Opportunities and Challenges of Sustainable and Environmentally Friendly Indigenous Cellulosic Fibers in Textile Fashion Industry: Overview

BY

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ABSTRACT

This comprehensive review explores the opportunities and challenges associated with the sustainable and environmentally friendly indigenous cellulosic fibers in Ethiopia's textile fashion industry. Ethiopia is endowed with a rich biodiversity, which includes various indigenous plant species that yield valuable cellulosic fibers, such as cotton, kenaf, and the lesser-known fibers like and jute. These fibers present immense potential for eco-friendly textile production, aligning with global sustainability goals and increasing consumer demand for sustainable fashion. The utilization of indigenous fibers can significantly reduce reliance on synthetic materials, diminish environmental impact, and promote local economies through job creation in rural communities. However, several challenges impede the widespread adoption of these fibers, including limited processing technology and knowledge, Government policy, inadequate supply chain infrastructure, and a lack of consumer awareness about the benefits of using sustainable materials. Additionally, issues such as climate change and land degradation pose significant threats to the cultivation of these plants. This review highlights the need for innovative strategies to address these challenges, such as investment in research and development, capacity-building for local farmers, and enhancing marketing efforts to raise consumer awareness. By leveraging the unique properties of indigenous fibers and promoting sustainable practices, Ethiopia has the potential to become a leader in the eco-conscious textile fashion industry while fostering environmental protection and economic growth. Ultimately, this review aims to provide insights for policymakers, industry stakeholders, and researchers interested in harnessing the potential of Ethiopia's indigenous cellulosic fibers.

Keywords: Indigenous fibers, Sustainable fashion, Eco-friendly textiles, Cellulosic fibers, Textile

1. Introduction

Humans have been using natural fibers derived from plants for thousands of years. These natural fibers are used in a variety of sectors to create valuable products and uses. Textiles, construction, medicines, and other products are among them. Natural fibers grow naturally and do not affect the environment until Scarcity of natural fibers and rising demand of fiber and fiber.

Since, only natural fibers are insufficient to meet the required demand of fiber nowadays, a synthetic fiber has taken the market of natural fiber, At the beginning of the twentieth century, major changes occurred and new developments in the field of synthetic fibers. People have started to use synthetic fiber in every industry of fiber materials(Rout et al., 2001).

fertilizers, pesticides, and other hazardous chemicals are applied to promote their production(Mohammed et al., 2015). Natural fibers increase all around the world, meeting the current needs and demands. However, due to

However, the production of synthetic fibers entailed numerous chemicals and hazardous substances that were detrimental to the environment and society. This appeal to natural fibers prompted businesses, industries, researchers, and technologists to find new and inventive ways to grow, develop, cultivate, and use natural fibers in a sustainable manner. The alarming rise of global warming issues and marine living organisms has raised awareness of plastic disposal issues (difficulties in recycling, environmental burden)(Cavalier and Padella, 2002, Wambua et al., 2003). As a result, biomaterials such as natural fiber have steadily superseded traditional plastics in numerous applications. (Lee et al., 2017). Growing environmental consciousness has sparked interest in the usage of natural fibers and composites, as well as their possibility to replace synthetic fibers at a cheaper cost and with greater sustainability. Thus, vegetable fibers have been widely explored due to their high potential and environmental friendliness. (Begum and Islam, 2013, Kutz, 2002).

This paper summarizes the ongoing problems and prospects for ecologically friendly cellulosic fibers in the textile and fashion industries. The specific objective of this review paper is to brighten a cheerful on the most recent textile sustainable and indigenous cellulosic fibers environmentally friendly knowledge by exploring the current state of the Indigenous cellulosic fibers in Ethiopia from and giving direction for its increased variety of cellulosic fibers.

