One Town One Product: Case Studies of Vibrant Communities in Sri Lanka

Edited by

Dimithri Devinda Jayagoda | Buddhini Chatumaduri Dharmawardhana

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Preface

The concept of One Town, One Product (OTOP) is an extension of the One Village, One Product (OVOP) initiative, first introduced in Oita Prefecture, Japan. Having lived in Beppu City for eleven years, pursuing my undergraduate, master's, and PhD studies I had the privilege of learning about this concept firsthand. Through my academic journey at Ritsumeikan Asia Pacific University, I engaged in several training sessions under the guidance of Professor Koichi Miyoshi, working on projects aimed at developing rural areas across different regions. During this time, I also witnessed how delegates from around the world visited our university to understand this concept and implement it in their respective countries.

It was through these discussions and experiences that I became deeply invested in the potential of OTOP. Conversations with Buddhini Dharmawardhana led us to the realization that while Sri Lanka already had a similar foundation, it lacked structured promotion and recognition. Our initial research revealed numerous examples of localized industries that were thriving but not widely acknowledged: Kajugama cashew, Ambalangoda masks, Matara beeralu lace, Thissamaharama curd, and many others. Each of these towns had built a unique identity around a specific product, demonstrating the potential of community-driven economic growth.

Recognizing the importance of small and medium-sized enterprises (SMEs) as the backbone of a strong economy, we set out to document and promote these industries. This book is the result of our efforts to highlight the impact of community-based businesses and their role in driving Sri Lanka's economic development. Beyond economic growth, this initiative also fosters community capacity development, women's empowerment, and local area development.

Our goal with this book is not only to document these success stories but also to create awareness and encourage further development of Sri Lanka's indigenous industries. We hope this will be the first of many efforts to uplift local businesses, strengthen Sri Lanka's economic landscape, and bring the country's rich entrepreneurial spirit to the global stage.

This book was first published in April 2025. Following a few amendments, we decided to reprint it as a second edition. I am thankful to the colleagues and scholars who suggested changes after reviewing the book, and I am especially thankful to Ms. Yenuli Minsandee Amaratunga for her contribution in proofreading.

We have published this book as an e-book to ensure easier access.

Dr. Dimithri Devinda Jayagoda
Buddhini Chatumaduri Dharmawardhana

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Chapter1: Introduction

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1.1 Background of the concept

The "One Village, One Product (OVOP)" strategy is similar to the "One Town, One Product (OTOP)" development initiative that emerged in the 1970s in Oita Prefecture, Japan, but has since been adopted by many countries to support domestic financial development and entrepreneurship (Natsuda, 2012). Its central idea is to identify and promote one unique product, craft, or way of life of a village or locality that represents its cultural, historical, or natural diversities. By doing so, it strives to rejuvenate the economy of the countryside, create jobs, keep the knowledge of traditions and techniques alive, and stimulate innovations. Examples include Bungo Wagyubeef and Yuzu in Oita Prefecture; conventional rice dishes in Akita Kiritanpo; crafts in Gifu lacquerware; and Hokkaido, famous for its sweet, smooth texture (Natsuda, 2012).

OTOP has become a powerful tool for economic revitalization in Japan, building on local strengths, high quality, and participation by communities. OTOP has had an immense impact by preserving local cultures, achieving sustainable development, and creating an exclusive global market for Japanese rural products. It

aims to capitalize on local culture, customs, natural resources, and skills to provide a product that can recompense that locality in the more widespread market. Having initially succeeded in revamping rural economies in Japan, the OVOP movement was readily adapted and implemented in other parts of the world thereafter. Several regions were helped in reviving their economic stagnation by creating unique local products and promoting them internationally. Following the movement's success in Japan, other countries started to adopt it, including Thailand, the Philippines, and Indonesia.

1.2 Case studies showcasing the implementation of OVOP or OTOP in countries across the world.

In **Japan**, the OVOP initiative originated with the launch in Oita Prefecture in 1979. The aim was to encourage the rural population to develop in one way or another through the promotion of one unique local product or service from each village. Several items like crafts, food products, agricultural goods, etc., were produced by the different countries using Japan's OVOP model that stands as a classic example of success. Building on this concept, OVOP and similar initiatives have been adopted in numerous countries around the world.

In **India,** there are examples of the adoption of the OVOP concept in many areas to promote the production of local handicrafts, fabrics, and agricultural products like Karnataka silk and Kerala spices. In India, OTOP resulted in rural development, cultural preservation, and

income generation for the greater bulk of rural artisans and agricultural producers. **Vietnam** has executed an identical endeavor with an aim to promote local products for domestic and international markets. Local products such as silk, handmade items, and traditional food products are the most common ones that are promoted via OVOP.

To make it similar to OVOP, **Thailand** has launched the OTOP program since 2001. According to Rattanakhamfu et al. (2014) the nature of its works involves the production of handmade items imbedded with the essence of Thai culture and tradition, including handicrafts, food items, and textiles. Like Japan, Thailand also aims to furnish benefits for occupational development and promote the economic development of rural communities through the OTOP program. OVOP has been used in **Malawi** to upscale the local economy by promoting the small-scale production of agricultural products, fabrics, and handmade products from rural communities. The adoption of this concept would improve rural living standards and provide export opportunities for local commodities. The same was adapted in **Kenya** to promote local products, including handicrafts, agricultural products (tea and coffee), and conventional apparel. This concept is utilized in **Ghana** to promote the local agricultural products and crafts to bring in good revenues for the rural community and work for the sustainable industry.

With a similar program, **Malaysia** has also shown goods to promote each state within the districts, such as

culinary products, handmade products, and natural resources, benefiting all from this rural economic development. The OVOP model applied in Nepal has concentrated on the development of handmade crafts, farming productions, and tourism services that are exclusive to their specific villages in order to promote the local economy. Under the OTOP concept, Cambodia encourages domestic producers and artisans to promote sustainable tourism by highlighting locally made products like fabrics, pottery, and other handicrafts. OVOP is also a strategy employed in Tanzania to uplift rural economies through a channel of support and marketing for unique local products that are centered on agriculture and crafts.

In the **Philippines,** the concept of OVOP was adopted, and in effect, the OTOP program was initiated (Department of Trade and Industry 2017). The initiative focuses on giving importance to promoting the locality of each town, which is best characterized by its handmade crafts, fabrics, culinary items, and other agricultural products. In the case of **South Korea,** it pursues almost the same as OVOP in Japan. Different regions in the country promote specialized products, like kimchi and traditional handicrafts that provide for rural economic growth through domestic commodities. OTOP is also present in **Indonesia,** where each region promotes its local product identified in line with its natural resources or cultural legacy. Undeniably, this has contributed to the heightened market visibility of Indonesian culture-based ornaments and products since then.

1.3 The key attributes of OVOP and OTOP

There are key attributes visible in these initiatives. Culture and local identity are two of the main features. OVOP highlights the unique cultural legacy, rituals, and conventions of the town, with the product being a local typical craft, culinary product item, or a service reflecting the identity of the area (Natsuda et al., 2012). By emphasizing a particular flagship product from the town, a background can be created for enhancing the local economy while creating job opportunities that can eventually lead to attracting tourism or investments in the area. This usually leads to the prosperity of small businesses and industries in that particular locality. The village or region selects a unique product that symbolizes its individuality, which might be local farming items, crafts, or some special services the product comes from. It should also be tightly linked to the cultural legacy or natural ravages of the area.

This concept also promotes sustainability. It promotes the use of natural local resources, which can help people economically and promote environmental consciousness. Marketability and branding are other features. The selected product is branded and marketed as the town's flagship item. Efforts are made to build a strong brand identity around the product, showcasing its unique features and storytelling about it. The presence of a unique product helps promote the branding and advertising of the town on both regional and international platforms. Local, regional, and national promotion efforts are undertaken to increase awareness and demand for the

product. This may include trade fair appearances, online selling platforms, and retail partnership opportunities for wider accessibility. According to JICA (2019), Quality improvement is also another aspect. There are all efforts to enhance the quality of the product that has been singled out. They could provide training for artisans or manufacturers to develop their skills and better training methods of production that will allow them to meet certain quality levels. As it prioritizes quality over quantity, those countries that implement the OVOP concept create high-quality products, not so much mass production. This also establishes the differentials between the two competing products in local and global markets.

