Chapter I

INTRODUCTION

'Where there is a challenge there has to be a response'

-M.S. Swaminathan

Throughout history, a deep connection has been recognized between the art of textile weaving and aspects of our inner understanding, a connection that persists to this day. While often subtle rather than explicit, textiles serve as a form of non-verbal communication, offering glimpses into the socio-religious and cultural narratives of societies. From ancient times, textile terminology has been utilized to convey philosophical concepts, as evidenced by terms such as 'sutra,' derived from the word for thread or 'sut,' meaning 'to string together.' Similarly, 'yantra' or 'jantra' refers to the loom, with 'tantra' also carrying connotations of weaving. Traditionally, the act of weaving textiles is imbued with a sense of reverence, viewed as a form of worship, and wearing sacred fabrics holds significance as both a creative endeavor and a source of spiritual and divine protection. (Dhamija, J. 2014)

The contemporary landscape of the 21st century indeed sees the realm of clothing as a dominant influencer across all aspects of our lives. Clothing isn't merely about what we wear; it's a cultural mirror reflecting our values, aspirations, and even our concerns about the world we inhabit. This dynamic industry continuously evolves, navigating through trends that emerge and fade with remarkable speed. However, amidst this rapid change, there's a growing consciousness about the environmental and social impact of clothing. The quest for sustainability has become a focal point for many within the industry and beyond. This movement recognizes the pressing need to reassess our approach to clothing production, from the sourcing of raw materials to the treatment of human resources involved in the process.

Traditional textiles, once overshadowed by synthetic materials in the race for efficiency and cost-effectiveness, are experiencing a revival. Their timeless appeal and often more eco-friendly production processes make them attractive options for designers and consumers alike. Fabrics like cotton, linen, wool, and silk are reclaiming their place in the spotlight, not just for their aesthetic qualities but also for their sustainability credentials. Ultimately, the pursuit of

sustainability in fashion isn't just a trend; it's a fundamental shift towards a more responsible and equitable industry.

India is blessed with a diverse range of natural fibers including cotton, jute, bamboo, sisal, coir, abaca, kenaf, banana, and ramie, which are abundant across different regions of the country. These fibers exhibit varying characteristics based on factors such as their plant origin, species, and geographical location. Typically, a considerable portion (around 30-40%) of agricultural and forest waste is either burned or left to decompose, leading to significant environmental hazards. Tackling this issue involves utilizing these waste materials in ways that enhance their value, thereby improving the economic viability of cultivation and generating employment opportunities. (Bhambure, S. Rao, A. & Senthilkumar, T. 2022)

Cellulose fibers sourced from leaves, stalks, or pseudo stems hold significant economic importance and contribute significantly to the livelihoods and food security of numerous farmers and processors. The development of new extraction methods ensures a steady supply of these plant fibers year-round, leading to value addition in textiles and product diversification. Additionally, plant fiber extraction initiatives contribute to poverty alleviation and employment generation in rural and semi-urban areas.

At ICAR-NINIFET in Kolkata, extraction of fibers from banana, pineapple, flax, and other plants is facilitated using newly developed extraction machines. For banana fiber extraction, the process begins with peeling the trunk, followed by two methods: hand scraping and machine stripping, known as "tuxing," yielding stripped stems called "tuxies." Mechanized machines have been introduced to streamline this labor-intensive process. Flax fiber extraction involves a retting process followed by scutching, where fibers are separated from the outer composites of the stalk. An improved extractor featuring two additional scutching rollers aids in breaking down the stalk into smaller intervals, enhancing efficiency.

Pineapple fiber extraction entails crushing the hard outer layer of waste leaves, followed by scraping and combing in the extractor. These advancements in extraction methods promise increased productivity and efficiency in the utilization of plant fibers. (Nayak, L, K. 2021).

The textile industry, when aligned with the UN's Sustainable Development Goals (SDGs), particularly SDG no. 12 focusing on Responsible Consumption and Production, holds significant potential for advancing multiple other SDGs. Through the adoption of sustainable practices, such as the use of renewable energy and cleaner technologies in fiber processing, the industry can make substantial contributions to goals related to Clean Water and Sanitation, Industries, Innovation, and Infrastructure, and Climate Action. (DiscoverSDGs,https://mci.textileexchange.org/discover/sdgs/, 2023)

1.1. Background of the study

Northeast India indeed a breathtaking natural beauty, with its lush green landscapes, rolling hills, dense forests, and diverse wildlife. The region is endowed with a overabundance of natural resources, ranging from rich flora and fauna to mineral deposits. Additionally, the Northeast is renowned for its vibrant cultures and traditions, each state within the region offering a unique tapestry of customs, languages, and festivals.