- To explore the trends of cellulosic fibers production and sustainable
- To explore the movements of cellulosic fibers invention in Ethiopia.
- To exploring the country's potential for cellulosic fibers production.
- To evaluate current research state cellulosic fibers initiatives working in the sector.
- To find out the different opinion of researcher on same indigenous cellulosic

2. Methodology

The study's aims were achieved using the following methods: Literature survey: To achieve the study's aims, the methodological approach that was employed is based on the exploitation of information gathered from sources. This data was processed and examined not just in terms of objectives, but also in terms of nature. The research effort is based on qualitative analysis of data collection and literature review from various resources such as books. Research papers, journals, reports, and available published and unpublished document. Then after analyzing it was finally assessed and for conclusions and research viewpoint.

3. Sustainability

After globalization all over the world the economic growth changed rapidly in the developing countries and the issue of environment rose at the same time because most of the production and manufacturing units were shifted to these countries. Sustainability is the word used to save the planet in the future (Reddy and Yang, 2005). Today with increase in population the use of products and their wastes have been increased and have caused hazardous impacts on the environment that in other word development that meets the needs of the present without compromising the ability of future generations Sustainability focuses on four major aspects: economy, society, culture, and environment (Wiebe, 2012).Sustainable development is defined as development that meets current needs without jeopardizing future generations' to meet their own needs (Basak et al., 2020). This has haggard the helpfulness of governments and strategy makers for sustainable development. The most suitable definition of sustainability on Environment and Development is 'meet the needs of the present without compromising the ability of future generation to meet their needs and desires 'Normally a variety of definitions and meanings of sustainability are possible. Sustainable production is important to efficiently use our resources and reduce waste and related costs (Muthu, 2017).

ability to meet their own. Generally, the four pillars of sustainability (social, economic, cultural, and environmental), with the iconic circle diagram illustration to have been presented (Purvis et al., 2019, Barrier, 2017).

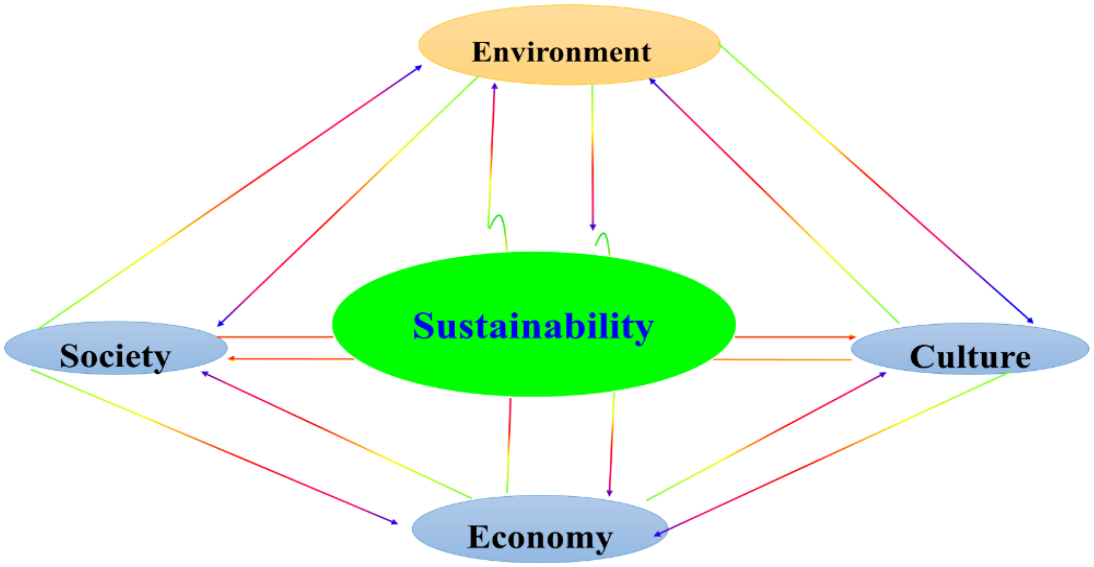

Figure 1: Sustainability cross- function integration concept (Purvis et al., 2019, Barrier, 2017)

Sustainable development is to be achieved, understanding the interlink ages between social, ecological, culture and economic dimensions of our world is of significant importance. To understand such interlink ages, it is adopt a systems approach to observing worldly phenomenon (Sisay, 2011).