Community engagement is crucial to the success of OTOP. Local communities are encouraged to take part in the furtherance of the selected product in an active way. This often entails partnerships between local governments, enterprises, and members of the community. Sustainable development is one of the aims of the OTOP strategy (JETRO, 2023). Hence, the program focuses on the distinct strengths and resources present in each town. It encourages environmental sustainability, safeguards cultural heritage, and community welfare. Moreover, these movements promote the grassroots participation of local communities, consisting mostly of cultivators, craftsmen, and small-scale entrepreneurs. Community people can get direct benefits from this initiative because they are in the value chain from product development.

It has a direct link to the development of tourism. OTOP can also be connected with tourism as it attracts tourists due to the unique local products and the history behind them. It would also promote the livelihood of the people through tourism-related endeavors. The OVOP movements aim to rejuvenate the local economy by focusing on a particular product, therefore creating employment opportunities and preventing rural-to-urban migration. The proposed strategy promotes self-reliance and strengthens regional pride. Promoting export marketing is another attribute. Some OVOP products remain well-marketed within the country, while others have broken into the international market and are recognized globally for their ruralness. Support from national governments is important to implement this concept. For instance, Japanese government support for this initiative is both prevalent on the international scene and on the national level, such as through training programs, grant opportunities, and marketing campaigns.

1.4 Employing the OVOP or OTOP framework within the context of Sri Lanka

If Sri Lanka were to adopt the OTOP strategy, each town or region could veritably produce some unique product or craft representative of its cultural and historical attributes, perhaps even of the natural attributes. With diverse resources and a rich heritage, Sri Lanka would have immeasurable options to implement these strategies. Here are a few potential examples for this subject.

Ceylon Tea (in Kandy) is known for its lush greenery. Tea cultivation in Kandy could focus on high-quality Ceylon Tea (Sri Lanka Tea Board, 2020). The town needs to improve the production methods used to grow tea, taking care of the quality of tea leaves, and promoting unique blends of teas. Marketing efforts could emphasize the area through the tea plantations and the cultural significance attached to Ceylon Tea. Handwoven textiles in Galle could modernize its specialization in handwoven fabrics, given the history it shares with the artistic community. Conventional weaving methods would be preserved and enhanced to create an assortment of special and searingly strong textiles. The cultural significance of these products and their highly eco-friendly nature could be the basis of sales pitches. As far as cinnamon products in the Southern region from Kalutara to Matara are concerned, given the high quality of cinnamon produced in Sri Lanka, traders in these areas could focus on cinnamon-based products. It could mean everything from cinnamon sticks to essential oils and other modern uses. This would be a great chance for the town to sell its unique taste of cinnamon, the one that was linked with the spice trade throughout history. Ratnapura, also known as 'The City of Gems,' is yet to take the mantle by expanding the specialization in gems and jewellery production (Perera, 2018). This would involve some great steps toward ethics in the sourcing of gems, innovative designs in jewellery, and keeping up with the quality in craftsmanship. It is worth noting that the success of the OTOP strategy depends on community engagement, participation, collaboration between local stakeholders, and effective promotional methods. The

selected product should not only be unique but should also ensure the sustainability of development and economic development. Tourism can play an important role in the process, and steps should be taken to attract tourists who would want to know about and buy these unique local products.

1.5 The approach adopted by a group of professionals to examine the subject

A group of professionals and academics initiated this study in 2024, conducting a basic pilot study in a few selected areas where one specific product is specialized. This study was carried out within a limited time frame, involving observations and discussions with local villagers. All ethical guidelines pertaining to research have been complied with. It is important to mention that the sole intention of this study is to identify key areas and their associated products and to emphasize the importance of incorporating the OTOP concept into Sri Lanka's local production. This approach seeks to foster economic growth and community development while preserving and promoting the country's cultural heritage and indigenous knowledge.

It should be noted that this is a basic study conducted by the group. The products and services produced in each town, the processes involved, and the challenges faced by the villages or individuals engaged in these industries were not explored in greater detail due to several limitations, including financial, time, and human resource constraints. The team intends to carry out extensive

research in the future, overcoming these challenges, and aims to publish additional volumes of this book as an extension of the current study. Furthermore, all members of the study and research group were advised to follow the ethical guidelines of research and academic standards in carrying out their respective research.

Rather than strictly adhering to the conventional style of a research book or academic publication, the authors have adopted a storytelling approach followed by famous case study-based research while incorporating elements of academic publication (Yin, 2018). This blend aims to make the content more comprehensive for any reader. It is believed that this method also facilitates any individual to grasp this concept more effectively.

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Chapter 2: Sri Lankan Traditional Mask Industry: A Cultural Legacy Worth Saving

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Abstract

The Sri Lankan traditional mask industry, deeply rooted in indigenous knowledge, serves as a testament to the island's vibrant cultural heritage. This study examines the historical development, craftsmanship and contemporary challenges associated with mask-making, particularly in Ambalangoda, the centre of this art form. Utilizing direct observations and interviews with artisans and the chief administrator of Bandu Wijesooriya School of Dance, the study explores the detailed process of mask carving and its deep connection to ritualistic performances like 'Kolam' and 'Shanthi Karma'. The findings reveal that financial instability faced by some small-scale traders and diminishing interest from younger generations pose considerable challenges to the industry's sustainability.

To preserve this cultural heritage, the study recommends governmental assistance in the form of financial aid, awareness programs, and educational initiatives. The incorporation of Information and Communication Technology to document and formalize traditional knowledge could facilitate its preservation and innovation. Additionally, encouraging tourism and

developing export markets for handcrafted masks could revitalize the industry while preserving its authenticity. By recognizing the traditional mask industry as both a cultural treasure and an economic resource, Sri Lanka can protect its artistic legacy and support the livelihoods of its artisans.

Keywords: *Traditional mask industry, Indigenous knowledge, Kolam, Shanthi Karma*

"Art and culture are not just frills, but crucial elements of human life"
(Daniel Libeskind)

1. Introduction

Renowned American architect and artist Daniel Libeskind states that art and culture are not just frills, but crucial elements of human life (cited in Srivastava, 2024). This quote emphasizes how culture and the arts are deeply embedded in and essential to our everyday lives. It also emphasizes that they are not merely flimsy embellishments but are essential elements of our identity. Culture also enriches how people live their lives.

Handmade masks represent one of our cultural legacies. A leading hub for these traditional masks can be found in Ambalangoda, a well-known tourist destination in Sri Lanka. What began as a family-run enterprise in this region has now grown into a larger operation, engaging numerous skilled artisans who carve and paint masks at the local museum.

2. Method

In this study, current literature concerning the Sri Lankan traditional mask industry has been referred to gain background knowledge about arts and crafts of Sri Lanka. The geographical area of the study is mainly Ambalangoda, and a case study has been done based on the mask industry in the Ambalangoda area. In this study, direct observation and interviews have been conducted. The consents were taken from interviewees, and ethical guidelines were followed throughout the study. The Ariyapala Traditional Mask Museum in Ambalangoda has been visited. In addition, Bandu Wijesooriya School of Dance has been visited, and the in charge of the school has been interviewed. A few villagers who craft masks have also been interviewed. All data have been analyzed in a qualitative way[1].

3. Overview of the Mask Industry

Amid a few generations within the contemporary mask industry, this paper focuses on one of the trailblazers in the industry, whose family lineage predates the

[1]Ethical guidelines have been complied with, and consents have been acquired from all individuals involved in the discussions. Furthermore, consents have been obtained for the publication of photographs related to the museum as well as the school of dance.

colonization era. As per documented history, they manage the mask museum located in Ambalangoda, which is deemed a notable tourist destination in Sri Lanka. Originally, it was a family-operated venture, which now employs many artisans who carve and paint masks at the museum. The primary customers of the organization are comprised largely of international purchasers (Gunaratne, Thudugala, and Ranasinghe, 2016). Prior to exploring the evolution of the mask industry and its present status, it is important to acknowledge the vitality of the art and culture that stem from indigenous knowledge in a broader context.

3.1. Identifying the vitality of the art, culture and creative work derived from indigenous knowledge

Wigg (2007) emphasised the significance of strengthening societal intellectual capital at both national and international levels to effectively engage in the global knowledge economy. As pluralism and the global emphasis on all-inclusive multicultural education, traditional wisdom has come to be recognized as a fundamental element in the culturally diversified advancement of the society (Wasonga, 2005; Lobb, 2012, cited in Gunaratne, Thudugala and Ranasinghe, 2016).

