking, or splitting if not properly sawn, seasoned, and dried (Desalegn et al., 2015; Kaba & Desalegn, 2020). Dimensional instability is another key common problem with fast-growing hardwoods such as *Eucalyptus* (Priadi et al., 2019). Achieving the right moisture content and stability for furniture making requires careful drying and monitoring (Kaba & Desalegn, 2020). Some species of *Eucalyptus* wood can be prone to long-end cracking, especially if not properly handled during processing and manufacturing (Famiri et al., 2001). This can lead to challenges in crafting intricate or delicate furniture designs.

Growth stresses are a major concern when processing *Eucalyptus* timber (Famiri et al., 2001). *Eucalyptus* wood such as E. viminalisis can have natural defects such as knots, gum veins, and insect damage, which may affect its appearance and structural integrity (Desalegn et al., 2015). No matter what kind of species it is, selecting high-quality, defect-free wood and properly addressing any defects during processing is essential. Due to its high density and natural oils, *Eucalyptus* wood can be challenging to finish and glue (Sadegh, 2012). Specialized techniques and finishes may be required to achieve the desired appearance and durability in *Eucalyptus* wood furniture.

Eucalyptus is often grown in plantations, and concerns have been raised about the environmental impact of large-scale *Eucalyptus* cultivation, including potential water usage, soil depletion, and impacts on local ecosystems (Amsalu & Yesgat, 2019). Sustainable sourcing practices and responsible forestry management are crucial in addressing these concerns (Jaleta et al., 2016). While *Eucalyptus* wood can be an attractive option due to its durability and availability, the cost of sourcing and processing *Eucalyptus* wood for furniture making can vary depending on factors such as species, quality, and location (Ghani & Lee, 2021). Balancing cost considerations with quality and sustainability is important for wood industries utilizing *Eucalyptus*.

Some physical and mechanical properties of *Eucalyptus* wood physical and mechanical properties of *Eucalyptus* wood make it a versatile and desirable material for a wide range of applications, including construction, furniture making, flooring, and woodworking (Kaba et al, 2018). Its strength, durability, workability, and natural beauty contribute to its popularity in various

industries (Getahun et al., 2014). Wood density is considered the most important wood property as it is the single parameter that closely influences most wood mechanical properties, shrinkage, calorific value of wood, and other properties (Sadegh, 2012). Thus, it is an important characteristic for wood quality assessment and it reflects the suitability of wood for most types of processing and many end uses (Zanuncio et al., 2022). For example, lower-density wood is preferred for wall panels, which do not have to be strong and stiff, whereas high-density wood is preferred for construction poles and beams, which must be strong and stiff (Sadegh, 2012). *Eucalyptus* wood is known for its relatively high density, ranging from 450 kg/m³ to 900 kg/m³ depending on the species and growth conditions (Getachew & Wubalem, 2010; Sadegh, 2012). This density contributes to its strength and durability, making it suitable for various structural applications (Kaba & Desalegn, 2020).

Proper drying of *Eucalyptus* wood is essential to prevent dimensional changes, warping, and decay (Kaba & Desalegn, 2020). *Eucalyptus* lumber exhibits a wide range of colors, including pale yellows, reds, browns, and even pink hues. The grain patterns vary from straight to interlocked, with a moderately coarse texture. *Eucalyptus* wood has moderate shrinkage and swelling properties, with tangential shrinkage ranging from 6% to 10% and radial shrinkage ranging from 3% to 6% (Kaba & Desalegn, 2020). *Eucalyptus* wood is naturally resistant to decay and insect attack, especially when properly seasoned and treated (Desalegn et al., 2015). *Eucalyptus* wood has moderate to good dimensional stability when properly seasoned and maintained (Thomas. et al, 2007). Proper drying and sealing treatments help minimize warping, cupping, and twisting. Proper drying involves proper stacking of lumber with adequate spacing between each board to allow for air circulation (Githiomi & Muthike, 2008). Use stickers (small wooden spacers) between each layer to promote airflow were used.