3.1 Sustainable Textile materials:

Sustainable fibers in the textile business include organic cotton, bamboo, flax, hemp, jute, ramie, sisal, and abaca. So, the use of sustainable fibers as a raw material for making textile fashion products is an approach to sustainability from the beginning (Holme, 2009). There is a great deal of misconception about the environmental impacts of textile production. Natural fibers are generally thought to be more sustainable than synthetic fibers. This notion is founded on the fact that natural fiber production requires fewer resources than synthetic fibers, and synthetic fibers have an impact on people and the environment. But the fact involves much more; albeit the manufacture of synthetic fibers requires a lot of resources, but cotton farming has also substantial consequences; for producing cotton, large amounts of insecticides, fertilizers, and water are needed. (Jungmichel et al., 2017). Creating 1 kg of cotton requires 8000 liters of water, whereas creating 1 kg of polyester requires less water but double the energy. Organic cotton, also known as low chemical cotton, is a sustainable alternative to conventional cotton since it has social and environmental benefits. Organic cotton production is distinguished by the absence of synthetic pesticides and fertilizers, as well as reduced water use. (Suparna et al., 2016).

3.2 Fiber

Fiber is the starting raw material for fashion textile products; the fiber determines the entire product's processing and procedures. Many fashion firms conduct research on fibers and raw materials to make their products feel soft, silky, glossy, and pleasant for user (Adnan Ali, 2010). Research continues in the textile business, and the usage of natural fibers increases as opposed to man-made fibers(Adnan Ali, 2010). Natural fibers are made from natural resources such as plants, animals, and minerals. Flow Figure 2 depicts the classification of the most common natural and synthetic fibers used in textile applications. Fibers are often classified as either natural or man-made. Natural subgroups include animal origin, vegetable origin, and mineral origin. (Petroudy, 2017, Pandey, 2015, Aisyah et al., 2018).

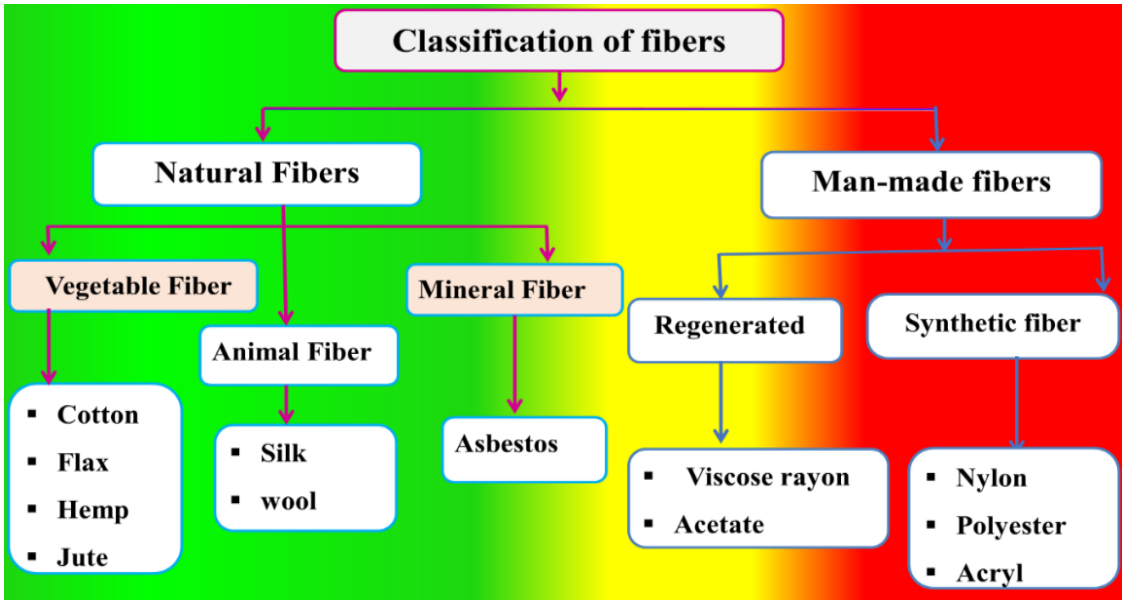

Figure 2: Classification of Fibers. The right said of figure that red color showing non sustainability manmade fibers they case influences environment (Adnan Ali, 2010, Petroudy, 2017, Pandey, 2015, Aisyah et al., 2018)