Indigenous knowledge, also referred to as local knowledge, folk knowledge, or local know-how (Gunaratne, Thudugala, & Ranasinghe, 2016, p. 152), represents a unique, culturally specific body of knowledge tied to particular communities, as identified by Lwoga (2011, as cited Gunaratne, Thudugala, & Ranasinghe, 2016, p. 154). Typically transmitted orally

across generations through traditional narratives, cultural legends, folk songs, puzzles and cultural practices, indigenous knowledge serves as a basis of demonstrating the creative expressions, skills and the societal and economic development of civilizations.

Considering the indigenous knowledge in relation to health practices and treatments of illness, the practice of 'Shanthi Karma' was utilized. These 'Shanthi Karma' demonstrate regional variations across Sri Lanka, and the low country, especially southwestern coastal areas, notably embrace the 'Shanthi Karma' of 'Kolam' dancing as a therapeutic method of healing some ailments. 'Kolam' dance aims to dispel the fright inside the human psyche. It is associated with dancing, drumming, and mask carving. Mask carving is a notable regional practice and cultural heritage in the southern maritime region, particularly prominent in the region of Ambalangoda. (Gunaratne, Thudugala, and Ranasinghe, 2016, p.154).

Some scholars recognize indigenous knowledge as the social capital of marginalized communities, developed through the adversities encountered in their lives (Senanayake, 2006, as cited in Gunaratne, Thudugala, & Ranasinghe, 2016, p. 152). In essence, indigenous knowledge can be deemed as the scientific understanding of local communities, applied to across various facets of their livelihoods, such as farming, medicinal applications, education, and environmental stewardship (Lwoga, 2011; Sukla, 2006, cited in Gunaratne, Thudugala, & Ranasinghe, 2016, p. 154).

3.2 Historical Context and Evolution of Mask Creation

According to Wijesooriya (2023), the conventional masks of Sri Lanka can be divided into various groups, each with its distinctive character and associated myths. These groups include 'Kolam', 'Sanni', 'Pali', and 'Raksha'. Each of these categories of masks is steeped in rich folklore and carries significant cultural and historical meanings.

Although precise documentation about the exact origin and historical development of these masks is sparse, the available chronicled proof suggests that the art of mask-making has been a crucial part of the coastal low-country communities for over two centuries. These communities, particularly those in the southwestern coastal areas of Sri Lanka, such as Ambalangoda, Bentara, Mirissa, and Pokunuwita, have become famous for their skilled craftsmanship and dedication to mask carving and traditional dancing. The mastery displayed in these areas has helped preserve and propagate the unique cultural heritage of Sri Lankan masks, ensuring that these artistic traditions continue to thrive (Wijesooriya, 2023).

The art of mask-making in Sri Lanka has evolved simultaneously with the development of the 'Kolam' dance. According to Sri Lankan folklore, the origin of the 'Kolam' dance, which is one of the most significant forms of mask dance, is tied to a peculiar pregnancy craving. This craving emerged during the reign of King Maha Sammatha. King Maha Sammatha's queen, while

pregnant, experienced an unusual desire to witness a performance that combined dance with elements of humour and satire. This craving was unique and unprecedented, as no existing performances could meet her specific desire (Aruna, 2022).

The king, eager to fulfil the queen's craving, faced a dilemma, as no one in the kingdom knew of such a dance. He promptly ordered the royal drumbeater to traverse the country and seek out any individual who could create and perform such a dance. Despite diligent efforts, the search proved futile, and the king became increasingly distressed. In response to the king's growing anxiety, God Sakra, moved by the king's sorrow, summoned Vishwakarma, the divine architect and creator of arts in heaven. Vishwakarma was given the task of devising a solution to satisfy the queen's peculiar pregnancy craving. Following divine directives, Vishwakarma left a collection of intricately carved wooden masks and books containing the necessary songs and detailed instructions for the performance in the royal garden. The next day, the royal gardener stumbled upon these items and immediately brought them to the king's attention. Overjoyed by this unexpected discovery, the king organized a group of people to craft the masks and adhere to the instructions contained in the books. These performers successfully created a dance that was rich in humour and satire, thus fulfilling the queen's craving (Wijesooriya, 2023).

This momentous event not only satisfied the queen's unique desire but also marked the inception of a new

form of dance, the ‘Kolam’, and the traditional folk art of mask-making (Wijesooriya, 2023). The ‘Kolam’ dance, characterized by its humorous and satirical elements, became an integral part of Sri Lankan culture. The art of mask-making, deeply intertwined with the ‘Kolam’ dance, flourished as a cherished tradition passed down through generations. This narrative highlights the cultural significance and the rich heritage associated with Sri Lanka's traditional masks and the ‘Kolam’ dance, celebrating their enduring legacy and their role in the island's vibrant cultural tapestry.

3.3 Creation of traditional masks and rituals attached to it

In the past, the wood from the 'Din' tree, which thrived along riverbanks, was commonly used for carving masks. However, due to its lack of durability and longevity, this type of wood was eventually replaced by the more resilient Vel Kaduru or Rukattana wood. Vel Kaduru, in particular, became the preferred material for crafting traditional low-country masks. This tree, often found in marshy areas near paddy fields, was favored because its wood was lightweight, easy to carve, and comfortable to wear during dances (Wijesooriya, 2023).

Further, according to Wijesooriya (2023), the process of mask carving was steeped in various rituals. Ancient craftsmen performed several rites before felling a Kaduru tree. They sought an auspicious time, offered flowers and lamps to the tree's deity, and they also requested the deity to relocate to another tree. Only after these ceremonies

were completed did they proceed with cutting down the tree for their craft. Since the Kaduru tree trunk is enveloped by a thick, milky bark, the initial step in mask-making is to strip it away. Once the wood dries out in the tender breath of wind, it is then sliced into the required dimensions. Our forebears, adhering to traditional and hereditary carving techniques, utilized poetic verses to accentuate the mask's features. These verses are specific to each mask. For example, here is a verse used during the carving of a 'Surambavalli' Mask that is mentioned below.

"Singithi muva mudune - Dēlē makaru dedene
Emeda nari varune - Kiyan me seti suramba varune"
(Wijesooriya, 2023, p.16).

The meaning of the poem is "on the top, a small, attractive face, and on either side, two dragons or makaras. A lady is placed in the middle of them. This would explain the traits of Suramba".

Figure:1 Ariyapala Mask Museum, Ambalangoda
Source: Author, 2024

Mc
the precise dimensions needed for mask-making, as stated by Ambum Kavi, special measuring tools are

employed. These techniques comprise procedures such as measuring by eyesight, finger measurements, or using cubit or 18-inch length techniques. 'Akshi Manaka', which involves observing with the eyes, and 'Anguli Manaka', using fingers, are essential in this regard.

After the artisans smooth the masks, they apply colors. Historically, the ancestors employed materials such as the tails of stingrays and the mouths of sailfish (Talapath), as well as the tender leaves of breadfruit trees (Del Savaran), to smooth the masks. Nowadays, coarse materials like sandpaper are utilized instead of those natural tools. The masks are colored utilizing barks from trees, flowers, and various types of stones sourced from the natural environment, and those are blended with Dorana Oil. These components are gathered and then ground together to create different colors. The brushes utilized for applying these colors are crafted from the roots of the screw pine tree (Vatakeyya) and the wool or manes of animals. When the artisans use conventional methods, it requires a considerable amount of time to dry and complete masks. No other color can be added until the initial layer is completely dry. Consequently, completing a mask using traditional techniques takes at least three weeks (Wijesooriya, 2023).

These traditionally created masks have served multiple purposes throughout history. Some masks, particularly, have been essential in various folk dances like the 'Kolam Maduwa' and rituals such as 'Dahaata Sanni', 'Devol Maduwa', 'Gara Maduwa', and 'Ridii Yaga'

(Wijesooriya, 2023). They have also been used in processions and in household decorations.

The transmission of knowledge of mask creation from one generation to the next is a fascinating field worthy of investigation. The shared set of values is strongly associated with the socialization process within the generation. Fathers engaged in chanting the 'sholakas' (ceremonial chanting) together with their sons. Sholakas elucidate the nature of masks. Chanting the shlokas was one of the techniques to apprehend knowledge. Shlokas indicated characteristics of masks that are written on Ola leaf books. For example, a shloka associated with the 'Gara Yaksha' Mask (a demon known as Gara) provided youngsters with insights into the design and form of the mask to be crafted and attributes of the character (Gunaratne, Thudugala, and Ranasinghe, 2016).