Eucalyptus wood has high tensile strength, ranging from 50 MPa to 150 MPa, depending on the species and growth conditions (Thomas et al, 2007). The compressive strength of *Eucalyptus* wood ranges from 40 MPa to 80 MPa, indicating its ability to withstand compressive loads. It exhibits good flexural strength, ranging from 60 MPa to 150 MPa, making it suitable for structural applications such as beams and joists (Desalegn et al., 2015). *Eucalyptus* wood has a high modulus of elasticity, typically ranging from 8,000 MPa to 20,000 MPa. This stiffness contributes to its resilience and ability to withstand bending and deformation under load (Thomas et al, 2007). *Eucalyptus* wood is classified as moderately hard to hard on the Janka hardness scale, with values ranging from 5,000 N to 12,000 N. This hardness contributes to its suitability for flooring, furniture, and construction purposes (Desalegn et al., 2015).

Some *Eucalyptus* wood is generally easy to work with hand and machine tools, although interlocked grain patterns may cause blunting effects during machining. It holds nails and screws well and accepts stains, paints, and finishes satisfactorily. The majority of *Eucalyptus* exhibits moderate mechanical properties (Desalegn et al., 2015). According to Ghani & Lee (2021), it also exhibits moderate fire resistance, with varying levels of fire retardancy depending on the species and treatment.

Table 2. Density and mechanical properties of some *Eucalyptus* timbers, and comparison with other Indigenous timbers of Ethiopia

No.	Name of species	Density	Mechanical characteristics of timbers at 12% MC				
			Modulus of rupture (N/mm^2)	Modulus of elasticity (N/mm^2)	Work to maximum load (mm N/mm^3)	Total work (mm $N/m m^3$)	Compression parallel to the grain (N/mm^2)
1	*E. globulus*	780 (H)	124 (H)	11655 (L)	0.1600	0.3194	52 (M)
2	*E. camaldulensis*	850(H)	131 (H)	14177 (M)	0.0735	0.1432	71 (H)
3	*E. deanei*	570 (M)	94 (M)	11553 (L)	0.2352	0.4214	47 (M)
4	*E. deglupta*	410 (L)	69 (L)	8332 (VL)	0.0679	0.1140	33 (M)
5	*E. grandis*	560 (M)	92 (M)	10308 (L)	0.1053	0.1830	45 (M)
6	*E. regnans*	480 (M)	88 (M)	14254 (M)	0.0799	0.1511	51 (M)
7	*E. saligna*	680 (H)	106(M)	11604 (L)	0.1359	0.2414	53 (M)
8	*E. viminalis*	670 (H)	136 (H)	15629 (H)	0.1783	0.4347	54 (M)
9	*Cordiaafricana*	410 (L)	64 (L)	6996 (VL)	0.0462	0.0949	29 (L)
10	*Hagenia abyssinica*	560 (M)	86 (M)	9563 (VL)	0.0952	0.2370	43 (M)
11	*Podocarpus falcatus*	530 (M)	88 (M)	9526 (VL)	0.1189	0.1195	41 (M)
12	*Pouteria adolfi-frederici*	680 (H)	93 (M)	10029 (L)	0.1060	0.1419	46 (M)

Source: Getachew & Wubalem, 2010.

Appropriate Sawing Methods of *Eucalyptus* Wood

Sawing of *Eucalyptus* timber requires careful consideration of several factors including the wood's hardness, grain characteristics, and intended use of the lumber (Sarker et al, 2022). Different species of *Eucalyptus* may have varying densities and grain patterns. Green, freshly cut timber will have a higher moisture content compared to seasoned timber (Kaba & Desalegn, 2020). Green timber may require different sawing techniques such as plain sawing, quarter sawing, and rift sawing to prevent warping and checking as it dries (Githiomi & Muthike, 2008). based on our specific requirements and intended use; By following these steps and considerations, we can effectively choose and implement the appropriate sawing method for *Eucalyptus* timber