4. Current Research on Utilization of Indigenous Cellulosic Fibers

Cellulosic fiber research in Ethiopia is mostly focused on cotton fiber, even if There is still the capacity to produce a large amount of natural fiber from plants or vegetable fiber, and many trials on the extraction and characterization of bast and leaf fibers have been conducted by various Ethiopian researchers, because the government's plan and policy priorities cotton. The five-year Growth and Transformation Plan (GTP) prioritizes export industries, particularly the cotton textile and garment sector

4.1 Cotton production in Ethiopian

The cotton value chain begins with the farmer, who grows cotton and collects "seed cotton" from the cotton plant's bolls. Cotton production processes differ widely, with labor-intensive systems in Ethiopia. In the last stage, finished items (garments, household textiles, etc.) are made from fabrics (Figure 3). (Mekuria, 2024). Furthermore, cotton offers a living for hundreds of thousands of individuals involved in growing, processing, commerce, and marketing (Zeleke et al., 2019). Cotton is widely farmed in the lowlands under large-scale irrigation systems and small-scale farms under rain-fed agriculture in Ethiopia (Walle et al., 2024). Cotton is primarily farmed for fiber production. In Ethiopia, a good cotton production is attainable from locations varied in altitude from sea level to around 1000 masl (Walle et al., 2024). Ethiopia's key cotton growing locations include the Omo-Ghibe, Wabi Shebelle, Awash, Baro-Akobo, Blue Nile, and Tekeze river basins. (Bayrau et al., 2014)

Figure 3. Schematic showing of cotton fiber production processing chain

. Cotton supply chine from cultivation to the final product. The using also using other animal feed and oil production area in textiles value chain in Ethiopia.

The development of the cotton sector in Ethiopia is currently one of the main focuses of the Ethiopian government. Therefore, a "National Cotton Development Strategy" (NCDS) and a corresponding roadmap have been developed, addressing the time period from 2017-2032 (Liwen et al., 2019).

4.2 Potential areas for cotton production in Ethiopia

All of the country's regional states have a high potential for cotton production, with variations in land size, environmental compatibility, and closeness to textile factories (Figure 4). Cotton, one of Ethiopia's principal cash crops, is widely farmed in the lowlands on large-scale and small-scale farms under both irrigation schemes and rain-fed agriculture. (Gudeta and Egziabher, 2019)

Figure 4. Map of the cotton production areas (Addis et al., 2021)

Ethiopia has a long history of cotton growing. The majority of cotton is grown in the Awash Valley, Gambela, Humera, and Metema. Cotton has grown in a variety of places around the country. Each region has a large potential area: Tigray 269130 ha, Amhara 678,710 ha, South nations, nationalities, and people region (SNNPR) 600,900 ha, Oromia 407420 ha, Gambella 316,450 ha, Benishangul 303,170 ha, Afar 200,000 ha, and Somali 225,000 ha. The majority of the lands are lowland and river basins. According to a 2010 assessment from the then-Ministry of Agriculture (MoA), the country has approximately more than 3 million hectares of potential cotton cultivation area. On the contrary, the current area covered by cotton crop in Ethiopia is believed to be only approximately 100,000 hectares, of which 60,000ha is commercially irrigated and 40,000ha is small scale, with 70% rain-fed and 30% irrigated. Varies between 76 and 102 centimeters (Brandenburg et al., 2022). Farmers in Ethiopia used to sow cotton using broad casting. Today, there are trainings and other educational systems, such as farmer field schools, where farmers learn how to sow cotton in rows and keep space between the plants and rows (Kabissa et al., 2022).