The Shloka of 'Gara Yaksha' in the 'Kolam' script of the family is translated into English as below. "Gara Yakshaha's very big eyes that resemble the fruits of the Gada tree, he also has large ears that are bright and radiant in appearance. On the top of the head, there are cobra heads that stare everywhere. When he is dancing he will heal all ailments and improve your health" (Gunaratne, Thudugala, and Ranasinghe, 2016, p.160).Therefore, the young individuals understood the nature of masks through descriptions in shlokas. In the past, knowledge on mask carving was confined to key individuals. As a result, the knowledge was mostly tacit, driven by the abilities, knowledge and experience of the person.

The lineage of Ambalangoda Kolam artists has been derived from one family, which is deemed as the central point of their tradition. The genealogy of Ambalangoda Kolam Dance can be illustrated as follows.

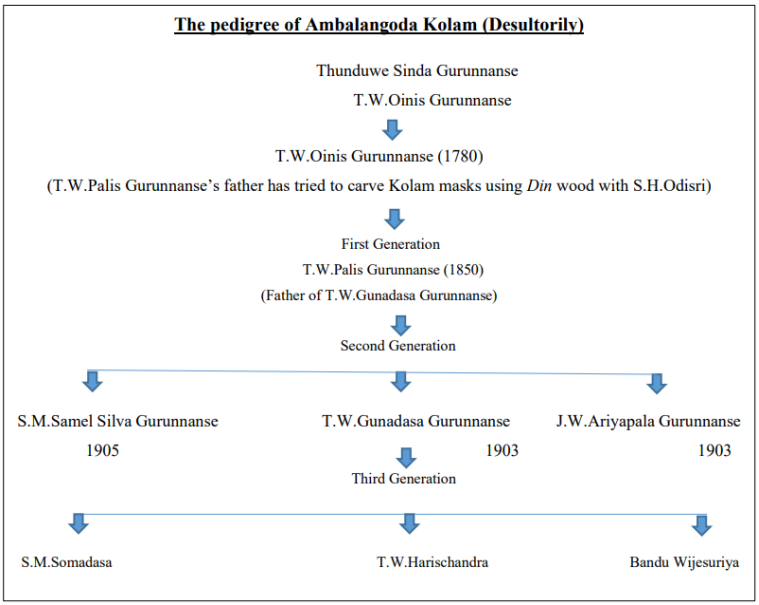

Figure 2: The Pedigree of Ambalangoda Kolam
(Source: Aruna, 2022, p.34)

The institution currently known as 'Ariyapala Traditional Masks' has a history that spans several centuries. This has been improved upon and mastered by the Wijesooriya family of Ambalangoda over generations. Currently in its seventh generation, the Ariyapala tradition practices traditional mask carving and Low Country dancing. The cultural legacy of this family has become interwoven with the identity of Ambalangoda.

One of its prominent figures is 'Ariyapala Wijesooriya Gurunnanse', hailed as one of the finest craftsmen Sri Lanka has ever produced. He taught the elaborate art of traditional mask carving and dancing to Mahindapala Wijesooriya, a master carver of national and international renown. (Ambalangoda Ariyapala Traditional Masks, 2023).

3.4 Challenges and obstacles faced by the traditional mask-making industry

Various families maintain inherited Kolam scripts relating to special know-how of carving and painting masks, etc. Recently, handwritten scripts on paper replaced the Ola leaves used by the ancestors. Ink scripts are preserved at the mask museum. Codifying knowledge, meaning the process of making implicit knowledge explicit, has only been done in a few sources and is generally deemed inadequate. Codified sources are closely guarded family secrets (Gunaratne, Thudugala, and Ranasinghe, 2016).

Presently, some members from the present generation who are descendants of families historically engaged in the mask crafting industry have ventured into other enterprises, owing to financial pressures. This lack of full commitment to mask-making, sporadic use of mask making techniques, and rare application of mask craft skills leads to the erosion of generational traditional knowledge pertaining to mask-making. The inability of some young individuals in the present generation to carry out customary and un-codified work routines due to their

usual daily tasks has become the root cause of poor knowledge utilization (Gunaratne, Thudugala, and Ranasinghe, 2016).

It was revealed that engaging in the traditional mask-making industry is not particularly lucrative for small-scale traders, as some artisans do not have a stable income. Crafting masks using traditional methods requires significant time and effort. To adequately compensate for labour costs, these masks must be sold at higher prices, which is why the primary clientele consists largely of foreign customers. The future of this industry appears uncertain, as it is an art form that demands extensive time and dedication to master. Despite their hard work, these artisans find it difficult to make a living from this craft. As a result, many young individuals today choose not to pursue mask-making.

The Head of the Art Institute, Bandu Wijesooriya School of Dance, Ms. Kanchana Wijessoriya, expressed her views as follows:

> "The mask industry differs from many other industries because it is based on art and continues to develop in harmony with art. It is an industry closely connected with traditional dance, art forms, and rural rituals such as 'Shanthi Karma'. However, today, these arts, dances, and cultural elements are rarely seen in villages. As a result, the mask industry is increasingly limited to selling masks primarily to foreigners. Mr.Bandu Wijessoriya is my father, who is one of the sons

> of Mr. Ariyapala. I am one of the daughters of Mr. Bandu Wijessoriya. We train students for 'Pahatha Rata Natum' (low country dancing style), in which we use traditional masks with our dancing costumes. Managing this school provides me with immense satisfaction and a profound sense of personal fulfilment. Many young men and women are learning dance here" (Wijessoriya, K, 2024).

It is apparent that to manage supply more effectively and keep up with the demand brought on by commercialization, certain customary practices have sometimes been abandoned. Earlier generations would look up auspicious times and specific days before logging Kaduru to carve masks, whilst at present, owing to cost efficiency, quality, affordability, and convenience, log dealers supply the logs to the craftsmen, and those customary practices and some rituals are ignored (Gunaratne, Thudugala, and Ranasinghe, 2016). Hence, culturally sensitive and natively enriched aspects of the mask industry have sometimes been overlooked.

As noted by Gunaratne, Thudugala, and Ranasinghe (2016), indigenous knowledge is predominantly tacit, intensely personal, and highly concentrated to specific people, families, and locals. Quality is reliant on the craftsperson's experience. Although indigenous knowledge can be captured and recorded, the effectiveness of recording experimental knowledge is problematic. Even at present, where Information Communication Technology (ICT) is highly popular and

accessible, modern knowledge management techniques still remain rudimentary due to low concern given towards using ICT to capture this kind of indigenous knowledge. This limitation contributes to an overall failure to capture and document knowledge related to mask carving as well.

4. Conclusions and Recommendations

The traditional mask-making industry of Sri Lanka is a vibrant cultural treasure that represents the island's rich heritage and artistic creativity. Rooted in indigenous knowledge and practices, it has been transmitted through generations, symbolizing the cultural identity of communities, particularly in areas like Ambalangoda. However, despite its historical significance, the industry encounters multiple challenges, such as the loss of traditional knowledge, financial difficulties, and declining interest among younger generations due to many reasons.

To preserve this legacy, a comprehensive approach is essential. Government involvement through financial support, simplified assistance schemes, and educational initiatives can empower artisans and promote the craft. Incorporating modern technology to modify traditional techniques can also aid in knowledge preservation while opening new avenues for innovation. Furthermore, raising awareness about the cultural and economic importance of this art can inspire renewed interest among younger generations. By protecting and promoting this industry, Sri Lanka can protect its heritage while

simultaneously enhancing tourism and community livelihoods**.**

There are many steps that can be taken to uplift the mask industry and the livelihood of mask crafters. Providing more government support and incentives to small-scale mask makers is beneficial. Moreover, giving due recognition and acknowledgement to the leaders in the mask industry in these areas would also significantly facilitate upgrading the mask industry. As evident, although certain government schemes and authorities offer some assistance to small-scale traders, some traditional small-scale mask makers often do not benefit due to their lack of awareness. Thus, it is essential to raise awareness among these small-scale traders and ensure that the assistance and procedures are easy and simple.

Uncodified knowledge should be codified and integrated with ICT. The traditional mask trade in Sri Lanka is a culturally rich enterprise that deserves due recognition. To sustain and grow this industry, the government should provide more financial and other forms of support to encourage young people to start their own businesses within the trade. It is imperative to acknowledge families and organizations involved in the mask-making industry, as they play a significant role in promoting and preserving the industry and culture associated with the craft. Additionally, promoting the tourist industry in those areas and expanding the export market for traditional handmade masks, while safeguarding the

authentic essence of it would rejuvenate the mask industry.