Agriculture and handloom weaving are indeed the important sectors of Manipur's socio-economic landscape, as well as in many other states across the Northeast region of India. These sectors not only provide livelihood opportunities for a significant portion of the population but also serve as custodians of cultural heritage and traditional craftsmanship.

The northeastern region of India, commonly known as the "seven sisters," encompasses Assam, Arunachal Pradesh, Nagaland, Mizoram, Manipur, Tripura, and Meghalaya, inhabited by both tribal and non-tribal populations. Textile weaving, predominantly undertaken by women, is a prominent practice in this region, showcasing a diverse array of over 38 tribes. Each tribe boasts unique designs, color palettes, and ceremonial motifs, reflecting a rich cultural heritage. These distinctive textile patterns not only vary among tribes but also within clans of the same tribe and across different villages, serving as indicators of social standing. (Traditional Textiles of India, NCERT, 2014)

Handloom weaving, in particular, stands out as a vital component of Manipur's socio-economic framework. The intricate designs, vibrant colors, and superior quality of Manipuri handloom textiles are a testament to the skill and dedication of local weavers. The use of locally

sourced raw materials, such as mulberry silk, not only adds to the authenticity of these textiles but also contributes to the sustainability of the industry. In addition to handloom weaving, agriculture plays a crucial role in driving the economy of Manipur. The cultivation of fruits, including pineapple, has emerged as a major source of income for farmers in the state. Pineapple cultivation, in particular, has gained prominence due to its economic viability and suitability to the region's climate and soil conditions.

Despite the abundance of natural resources in Manipur, there remains significant unexploited potential, especially in the post-harvest utilization of agricultural resources. This underutilization represents a missed opportunity for maximizing economic returns and promoting sustainable practices in agriculture.

In light of these factors, there is a growing recognition of the need to explore innovative approaches to harnessing the full potential of Manipur's agricultural resources. By promoting value addition and diversification, as well as exploring avenues for utilizing agricultural by-products, such as pineapple leaves, the state can unlock new opportunities for economic growth and development.

Kingdom	**Plantae**
Family	Bromiliaceae
Genus	Ananas
Species	A. comosus
Binomial	Ananas comosus

According to the **Krishi Vigyan Kendra** report on pineapple cultivation, this fruit thrives in regions with high rainfall and humid coastal climates, making it particularly suitable for cultivation in the northeastern states of India. Key commercial producers of pineapple include Assam, Meghalaya, Tripura, Mizoram, West Bengal, Kerala, Karnataka, and Goa. The fruit juice from pineapples is exported to countries such as Nepal, the UK, Spain, and the UAE. Pineapples offer numerous health benefits, including boosting the immune and digestive systems. The bromelain enzyme found in the fruit aids in digestion and is beneficial for treating conditions like dyspepsia, bronchitis, high blood pressure, and arthritis. Ideal conditions for pineapple cultivation include temperatures ranging from 20°C to 36°C, along with a humid climate. The soil pH should be acidic, falling within the range of 5.5 to 6. Sandy loam soil is considered ideal, while heavy clay soil should be avoided. India predominantly cultivates

several varieties of pineapple, including Kew, Giant Kew, Queen, Jaldhup, Mauritius, and Lakhat. The northeastern region of India commonly cultivates varieties such as Giant Kew and Queen.

Pineapple (Ananas comosus) cultivation is a significant agricultural activity in the northeastern region of India, particularly in Manipur, one of the seven sister states. Known locally as "Kihom" in Manipur, the pineapple plant plays a crucial role in the region's agricultural landscape and economy. According to data from the Imphal Free Press, (2023) Manipur produced a noteworthy 134.82 metric tons of pineapple fruits during the 2021-2022 harvest season, positioning itself as the 6th largest producer of pineapples in the country.

Despite the impressive fruit yield, a notable aspect of pineapple cultivation in Manipur is the underutilization of its resources. While the fruits are harvested for consumption and commercial purposes, the leaves of the pineapple plant are often overlooked and discarded after harvest. This represents a missed opportunity for maximizing the potential of the pineapple plant and harnessing its various components for additional economic and environmental benefits.