4.3 Organic cotton production

Organic cotton is defined as cotton derived from non-genetically modified plants that has been certified to be grown without the use of synthetic agricultural agents such as fertilizers or pesticides. There are many degrees of certification, but at the very least, a crop must be produced on chemical-free soil for at least a few years. (Hansen and Schaltegger, 2016). Humus, or soil organic matter, is the primary source of nutrients for plants. It was also proposed that the dry matter of plants is generated from soil nutritive fluids containing are subsequently successively oxidized to nitrate. The oxidized nitrogen is a significant source of nitrogen for eukaryotic primary producers. (Zerkle and Mikhail, 2017). Animal gut micro biota are also responsible for adding up nitrogen, which is why animal faces have been considered a key source of nitrogen and fertilizing agent. (Aiysha and Latif, 2019). The most important source of nitrogenous compounds for agriculture is the Haber–Bosch process of ammonia production (Wendeborn, 2020). Normally all of the nitrates in the soil come from the process of decay show in (figure5).

portions of soil organic matter (Feller et al., 2012). Nitrogen is the main component of earth's atmosphere (Luo et al., 2018). Exists as a diatomic molecule with one of the strongest known triple bonds, resulting in its underactivity in typical atmospheric conditions (Howie et al., 2016). Thus only a few organisms can pick up molecular nitrogen due to its stability (Galembeck et al., 2019). In addition, bacteria fix nitrogen from the environment in the form of ammonium ions, which

Nitrogen-fixing bacteria in soil can convert nitrogen from the soil air to ammonia, which is then turned into nitrates by the nitrogen cycle's nitrifying bacteria. One type of plant is very crucial to the nitrogen cycle. Early maturing at planting time was determined to be the most effective for rapid ripening. Under normal conditions, 22.5 kg/ha nitrogen for rained cotton and 45-67.5 kg/ha for irrigated cotton appears to be adequate. However, because ecologically friendly cottons have been released into the Ethiopian market, conventional white cotton continues to account for the majority of cotton products.