Tony Hsieh, former CEO of Zappos, remarked, "Your culture is your brand" (Snyder et al., 2013). It is important to strengthen our cultural heritage to a national brand by promoting and enriching these types of culturally vibrant trades. These initiatives will not only facilitate the preservation of Sri Lankan culture, tradition, and indigenous knowledge, but they will also foster the economic growth of the country. By creating a stable income stream for individuals, it can address several social and economic challenges in Sri Lanka, including unemployment, poverty, and low Gross Domestic Product (GDP).

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Chapter 3: From Mangroves to Markets: The Rural Craft of Beverage Production in Sri Lanka

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Abstract

Mangrove Apple (*Sonneratiacaseolaris*), belonging to the family Lythraceae, is a native plant abundantly grown in the world's tidal halophytic forests, in coastal areas. The tree produces a small, round-shaped, greenish-yellow berry, known as the mangrove apple fruit, valued by rural communities for its soothing flavour and nutritional benefits. *Sonneratiacaseolaris* are essential to this ecosystem, mainly preventing soil erosion, riverbank stabilization, flood control, groundwater recharge, and pollution control. (Wickramasinghe S., 2022).

Figure 1: The (*Sonneratiacaseolaris)*, Mangrove apple tree at Polduwa,

The traditional drink made from the ripe fruit of the mangrove apple reflects the inheritance of Sri Lanka's coastal heritage. Highlighting the rural areas of Itthapana reveals the beverage manufacturing industry's historical context and evolution. Some local cooperatives, universities, and sometimes government institutes aim to promote the sustainable use of mangrove forests, including mangrove apples. The findings reinforce the potential of mangrove apple drink as a catalyst for economic development and environmental conservation in rural Sri Lanka, advocating for the expansion of this niche industry to regional and international markets.

Keywords: *Mangrove, Kirala drink, Environmental protection,*

1. Introduction

1.1 The Mangrove Apple (Sonneratiacaseolaris) - Gift of Mother Nature

Figure 2: Mangrove Apple Fruit
Source: Author 2024

Mangrove Apple (*Sonneratiacaseolaris*), belonging to the family Lythraceae, is a native plant abundantly grown in the world's tidal halophytic forests in coastal areas. This remarkable tree thrives in the brackish waters where freshwater meets the sea. *Sonneratiacaseolaris* ('Kirala' in Sinhala and 'Mangrove apple' in English) is a widespread underutilized fruit species of the

coastal region of Sri Lanka, particularly in Puttalam, Negombo, Mannar, Batticaloa, Galle, and Trincomalee, where the rich mangrove forests provide an ideal habitat for its growth. Sri Lanka comprises three identified species. In Sri Lanka, *S. alba* and *S. apetala* are considered uncommon and extremely uncommon species, respectively. *S. caseolaris* is a frequent mangrove feature in low-saline estuaries, particularly on the southern and western coastlines (Jayathissa L. P., 2016).

Typically grow up to 10-15 metres (Lanka Mangrove Museum, 2023) in height. It consists of obovate-elliptic coriaceous (Minh N. P., 2019) green leaves, aromatic white flowers, and specialized pneumatophores (breathing roots) that protrude from the soil and are well-adapted to the waterlogged, saline conditions of mangrove forests.

Figure 3: The Mangrove Apple Flower

Source: Author 2024

The tree produces a small, round-shaped greenish-yellow berry, known as the mangrove apple fruit. There is a star-shaped covering on the top, encased in a fibrous shell, and it has a soft, juicy interior with a sweet-sour taste valued by rural communities for its soothing flavour and nutritional benefits. Mangrove apple trees are essential to this ecosystem, mainly preventing soil erosion, riverbank stabilization, flooding, groundwater recharge, and pollution control (Wickramasinghe S., 2022).

Considering the sustainable development growth proposed by the United Nations, a new dimension is required to solve the world's hunger, either by a physical, political, or economic strategy. In the physical aspect, the concepts of bio-economy in the food industry occur by implementing the material from renewable resources. Mangrove fruits, for example, are a possibility due to their high phytochemical content. However, it is critical to note that the investigation of mangrove fruit should be represented in conservation strategies in each region (Budiyanto F., 2022).

1.2 The Essence of Mangrove Apple Drink

The traditional drink made from the ripe fruit of the mangrove apple reflects the inheritance of Sri Lanka's coastal heritage. With its dynamic greenish-yellow tone and captivating fragrance, each sip bursts out tropical refreshment. Mangrove Apple juice (Kiralabeema) is a medicinal drink that has been enjoyed for past years. It is one of the most significant uses of the mangrove apple fruit, popular in Sri Lanka's hot tropical environment. This drink is made by blending fruit pulp with sugar, water, and sometimes a bit of salt or spice. It provides a soothing refreshment. For a refreshing drink, fruit pulp is peeled, pulped, and mixed with water. To add abundance to the substance, stir in the honey, sugar, or milk made from coconuts. The taste of the mangrove apple drink is just like the aroma of the wood apple drink. In addition to being used in drinks, the fruit is consumed raw as well as in a variety of culinary applications, including desserts, jams, and chutneys. In indigenous medicine, the fruit is

believed to be astringent and antiseptic as it contains alkaloids, tannin, flavonoid, saponin, phytosterol, and carbohydrates (Minh N. P., 2019).

2. Method

2.1 From Fruit to Beverage - The Production Process

Mangrove Apples should be harvested when they are fully mature. Typically, the fruit colour changes from green to yellowish or reddish. Sometimes, it may depend on the species. The best time to harvest mangrove apples would be during the peak of the southwest monsoon season and the northeast monsoon season when the fruits are fully mature. Studies depict that a single tree produces plenty of fruits twice a year, and even in the low production season, it is capable of getting some harvest (Jayathissa L. P., 2016).

Villagers use sharp knives and fruit-picking poles to harvest the fruits from the tree, collect them into wooden crates or baskets and choose mature fruits that are free from pest attacks. For the preparation of fruit drinks from mangrove apples according to the traditional method practised at the domestic level. Ripened fruits are washed, and the calyx is eliminated. Then, the fruits are crushed and completely mixed with enough water to get a homogeneous mixture. It was then strained through a strainer to remove the seeds and skin parts. The filtered liquids are blended with sugar to make the mangrove apple drink.

In the industrial method, fruits are mixed to obtain a consistent fruit pulp and used in the preparation of fruit drinks. This technique may not be applied to mangrove apple (*S. caseolaris*) fruits because they are full of a large number of tiny seeds contained in the edible part, and damaged seeds accelerate the darkening of the pulp, leading to an extremely astringent flavour. Consequently, the fruit drink manufactured in the typical manner that is practised at the home level was utilized to make a bottled mangrove apple fruit drink and test its lifespan. In that process, the fruit drink was preserved with sodium benzoate (11.0 mg per litre) and sodium metabisulphite (4.0 g per litre); 190 mL aliquots were taken into 200 mL bottles and then sealed before pasteurisation at 85 °C (Jayathissa L. P., 2016). The enzymatic browning of the fruit pulp was a major problem in the commercialization of fruit products. The rate of enzymatic fruit product depends on the oxygen and the concentration of the enzyme polyphenol oxidase. Hence, a method was developed to get the fruit pulp at low temperatures to reduce the rate of enzymatic reaction (Jayathissa L. P., 2016).

2.2 The heart of rural production

Figure 4: Mangrove apple drink (kirala)
Source: Author 2024

When tourists, pilgrims, and travellers travel along the east-coast areas along the Hambanthota road, they would find the Kirala vendors selling Kirala drinks under large beach umbrellas, under tree shades, or at the verandas of their homes by the roadsides. This industry usually spreads in coastal areas like **Matara, Galle, Ambalangoda, and Hambanthota.** The potential of the mangrove apple (kirala) drink as a rural industry lies in its multi-dimensional contributions to the well-being of the local economies, cultures, environments, and community.

Thus, Mangrove Apple drink production offers a source of income for local communities involved in harvesting. Southern areas in Sri Lanka, for a considerable portion of the year, undergo high levels of solar radiation. Hence, mangrove apple is the best hydrating beverage for this condition.

It supports rural livelihoods, and also, this industry reduces the dependency on seasonal agriculture cycles. This creates employment opportunities among the harvesters and processors to distributors and retailers. This supports expanding the rural livelihoods and developing the socio-economic conditions by creating jobs in the community. Environmentally sustainable

harvesting techniques support the preservation of these habitats, which provides multiple economic benefits such as biodiversity conservation and carbon sequestration. By promoting sustainable harvesting and processing methods, the industry assists environmental stewardship among the local communities.