Pineapple leaf fiber extraction from the leaves can be conducted manually or using machines. In the manual method, after the retting process, the leaves are scraped to extract the fiber. However, this process often results in significant fiber damage and requires substantial time and labor. Alternatively, the mechanical extraction method involves crushing the green leaves using a raspador machine, followed by combing to separate the fiber from the soft parts of the leaves. At ICAR-NINFET, an improved pineapple leaf fiber extractor has been developed. This machine features feed rollers, scraping rollers, and combing rollers to facilitate uniform and high-quality fiber extraction. The machine allows for multi-feeding, enabling up to three leaves to be processed simultaneously. With a capacity of 30 kg/hr and an average yield of 2 percent per leaf, this extractor significantly enhances the efficiency and productivity of pineapple leaf fiber extraction.

The pineapple leaf fiber (PALF) possesses a white hue and exhibits a smooth, glossy appearance reminiscent of silk, along with medium length and notably high tensile strength. Its surface texture is soft, and it demonstrates good absorbency while maintaining color integrity better than many other natural fibers. Due to its high cellulose content, PALF is inherently

hydrophilic. Chemical analysis reveals a diverse composition within PALF, including polysaccharides, fats, waxes, pectin, lignin, uronic acid, anhydride, pentosan, color pigments, and various inorganic constituents. The fiber's cellular structure is held together by pectin, and its arrangement resembles that of cotton fibers, with a cellulose content ranging from 70% to 82%. In yarn preparation, PALF exhibits greater tensile strength than jute fibers. Given these properties, PALF shows promise for use in manufacturing reinforced composite materials, particularly when combined with synthetic fibers due to its cost-effectiveness and biodegradability. The superior mechanical properties of PALF are attributed to its high alpha-cellulose content and low microfibrillar angle (14∘). (Asim, M., Adam, K., & Jawaid, M., & et. al.2015).

Pina, extracted from the leaves of the pineapple plant, serves textile purposes. The fiber, soft, lustrous, and typically white or ivory in color, is highly sensitive to acids and enzymes. Immediate rinsing to remove acids is crucial, and presoaking in detergent should be avoided to prevent damage. Hand washing is recommended for laundering pina fabrics. These fabrics are known for being lightweight, sheer, and stiff, often adorned with embroidery for formal and wedding attire in the Philippines. Additionally, pina fiber is utilized in the production of mats, bags, tablecloths, and various apparel items. Current research aims to develop commercially viable blends of pina that can seamlessly integrate with other fibers.(Kadolph, J, S. 2014).

A forward-thinking company has devised an innovative approach to repurpose agricultural waste generated from pineapple cultivation into natural textiles, effectively tackling environmental and social challenges. With the global rise in pineapple consumption, there's a corresponding surge in pineapple waste, particularly discarded leaves, amounting to approximately 25 million tonnes annually. Traditionally, these leaves are either burned or left to decompose, contributing to methane emissions, a potent greenhouse gas. Simultaneously, the fashion industry, especially fast fashion, has witnessed remarkable growth, exerting considerable strain on the environment. It's estimated to contribute to 10% of greenhouse gas emissions and consumes vast quantities of water, aggravating freshwater scarcity worldwide. Ananas Anam has presented a dual solution to these pressing issues by utilizing pineapple leaf fibers to create two natural fabrics: Pinatex and Pinayarn.

The process involves collecting discarded leaves, extracting long fibers using semi-automatic machines, washing, drying (either naturally or in ovens), and blending them with corn polylactic acid to form a non-woven mesh that serves as the base material for the textiles. Pinayarn is a compostable and biodegradable yarn, while Pinatex serves as a sustainable alternative to leather, eliminating the need for tanning processes involving harmful substances. Moreover, by circumventing leaf incineration, significant reductions in CO2 emissions are achieved, approximately six kilograms for every kilogram of yarn produced. (Innovation Snapshot, 2014).

The utilization of pineapple leaf fiber (PALF) presents a promising solution to the challenge of underutilized pineapple leaves in Manipur, particularly in the context of the state's renowned handloom and textile industry. Traditionally, the main materials used in weaving traditional textiles in Manipur are cotton and silk. While silk is highly valued for its luxurious texture and lustrous appearance, its production involves complex rearing practices for silkworms and is often prohibitively expensive.

Karolia, A. (2019) describes the preparation of yarns for weaving Manipuri textiles, which primarily involves cotton and mulberry silk (known as Kabrang) or blends of the two. Initially, cotton was cultivated in both the plains and hills of Manipur, but weavers later began purchasing various yarns directly from wholesalers in the local market. These woven textiles are then marketed by wholesalers in locations such as Guwahati, Mysore, Bangalore, and even China. Some weavers have opted to incorporate acrylic, polyester, and synthetic yarns into their weaving process as a means to reduce the cost of raw materials.