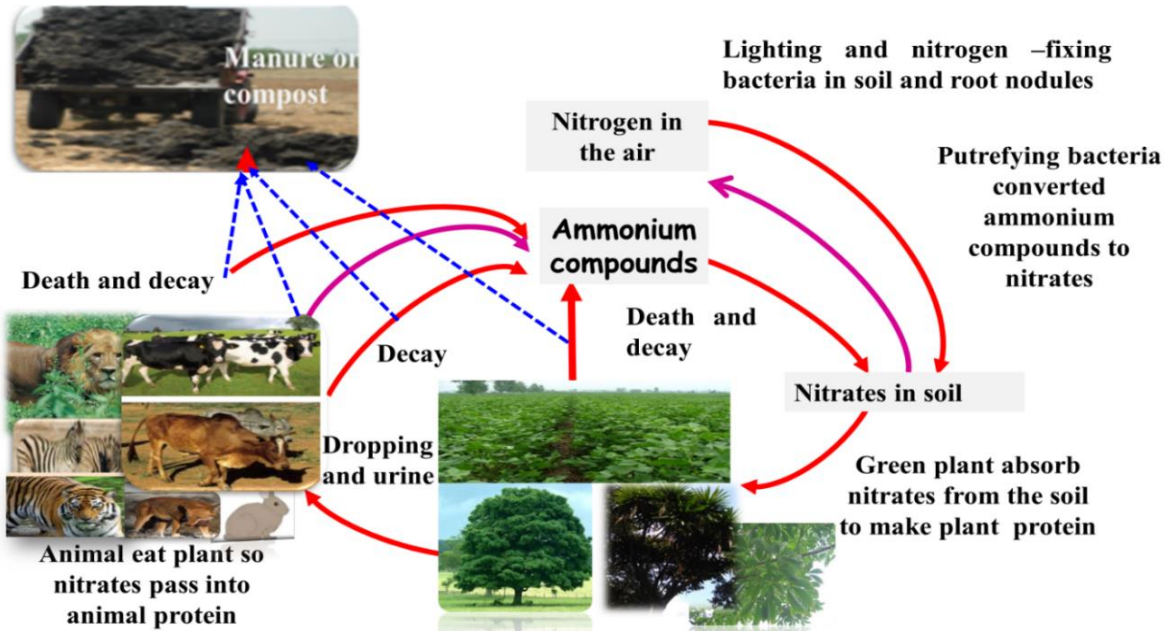

Figure 5. The nitrogen cycle in nature

Organic cotton may provide value at every level of the production process, benefiting both agriculturalists and intermediaries. Ethiopia now produces organic cotton. Aside from the enormous benefits of organic cotton production, there are some problems associated with organic cotton that act as a barrier to development. Organic cotton farming is generally more labor intensive, and yields are usually lower than conventional cotton cultivation systems; thus, to be successful, the price of organic cotton lint should be higher than that of conventional cotton, or farmers should be given subsidies. (Usher, 2006). Ethiopia is becoming known for its organic cotton production, and there are several certified organic cotton producers in the country's southern region, with ambitions to expand to other prospective cotton producing areas. However, in farming, the use of natural fertilizers such as bone meal, castor cake, and wood ash is not normal.

4.4 Non cotton Indigenous Cellulosic Fibers

Non-cotton Indigenous Cellulosic fiber can be found in plant fibers. A large range of plant kinds found in Ethiopian nature provide opportunities to extract novel fibers. The problem is to locate appropriate and sustainable resources for bio fiber expansion. The current work focuses on the exploration of Urera hypselodendron trunk fiber (Azanaw et al., 2018). Yucca elephantine plant leaves fibers (Azanaw et al., 2019). Ensete, Ethiopia's sole known wild species, is concentrated in the southern highlands but also grows in the central and northern highlands near Lake Tana, the Simien Mountains, and as far north as Adigrat and southern Eritrea. (Sisay, 2011). Yucca elephantine plant. A tree found in damp or drier forests ranging from Ethiopia and East Africa to Southern Africa. Yucca elephantine plant leaves can provide cellulose fiber. (Azanaw et al., 2019). The following figure show about each plant and fibers.

Figure 6. Non cotton Indigenous Cellulosic fiber plants (Azanaw et al., 2019, Sisay, 2011)

Dissimilar portions of florae give raw resources for Manufacturing cellulosic fibers. Parts of different plants give fibers with excellent properties. Leaf part of Yucca elephantine plant and False Banana (Enset) provide fibers with unique properties. Cotton seed fruit give fibers for special applications in figure 3.

5. Opportunities

Because of its great variation of altitude (ranging from around 155 meters below sea level at Assale Lake in the Danakil depression to roughly 4,533 meters at Ras Dejen), Ethiopia features some of the tallest and lowest-lying peaks. Ethiopia offers a great array of temperatures ranging from wet tropics to alpine climes suited for effective development of most sorts of temperate and tropical crops..