Mangrove apple drinks can be used as a unique local product to attract tourists who prefer to experience the culture and traditions of our country. It supports the development of market visibility for local products and services. Also, there is a potential to develop this industry to reach the wider regional and international market beyond the local market. It enhances the income opportunity for rural producers and exporters' resilience to economic growth.

2.3 The story of the Itthapana - The beverage manufacturing Factory

Itthapana, Horawala, located near the Benthara River, was a mesmerizing location that spanned along its banks. 20-25 years ago, rural people in the village lived sustainably and depended on agriculture to maintain their livelihood. Saline water from the nearby Benthara River rarely affected their farming, and farmers in the area were able to get plentiful paddy harvests since the unique traditional rice varieties used had a higher tolerance level to increased salinity and water levels. In response to the residents, the "Karijja Wella" proved successful in reducing seawater beyond a certain level. In addition to paddy cultivation, village women frequently engaged in different types of handicrafts using reeds grown in the

nearby swamps. It generated good income at the time. The handicrafts were sold in areas like Paravigama, Miigama, Aluthgama, and Mathugama and offered creative and financially successful women. Some people used to sell Lotus and Watakeyya flowers at the closely located and famous Buddhist temple, Kandewihara. As a whole, the people valued their reliable income and loyalty to the realm of nature.

After several years, it affected the sustainable existence enjoyed by the villagers of the area. Saltwater penetration to paddy crops steadily began to increase and reduce the productivity and harvest of the paddy fields, and they were no longer capable of productive farming. Production of cheaper plastic mats and mass-produced products which considerably decreased the demand for reed-based products. Paddy cultivation completely ceased, and approximately 300 acres of paddy lands were abandoned and then quickly invaded by exotic invasive species. Villagers fell into poverty, but outside investors started to invade the mangrove forest around the river to exploit the area for money. Wealthier businesspeople and companies opened non-eco-friendly tourist destinations, and boat services appeared along the riverbank, which was rapidly being destroyed by mangrove forests that were previously healthy, thriving, and rich in vegetation. As a result, tourism developments in the area. The Benthara River mangrove environment has become one of the most threatened mangrove ecosystems. The entire area appeared to be on the approaching ruin.

In 2004, environmental economics specialist Dr Suren Batagoda, an alumnus of the Faculty of Applied Sciences, University of Sri Jayawardanapura, learnt of the past and present situation of the ruined Horawala-Ittapana. He was motivated to assist this rural community and its unique ecosystem. He initiated an investigation of the sustainable economic potential of this mangrove ecosystem. He took immediate action to identify the need of the community to earn money through eco-friendly businesses. He constructed a small building in the area with the necessary facilities for a beverage manufacturing factory by using unutilized Mangrove Apple fruit *(Sonneratiacaseolaris)* for beverage manufacturing and sale. The business quickly drew attention from local villagers and produced 30,000 - 35,000 bottles of Mangrove Apple per month. A result of the success of this sustainable business was a revival in reed-based handicraft manufacturing. Unluckily, Dr Batagoda's terrible health prevented him from continuing with the procedures to which he had dedicated his life. Once again, the fate of the mangroves fell into uncertainty. Again, 2019 is the year when Dr Batagoda discovered the Centre for Sustainability (CFS) at the University of Sri Jayawardenepura. He was impressed with the many successful projects conducted by the CFS in environmental preservation, habitat rehabilitation, sustainable tourism, and ecological business. He decided to donate the land he had bought at Ittapana-Hawala village with the beverage processing factory building to the university by converting it into a mangrove research facility for researchers, students, and the wider academic community.

The CFS team, led by Dr Priyan Perera, CFS director and senior lecturer in DFES, worked for 18 months to collect fundamental information on the ecology, sociology, and economy of the Ittapana-Horawala area. This data was subsequently utilized to develop a strategy with the purpose of enhancing the rural community's financial circumstances while also safeguarding the Horawala mangrove ecosystem. The plan intends to cover the following key elements: preserving the mangrove ecosystem, increasing both regional and national understanding, and enhancing the community's financial standing (Centre for Sustainability, 2021).

3. Main challenges among vendors in the industry.

Rural producers frequently struggle with limited access to the market due to poor infrastructure and lack of transport facilities. This hinders their capacity to reach a larger consumer base and offer mangrove apple products at competitive pricing. Because processing techniques vary and modern processing equipment isn't always accessible, it can be difficult to maintain the constant quality of items made from mangrove apples. The effects of climate change, such as increasing salinity, rising sea levels, and harsh weather, can also affect mangrove ecosystems. The production of mangrove apples may be adversely affected by these changes.

4. Sustainability and Conservation

Figure 5:Mangrove Forest, Madu River. Source: Author,2024

Some local cooperatives, universities, and sometimes government institutes aim to promote the sustainable use of mangrove forests, including mangrove apples. The Ministry of Environment is initiating programs and projects for mangrove conservation and sustainable utilization (Ministry of Environment, 2021).

Seacology, a non-profit environmental conservation organization became the first nation in history to preserve the restoration of mangrove forests. They help to mitigate poverty in coastal communities by providing sustainable livelihood training for local communities, increasing economic security for families. They provide job training and micro-loans to empower women and young people by setting up village-based organizations (CBOs) to promote fishing and agriculture, fostering sustainable livelihoods that can ensure healthier environments. Almost entirely women in the village coordinate economic development and mangrove conservation activities (Seacology, 2016).

The Sri Lanka Mangrove Conservation Program began in 2015, with an agreement to collaborate among one of Sri

Lanka's NGOs called Sudeesa, Seacology, and the government of Sri Lanka. Through this contract, all three parties devoted five years to conserving all 8,815 hectares of Sri Lanka's current mangrove ecosystem and re-establishing a further 3,885 hectares utilizing nursery-raised mangrove seedlings (Seacology, n.d.).

5. Discussion

Sonneratia caseolaris is a widespread, underutilized fruit species of the coastal region of Sri Lanka, particularly in Puttalam, Negombo, Mannar, Batticaloa, Galle, and Trincomalee, where the rich mangrove forests provide an ideal habitat for its growth. Considering the sustainable development growth proposed by the United Nations, the concepts of bio-economy in the food industry occur by implementing the material from renewable resources like mangrove apple fruits (*Sonneratia caseolaris*)**.** In this chapter, we looked at the cultural and economic significance of Sri Lanka's mangrove apple beverage industry, which is highly significant to rural communities. Sri Lanka's heritage is reflected in the mangrove apple drink.

From a financial point of view, many rural families boost their income by producing a variety of mangrove apple drinks. The sale of this beverage at the local market and to tourists generates good income. By promoting local entrepreneurship, the beverage also encourages sustainable economic development. Mangroves play a crucial role in maintaining the health of coastal ecosystems. Mangrove Apple trees are essential to this ecosystem, mainly preventing soil erosion, riverbank

stabilization, flood control, groundwater recharge, and pollution control. As we conclude this chapter, environmentally sustainable harvesting techniques support the preservation of these habitats, providing multiple economic benefits. By helping rural producers in villages and promoting sustainable practices, we can ensure that this legacy persists for future generations. By considering this unique aspect while empowering the communities that keep it alive, we can create a brighter and more sustainable future for both the people and the environment.

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Chapter 4: Dried Fish Production in Sri Lanka: Challenges and Opportunities for Sustainable Growth

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Abstract

This article studied the current status of the dried fish industry in Sri Lanka, including the current practices, its contribution to the economy and the livelihood of the local community within the country. This further investigated the key challenges of the industry, such as quality control during dried fish processing and the introduction of technological advancements. The dried fish sector in Sri Lanka significantly impacts the socioeconomic well-being of the people who dwell near the coastal belt and are adjacent to the inland water bodies. By analysing the potential of value addition in the industry, the introduction of modern technologies for processing, and market diversification, the marine and inland dried fish industry in Sri Lanka can be uplifted while achieving sustainable growth in the sector.