The introduction of PALF as an alternative fiber offers several advantages. Firstly, PALF possesses properties similar to silk, such as its long, fine fibers and lustrous appearance. This makes it suitable for various textile applications, including traditional weaving techniques practiced in Manipur. By incorporating PALF into traditional textiles, weavers can achieve a similar aesthetic to silk at a fraction of the cost, making these textiles more accessible to a wider range of consumers.

Moreover, PALF utilizes a readily available resource that is currently being wasted after pineapple harvesting. By repurposing pineapple leaves into fiber, this initiative promotes sustainability and reduces agricultural waste, aligning with global efforts towards environmental conservation.

Furthermore, the cultivation of pineapples and extraction of PALF require minimal additional skill training for local communities. Unlike silk production, which involves intricate rearing practices for silkworms, processing pineapple leaves into fiber is a relatively easier process that can be easily integrated into existing agricultural and weaving practices in Manipur.

Utilizing sustainable raw materials in textile production is crucial for mitigating the environmental impact of the fashion industry. While synthetic materials dominate contemporary clothing manufacturing due to their affordability and versatility, they often contribute to pollution and resource depletion. In contrast, natural fibers offer a more sustainable alternative, as they are biodegradable, renewable, and have lower environmental footprints throughout their life cycles. When considering sustainable textiles, it's not just about the materials themselves but also about preserving traditional weaving practices and knowledge. Traditional textiles represent a rich cultural heritage and often involve techniques that have been passed down through generations. By continuing to support and invest in these traditional practices, we not only preserve cultural identity but also promote sustainable production methods that utilize local resources and minimize environmental impact.

One such example of harnessing local resources for sustainable textile production can be found in Manipur, where the left-over pineapple leaves presents an opportunity for economic growth and environmental management. Instead of allowing these leaves to go to waste after pineapple consumption, they can be repurposed into valuable pineapple leaf fiber. By transforming agricultural waste into a usable material for textiles, we can reduce waste, conserve resources, and create new economic opportunities for local communities. The production, processing, and export of pineapple leaf fiber have the potential to support livelihoods for small-scale farmers, daily-wage workers, and artisans in Manipur and beyond. This not only boosts economic development but also fosters a more sustainable and resilient local economy.

Moreover, by focusing on traditional weaving techniques and incorporating locally sourced materials, such as pineapple leaf fiber, into textile production, dyeing the fiber with plant dyes, we can create unique and culturally significant products that resonate with consumers who value sustainability and authenticity. In essence, the integration of sustainable materials, traditional knowledge, and local resources in textile production exemplifies a holistic approach to sustainability that prioritizes environmental management, cultural preservation, and economic development. By embracing these principles, we can pave the way for a more sustainable and resilient future for the textile industry and the communities it serves.

1.2. Statement of the problem

- The problem highlights several key issues regarding agricultural waste in India, particularly focusing on the potential of utilizing pineapple leaf fiber in textile production in the northeastern region, specifically Manipur.
- India, being an agrarian country, generates a substantial amount of agricultural waste. This waste is expected to increase with the country's growing population and the consequent rise in demand for agricultural products.
- Agricultural waste comprises the residues of plants left in the fields after harvesting crops. These residues present an opportunity for utilization in various sectors, including textile production.
- Different types of fibers can be extracted from various parts of fibrous crop plants, such as bast, leaf, seeds, and pseudo stem fibers. These agro-fibers have the potential to serve as alternatives to synthetic fibers, which are often harmful to the environment.
- The northeastern region of India is characterized by its heavy reliance on agriculture, resulting in the availability of significant amounts of agricultural waste. Pineapple cultivation is particularly prominent in this region, with Manipur being a major contributor to its production.
- Pineapple leaves, which are abundant after harvesting the fruit, present an opportunity for extraction and utilization as fiber. This is significant in Manipur, where pineapple cultivation is prevalent and the leaves are typically discarded after harvesting for their fruits.

- Utilizing pineapple leaf fiber in textile production in Manipur can contribute to the "vocal for local" initiative, promoting the use of locally sourced materials in manufacturing processes. This not only supports the local economy but also fosters sustainable practices by reducing reliance on synthetic fibers. Traditional skill and practices of weaving of traditional need to be sustained in the fast growing technology. Therefore, natural resources can be used in sustaining the culture and tradition of a society.

1.3. Rationale of the study

The rationale of the study is centered on the abundance of pineapple leaf waste in Manipur and the potential economic and environmental benefits of utilizing this waste material for textile production.