Plain or Flat Sawing is the most common method where the log is sawn parallel to its length in a series of cuts. This method produces flat-sawn lumber with a cathedral grain pattern and is suitable for general construction purposes. While Quarter Sawing is first quartered the log, then each quarter is sawn separately. Quarter sawing produces lumber with a straight grain pattern, greater stability, and resistance to warping. It is ideal for applications where stability and aesthetics are important, such as flooring and furniture. Another appropriate method of sawing *Eucalyptus* wood is Rift Sawing. This method involves cutting the log at a slight angle to the radial plane of the log to produce straight-grain lumber. Rift sawing is suitable for producing lumber with minimal radial or tangential shrinkage, making it ideal for applications where dimensional stability is crucial, such as instrument making (Yasin & Raza, 1992; Jiang, 2007; Vilkovský et al., 2023).

Using sharp saw blades appropriate for cutting hardwoods like *Eucalyptus.* Dull blades can lead to increased sawing time, overheating, and poor-quality cuts. Maintain consistent feed rates and sawing speeds to achieve uniform lumber thickness and minimize waste. Consider the width and thickness of the lumber required for your project when making cuts (Vilkovský et al., 2023).

Utilization Practices of *Eucalyptus* Wood

Utilization practices of *Eucalyptus* wood vary globally based on factors such as local regulations, environmental considerations, and industrial needs. It is used in various industries such as construction, furniture making, plywood, and chipwood production (Desalegn et al., 2015). *Eucalyptus* wood is widely used globally for pulp and paper

production, and for construction purposes, including roofing, flooring, and structural framing (Alemayehu & Melka, 2022). It is also a popular choice for making furniture due to its availability and affordability (Kaba et al., 2018). Currently, it is widely used for Maplestory furniture such as sofa and bed frames (Kaba et al., 2018).

Eucalyptus wood is utilized for biomass energy production in the form of wood pellets, chips, or direct combustion. Its high calorific value and fast growth make it an efficient renewable energy source (Birhanu & Kumsa, 2018; Madalcho et al., 2019). It is commonly used for charcoal production, meeting domestic energy needs, particularly in rural areas (Jaleta et al., 2016). Certain species of *Eucalyptus* are cultivated for extracting essential oils used in various industries like pharmaceuticals, cosmetics, and aromatherapy (Dessie et al., 2019).

CONCLUSION

Nowadays *Eucalyptus* timber is used for fuel wood and construction purposes throughout the country. Since *Eucalyptus* was introduced to Ethiopia it is not widely used for sawn lumber application. *Eucalyptus* timber has not yet achieved significant commercial importance for sawn lumber production other than fuel wood. This is mainly because the market has not had substantial experience with processing *Eucalyptus* timber. End users of *Eucalyptus* timber in Ethiopia are unaware of the special properties of this timber felling technique, sawing method, and its drying behavior which demands proper attention and care. The worldwide experience with this timber indicates that proper felling, conversion, drying, and sawing techniques improve the sawn lumber quality and increase its value. It's well-known that *Eucalyptus* timber has a high level of growth stress that affects sawn lumber quality, yield, and recovery. The presence of growth stress creates collapse, split, surface/end checks, cupping, distortion, and high shrinkage on sawn lumber quality produced from *Eucalyptus.*

To ensure the sustainable use of *Eucalyptus* resources in Ethiopia, better *Eucalyptus* tree management techniques, innovative wood processing technology to improve the value-added products obtained from *Eucalyptus*, and market development are imperative. It is also vitally important to strengthen the capacity of relevant stakeholders, such as local communities, government agencies, and the private sector, through knowledge-sharing platforms, technical assistance, and training programs. focused on best practices for *Eucalyptus* cultivation, management, and utilization. By putting these suggestions into practice, Ethiopia may guarantee long-term resilience in the forestry industry, socioeconomic benefits, and environmental sustainability while utilizing *Eucalyptus* as an alternate species in its wood industries.

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