Keywords: *Dried fish, Fishing, Seafood, Sri Lanka, Sustainability, Economic impact*

1. Introduction to dried fish production in Sri Lanka

The fishery industry has been a major economic activity in Sri Lanka that provides an income generation method for the coastal communities. Sri Lanka has a coastal belt of approximately 1,760 km, which has made fisheries play a prominent role in the local economy. In addition, the Exclusive Economic Zone (EEZ) of Sri Lanka extending up to 200 miles is the area reserved for the country, which is area-wise equal to 517,000 $km^{2,}$ rich in marine biodiversity, including different fish species (FAO, 2019). Moreover, the total extent of lagoons and estuaries is around 1210 km^2. Therefore, Sri Lanka possesses an adequate level of physical resources that can position its fisheries sector as a major opportunity for economic growth.

The fisheries sector in Sri Lanka has three segments, including coastal fisheries, offshore/deep-sea fisheries, and inland fisheries and aquaculture. The growth in overall finfish aquaculture and shellfish culture is occurring due to the available resources within the country supporting the local communities and ensuring food security via improvement in the seafood industry. There is a range of fish and fish products available throughout the country, such as fresh fish, dried fish, Maldives (smoked) fish, and Jaadi (fermented fish). In addition, there are opportunities for value addition in the fish industry that can transform raw fish into more refined products. That has enhanced the economic value of fish products in Sri Lanka while creating employment

opportunities for local communities (Koralagama et al., 2021).

Among these fish and fish products, dried fish, which is also known as "Karawala", has been an important commodity in the trade within the country, which also plays a prominent part of the culinary tradition of the country. While a greater proportion of the total fish production is iced and consumed as fresh fish, 14% of the fish catch is preserved using conventional techniques such as sun drying, salting, smoking, and fermentation, and finally producing "dried fish." As a conventional technique, salting along with sun drying of fish has been used as a method of reducing post-harvest losses of fish and also to produce a microbiologically stable fish product that has a long shelf life. For this production, fish catches from both marine and freshwater bodies are used in Sri Lanka. Dried fish is consumed as a main course and as a flavourful addition to the main meat, rice, and vegetable dishes within the country (Koralagama et al., 2021).

The dried fish industry provides opportunities for livelihood for countless women and men while playing a significant nutritional and cultural role in the local diet (Koralagama et al., 2021; Weeratunge et al., 2021). These dried fish are primarily traded within the local market via a value chain with the participation of local fishing communities and cultures. According to the statistics of NARA (2022), the dried fish industry employs around 585,000 people. By providing employment, income, food security, and economic

opportunities, the dried fish industry plays a major role in the resilience and well-being of the coastal community and those who dwell near the inland water bodies. This article discusses dried fish production in Sri Lanka, the challenges in the industry, and the potential for development in this sector.

2. Present status and trends in dried fish production and consumption in Sri Lanka

2.1 Dried fish production and consumption in Sri Lanka

Table 1: Statistics related to total fish production and dried fish production in Sri Lanka

	2017	2018	2019	2020	2021
Annual marine fish production (Mt)	449,440	439,370	415,490	326,930	331,675
Annual inland fish production (Mt)	81,870	87,690	90,340	101,810	104,235
Domestic dried fish production (Mt)	60,190	61,250	54,880	59,760	51,340
Dried fish imports (Mt)	33,012	32,704	35,059	42,746	32,585

Reference: Fisheries statistics (2021, 2022)

Table 2. Per capita consumption of dried fish over the past years (kg/year)

	2006/2007	2009/2010	2012/2013	2016	2019
Marine dried fish	3.8	3.7	3.5	3.5	1
Freshwater dried fish	0.1	0.1	0.1	0.1	-

Reference: Fisheries statistics (2021, 2022)

The total marine fish production in Sri Lanka has decreased from 449,440 Mt in 2017 to 331,675 Mt in 2021, as shown in Table 1, whereas inland fish production has increased from 81,870 Mt in 2017 to 104,235 Mt in 2021. This reduction during those five years could be attributed to several factors, such as the COVID-19 pandemic issue, climate change impacting fish populations, or the economic crisis that prevailed within the country, which hindered the fishermen from going fishing due to high fuel prices, etc. In contrast, inland fish production has seen a positive trend during that period, which could be due to increased aquaculture efforts such as an increase in inland boats and other fleets, improved management of inland water bodies such as fingerling development programs, etc (Fisheries statistics, 2022).

However, only around 1/8 of the total fish production has been used for the production of dried fish within the country by 2021. In addition, a total of 32,585 Mt of dried fish had been imported to the country in 2021. This data suggests that there is still potential for improving the dried fish production (both inland and marine) within the

country. The possible reasons for this phenomenon could be a lack of processing technologies, lack of quality control systems, inadequate infrastructure, or low per capita consumption of dried fish compared to fresh or frozen products.

The per capita consumption of marine and freshwater dried fish in Sri Lanka is depicted in Table 2. Per capita marine dried fish consumption has decreased gradually compared to 12-13 years back, while freshwater dried fish consumption did not show a considerable growth. This could be attributed to a change in consumer preferences or potentially a loss of dried fish quality over the years. Inland dried fish production also may have potential challenges in production, distribution, and maintaining the quality of the product. The most consumed dried marine fish species are sprats (41.7%), followed by mainly Balaya (11.1%), Keeramin (8.1%), Keelan (7.9%), and Katta (7.0%) on average per household monthly in 2019 (Fisheries statistics, 2021).

2.2 Marine and inland dried fish production in Sri Lanka

Dried fish production in Sri Lanka is mainly scattered in both marine and inland regions. Marine-dried fish production is prevalent in geographical locations such as Jaffna, Kilinochchi, Mullaitivu, Mannar, Negombo, Galle, Puttalam, Chilaw, Kalutura, Hambantota, Ampara, Batticaloa, and Trincomalee (Koralagama et al., 2021). These areas have direct access to the coastal belt, which facilitates capture and processing of various types of

marine fish species. Adequate sunlight reception for these coastal areas accelerates the fish drying process, reducing the growth of spoilage microorganisms.

In addition, inland dried fish production can be seen in areas such as Anuradhapura, Polonnaruwa, Moneragala, Ampara, and Minneriya districts. These inland dried fish are produced based on natural reservoirs and tanks in these dry zone areas of Sri Lanka (Jayasekara et al., 2022). These water bodies are nutrient-rich habitats for various inland fish species. Local communities that are dwelling adjacent to these inland water bodies have developed generational expertise in fish harvesting in these areas and dried fish processing techniques.

However, Sri Lankans enjoy both marine and inland dried fish well for a few reasons, such as their nutritional value, economic accessibility, and unique flavour profile. Table 3 shows the marine and freshwater fish species used to produce dried fish in Sri Lanka that mainly describe the common raw materials used for dried fish. Considering the fish species currently used in the industry, there is a high chance of expanding the dried fish industry within Sri Lanka, especially the inland dried fish industry. Unfortunately, inland dried fish, which have potential economic and nutritional benefits, generally receive less attention compared to the marine sector**.**

Table 3: Marine and freshwater fish species used to produce dried fish in Sri Lanka

Categories	Common name	Scientific name	Sinhala name
Marine	Anchovy	*Stolephorus indicus*	Halmessa
	Double potted queen fish	*Scomberoideslysan*	Katta
	Shortfin scad	*Decapterusmacrosoma*	Linna
	Indian mackerel	*Rastrelligerkanagurta*	Kumbalawa
	Skipjack tuna	*Katsuwonus pelamis*	Balaya
	Pony fish	*Leiognathidae sp.*	Karalla
	Narrow-barred Spanish mackerel	*Scomberomorus commerson*	Thora
	Grey reef shark	*Carcharhinus sp*	Mora/Keelan
	Japanese Spanish mackerel	*Scomberomorus niphonius*	Sawara
	Sail fish	*Istiophorusplatypterus*	Thalapath
Inland	Cat fish	*Clarias brachysoma*	Magura
	Pearl spot cichlid	*Etroplussuratensis*	Koraliya
	Murrel	*Channa striata*	Loola
	Red-finned barb	*Puntius filamentosus*	Pethiya
	Bar eyed goby	*Glossogobiusgiuris*	Waligouwa

Reference: Jayasekara et al., (2022), Koralagama et al., (2021), Neranjala et al., (2022)

Diversification of the fish species used for dried fish production is a crucial factor that can help diversify consumer preferences while creating new product ranges as well. Those fish species with mild or less pronounced flavors can be used for dried fish production, as these flavors can be enhanced through salt and drying processes in the dried fish development. Further, introducing underutilized fish species after value addition through drying and salting can improve sales and profitability. At the same time, using these underutilized fish species to meet the dried fish demand within the country can reduce the pressure on overexploited fish stocks.