- Abundance of Pineapple Leaf Waste: In Manipur, pineapple cultivation is widespread, resulting in a significant amount of waste in the form of discarded pineapple leaves after the fruits are harvested. This presents an opportunity to convert this waste into a valuable resource for textile production.
- Economic Growth and Eco-Friendly Materials: Utilizing pineapple leaf waste for textiles can contribute to economic growth by creating new avenues for income generation, particularly for small-scale farmers and daily-wage workers. Additionally, producing textiles from natural, eco-friendly materials aligns with sustainable practices and addresses concerns about environmental degradation associated with synthetic fibers.
- Livelihood Opportunities: Processing and exporting textiles made from pineapple leaf fiber can become a major source of livelihood for local communities involved in farming and textile production. This not only provides economic stability but also enhances the socio-economic well-being of the region.
- Preservation of Traditional Skills: By experimenting with pineapple leaf fiber for textile production, the researcher aims to retain the traditional skills of local weavers. This

ensures the preservation of cultural heritage and traditional craftsmanship while introducing innovative materials and techniques.

- Alternative to Conventional Fibers: Pineapple leaf fiber serves as an alternative to conventional fibers like silk. It offers a sustainable and potentially cost-effective option, especially when considering the abundance of pineapple cultivation in Manipur.
- Integration with Handloom Industry: Manipur has a rich tradition of handloom weaving, and integrating pineapple leaf fiber into the weaving industry can further enhance its prominence in the textile sector. This not only meets the demand for new materials but also reinforces Manipur's position as a key player in the handloom industry in India.
- Community Interest in Innovation: There is a growing interest among the people of Manipur in exploring new materials for weaving while preserving traditional textiles. However, this experimentation often lacks scientific backing. The researcher aims to bridge this gap by conducting systematic research on the utilization of pineapple leaf fiber, ensuring both innovation and scientific rigor.

1.4. Objectives of the study

1. To study the present status of availability of pineapple leaf fiber in India.

2. To test the properties of extracted pineapple fiber.

3. To modify the fibre for producing pineapple yarns for the traditional textiles and surface ornamentation.

4. To develop union fabric samples on handloom using the produced yarns as weft with silk/rayon/cotton yarns as warp.

5. To study the properties of the samples produced.

6. To develop the traditional textiles of Manipur using Pineapple leaf fibre yarns.

7. To produce colour palettes with reactive & locally available natural dyes used in making the traditional textiles.

8. To create awareness about the use of pineapple waste in the area of textiles.

Hypothesis

Null hypothesis (H_o) - Traditional textiles using pineapple leaf fiber will not be accepted by the consumer

Alternate hypothesis (H_1) - Traditional textiles using pineapple leaf fiber will be accepted by the consumer

Delimitation of the study

The study is delimited to hand woven traditional textiles of Meitei community of Manipur

1.5. Scope of the study

- The scope of the study encompasses various dimensions, from assisting local pineapple growers to promoting traditional textiles made from pineapple leaf fiber in Manipur and beyond:
- Assistance to Pineapple Growers: The study aims to assist local pineapple growers in Manipur by providing guidance on the utilization of pineapple leaf waste after harvesting fruits. This involves exploring methods for extracting fiber from the leaves and understanding the potential economic benefits.
- Skill and Income Generation for Weavers: By utilizing the fiber extracted from pineapple leaves, the study seeks to generate skills and income opportunities for local weavers in Manipur. This involves training weavers in the spinning process and facilitating the production of traditional textiles using pineapple leaf fiber.
- Fiber Extraction Methods: The study considers both manual and machine extraction methods for PALF fiber. While manual extraction may be suitable for small-scale operations, machine extraction, using decorticators available in research institutes or from producers, can facilitate bulk production.
- Spinning and Yarn Preparation: Local weavers will be involved in the spinning process to prepare different yarns from the extracted fiber. This includes achieving yarns similar

to silk by joining the ends of strands and utilizing motorized spinning machines as an alternative to traditional charkha.

- Promotion of Traditional Textiles: Incorporating pineapple leaf fiber into traditional textiles sustains the practice of weaving while offering sustainable alternatives. The study aims to innovate traditional textiles by exploring pineapple fiber as a raw material, thus preserving cultural heritage while meeting contemporary demands.
- Market Opportunities: The locally produced traditional textiles can be marketed through the handloom industry of the state government, promoting Manipur's local products to other states and industries. Value addition, such as using plant dyes and surface ornamentation, can enhance consumer appeal and marketability.
- Expansion into Fashion Garments: In addition to traditional textiles, the study explores the potential for constructing fashion garments using pineapple fabric for the global market. This opens up opportunities for diversification and reaching a broader consumer base beyond traditional textile markets.