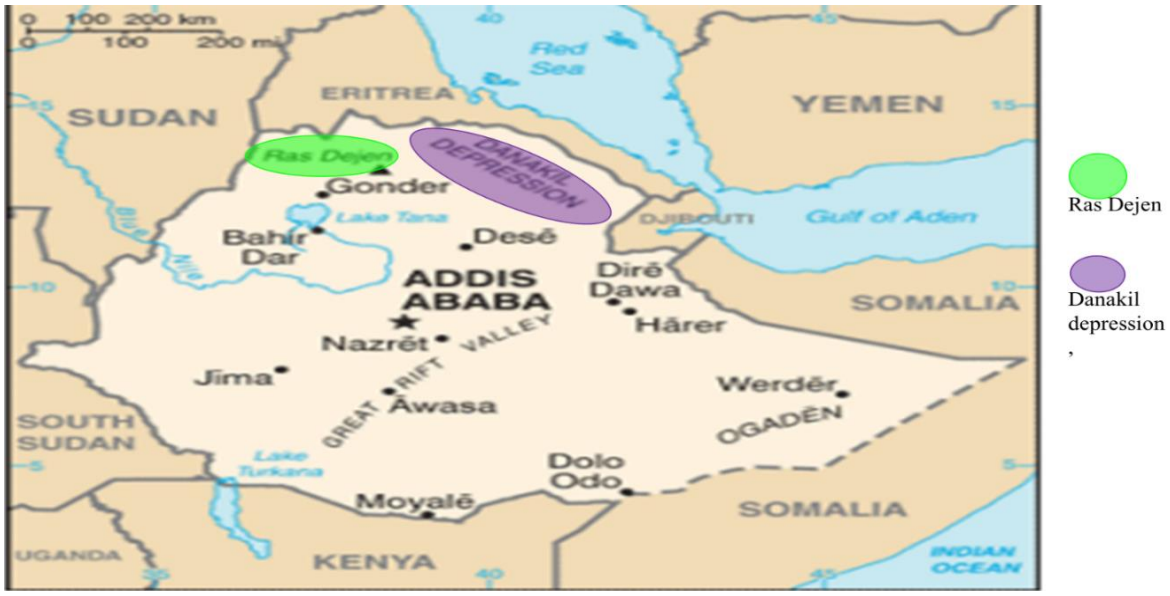

Figure 7. Map of Ethiopia Courtesy of the CIA

There are four distinct seasons in Ethiopia. Summer occurs between June and August. Fall lasts from September to November. Winter is the dry season, lasting from December to January. Finally, spring normally occurs between March and May(Fazzini et al., 2015).

The country contains twelve major river basins that include four major drainage systems. The majority of Ethiopia's rivers are seasonal, with nearly no perennial rivers below 1,500 metres height. Approximately 70% of the entire runoff occurs between June and September. The dry season flow comes from springs, which provide base flows for small-scale irrigation. Internal renewable surface water resources are estimated at 120,000 million m^3/year, while renewable groundwater resources are around 20,000 million m^3/year. However, 18,000 million m^3/year is considered to be overlap between surface water and groundwater, giving a total value of 122,000 million m^3/year (Gebul, 2021). Agriculture uses the most water (Figure 8). Irrigated and rainfed agriculture are both significant contributors to Ethiopia's economy. Nonetheless, rainfed agriculture produces nearly all food crops (97%) in Ethiopia, with irrigation accounting for only approximately 3% of food crops. Most industrial crops, including sugar cane, cotton, and citrus, are irrigated. Although irrigation technology is not yet widely used, it has the potential to reduce risk and increase yield. (ISLAND, 2005). The overall mean annual flow from all river basins is projected to be 122 billion cubic meters, with a groundwater potential of 2.6 billion cubic meters. These water resources could be used for irrigation. Ethiopia has one of the largest cattle inventories in Africa (Negussie et al., 2011).

6. Challenges

Even though cellulosic fiber has a huge potential to contribute to Ethiopia's textile sector, there are various hurdles that must be overcome in order to fully realize it's potential. The major challenges include: Significant absence of government commitment Policy, as well as a lack of well-organized research, information, and technology connected to the use of cellulosic fiber (excluding cotton), play an important role. Lack of communication between academics and policymakers or other organizations poses the following obstacles to cellulosic fiber research.

6.1 Challenges in integrating of indigenous knowledge and modern science

Indigenous knowledge is the understandings, abilities, and theories generated by communities that have extensive histories of engagement with their natural environs.(Bruyns, 2005). It refers to the distinct, customary, and local knowledge that exists within and has evolved around the distinctive societal conditions indigenous to a given geographic area. Indigenous peoples have historically offered a variety of ecological and cultural services to humanity. Preserving traditional farming knowledge and methods helps maintain biodiversity and protect the world's natural resources (Semali and Kincheloe, 2002).

6.2 Challenges in Technology and knowledge

An efficient technology for experiments Lab work has always required experience and knowledge, but now this knowledge and experience have a new dynamic dimension known as technology. Several technological and knowledge-related challenges exist. Most executives face difficulties because they lack experience and knowledge. They lack the skills required to carry out tasks effectively and efficiently. Due to time and resource waste caused by a lack of skills and the underutilization of available technology. As a result, there is no action research and almost no used technologies, leaving the cotton industry dependent. The government's lake of development sustainable textile production can assist start-ups with equipment installation such as lab instruments and not technological transfers, among other things.

Semali and Kincheloe (2002). It necessitates taking into account the local and global dimensions, as well as their interactions. It also necessitates widening the spatial and temporal horizons to account for the requirement for both intragenerational and intergenerational equity. Nonetheless, cellulosic fiber research in Ethiopia primarily focuses on the lack of integration of indigenous knowledge and current science in cellulosic fiber. There is still the potential to create a large amount of natural fiber from plants or vegetables, but researchers and society are relying on cotton as an example of direction priority. Cotton faces numerous obstacles, despite its well-known civilization, including

6.3 Challenges in Government policy

Government does not give budget for researchers to support work forward. Also not runs special programs like motivation. That menace not supporting from government comes by way of financial and technical support, and also through assistance to new fiber materials.

6.4 Sustainability Challenge.

Large scale production of cellulosic fibers has often prioritized investments in view of short-term profitability (field preparation, machines, management), and the cropping and planting system in place are not environment friendly or sustainable

7. SWOT analysis in indigenous cellulosic fibers in Ethiopia

SWOT analysis is a regularly used tool for examining both internal and external surroundings concurrently in order to get a systematic approach and support for a decision situation (Yüksel and Dagdeviren, 2007). Strategic elements are those internal and external aspects that have the most impact on the establishment's future. SWOT divides these characteristics into four categories: strengths, weaknesses, opportunities, and threats (Kangas et al., 2001). Furthermore, the selection to be in harmony with the current and future goals of the decision makers (Kajanus et al., 2004). SWOT analysis is a systematic and comprehensive examination of issues related to new technology, management, or planning. Figure 10 illustrates how SWOT analysis fits into an environmental scan (Kahraman et al., 2008).

SWOT is an abbreviation for strength, weakness, opportunity, and threat. The first two components (strengths and weaknesses) pertain to internal factors, whereas opportunities and threats encompass a larger context or environment in which the business operates (Lumaksono, 2014). SWOT analysis can be implemented by evaluating and sorting things that affect all four elements, then applying it in the SWOT matrix image, where the application is how strengths can take advantage of opportunities.overcome weaknesses which prevents advantages from opportunities that exist, then how strengths are able to deal with existing threats, and finally how to overcome weaknesses that can make threats real or create a new threat (Chermack and Kasshanna, 2007). SWOT analysis evaluates and balances strengths and opportunities based on specific criteria. In addition, the SWOT analysis method can be utilized to evaluate the proposed framework against best practice frameworks in developing nations. (Terrados et al., 2007).

8. Conclusion

Sustainability has become an important characteristic of today's textile and clothing manufacturing, the procedure of converting textile industry into more sustainable one is actual sensitive, requirements a lot of knowledge, skills and commitment. Using sustainable fibers in textiles is a step toward this milestone. Cellulosic fiber has demonstrated strength in the market of textile fashion; these are much better and useful alternatives of dominant and high impact fibers. Cellulosic fiber has wide range of applications. But the use of these fibers is not common in textile fashion products especially when we talked about indigence cellulosic fiber. Use of indigence cellulosic fiber in the textile fashion industry is very limited or in very little percentage in different composites, indigence cellulosic fiber has potential to use in fashion products and other industries to make the environment green. By-products produced from these fibers are also very useful.

Many fashion companies are still working with conventional cotton products and making a lot of fashion products with multiple designs and colors. Customers are becoming aware day by day and want products that are good for their skin and bring comfort for them. And this learning makes customer aware about harmful and hazardous products they are using in their daily life. The future of textile industry will depend on the products that have reduced environmental and social burdens during their entire product life cycle. A part of this is the introduction of sustainable materials that will reduce these impacts during their growth and processing. And this review paper will provide fashion companies good knowledge of sustainable fibers (the raw material for their products) and brief description about their properties to support the use of cellulosic

fibers in their product that will serve the society as well as environment.

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