2.3 Current dried fish production practices in Sri Lanka

Improper post-harvest handling of newly caught fish may lead to considerable losses in fish production. That will eventually result in a huge economic loss to the fishermen as well. Dried fish production is a promising way to minimize the post-harvest losses in daily fish production. However, in Sri Lanka, dried fish is mainly produced by low-quality/damaged fish and/or excess fish in peak fish production seasons.

Even though modern technologies are available for dried fish production in the world, Sri Lanka still mostly relies on conventional production, which uses techniques such as salting, smoking, and sun-drying. However, these techniques considerably inhibit spoilage and pathogenic

microbial growth in fish, thus, dried fish has a long shelf life without a need for refrigeration or freezing. Therefore, dried fish has become a convenient animal protein source for the local community who do not have access to refrigerators or freezers.

Currently, the widely used method for dried fish production in Sri Lanka is salting followed by sun drying (Figure 1-7). The initial step in dried fish production is preparing the fish for the drying process. Generally, small fish, such as anchovies are typically processed whole, while larger fish undergo further preparation, which includes slitting or cutting into slices, depending on the size of the fish. Hygiene is a crucial factor throughout the dried fish production process, although it is not much of a concern in most areas of dried fish production in Sri Lanka. The fish is thoroughly cleaned, with the removal of guts and heads for larger fish.

For washing purposes, clean and uncontaminated water is essential. However, most of the marine dried fish production in Sri Lanka uses water readily available in coastal areas near the processing site. After cleaning, the fish are rubbed with coarse salt. The salt quality is critical as it must be clean and used in appropriate amounts. Then, these salted fish in plastic barrels or containers are kept there for a few hours to days (small maximum 8 hours, large fish 2-3 days) as depicted in the flow chart (Figure 1), thereafter exposed to sun drying in the hot sun for a few days (small fish- 8 hours, large fish 2-3 days).

During salting, salt added to fish can quickly draw into the flesh, and moisture in fish can be removed by osmotic dehydration. Coarse salt is always recommended for salt rubbing for the dry salting technique. That is because fine salt draws water too quickly from the outside of the fish, leaving the outer surface like a crust. Consequently, the water inside the fish could not escape, and the salt could not penetrate deep into the fish, resulting in a phenomenon called "Salt burn".

Further, there is another method of producing dried fish in the country which uses only sun drying without salting fish. This dried fish type is commonly known as "Boat dried fish" or "Bottukarawala". These boat-died fish are processed at sea, subjecting fish to cleaning and drying processes. Boat-dried fish is popular among local consumers due to its unique flavour, texture, and high quality.

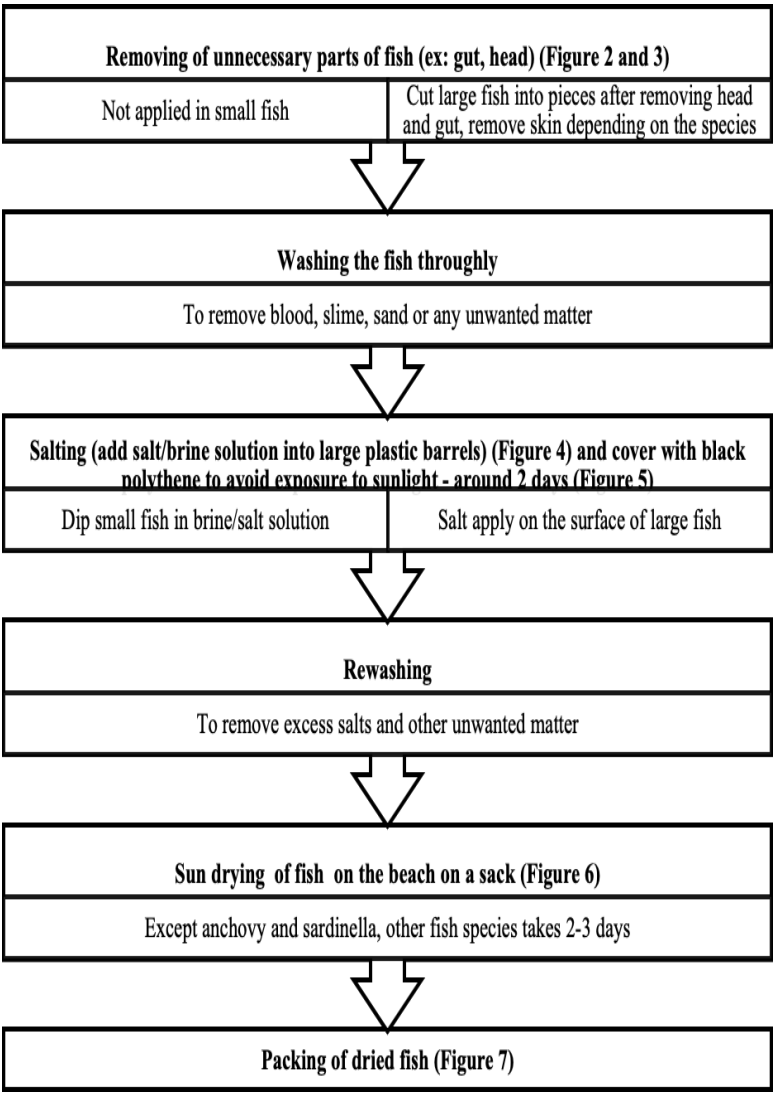

Figure 1: The general procedure of dried fish production in Sri Lanka
Source: Author 2024

Figure 2: Cleaning of fish to remove guts and heads of fish
Source: Author 2024

Figure 3: Preparation of small and large fish for dried fish production
Source: Author 2024

Figure 4: Salting of fish in plastic containers
Source: Author 2024

Figure 5: Covering of containers with black polythene to avoid contact with sunlight
Source: Author 2024

Figure 6: Sun drying of salted small fish and split large fish
Source: Author 2024

Figure 7: Packaging of dried fish in cardboard boxes
Source: Author 2024

3. Economic and social impacts of the dried fish industry

Dried fish production and related activities perform several functions in the social and economic sectors. Most importantly, it generates sufficient income for many fishing households through direct and indirect employment opportunities in the sectors (Table 4). As Table 4 describes, the total number of marine and inland fishing households has considerably increased from 2017 to 2021. In contrast to marine fishers, who include both men and women, the number of inland fishers (men and women) involved in inland fisheries has gradually increased from 60,595 in 2012 to 91,020 in 2021, which is a positive trend. Fisheries, in general, provide alternative livelihoods to both men and women in the coastal belt and nearby inland water bodies. The dried fish industry may provide employment opportunities for fishermen, processors, traders (wholesalers/retailers), and transporters, contributing to rural livelihoods. Thereby, dried fish and related activities generate earnings for the communities living near the coast and freshwater bodies, particularly in rural areas with limited income generation opportunities.

Table 4: Local community engagement in fisheries

	2017	2018	2019	2020	2021
Marine fishing households	183,650	181,880	185,390	185,570	185,810
Inland fishing households	54,170	56,250	64,290	81,070	81,410
Marine fishers (Men and women)	220,870	218,130	224,610	225,020	224,190
Inland fishers (Men and women)	60,595	61,590	70,715	90,650	91,020
Direct and Indirect Employments (Marine & Inland)	582,000	583,000	585,000	586,000	586,000
Fishing and related livelihoods (Mn)	2.7	2.7	2.7	2.7	2.7

Source: Fisheries statistics (2021, 2022)

Dried fish processing is a primary livelihood for many coastal communities in Sri Lanka, especially for women in fishing families. Dried fish production is a labour-intensive process in developing countries like Sri Lanka as these countries still rely on conventional processing techniques. There are multiple stages involved in this industry from fishing to final consumption. Fishers, buyers, processors, sellers, and consumers are the main

players in the dry fish value chain. Men dominate fishing and ownership of processing centres while women contribute as a low-wage workforce.

Currently, women are mostly carrying out almost all the processing-related activities such as sorting, de-heading, gutting, and drying. Most of these women are wives of fishermen who are eagerly trying to help the families, mostly to cover up the expenses for their children's education. In addition, the dried fish industry is involved in strengthening the cooperation within fishing communities. Most of these fishermen and their families share common challenges in their lives. Therefore, they have a unity to share their resources and labour within the community, thus building up a strong bond within the community. Experienced fish processors and fishermen willingly pass on their knowledge and skills to younger generations to help them face these challenges in the industry.

4. Challenges and opportunities in the dried fish industry

The Sri Lankan dried fish industry has faced several challenges due to inadequate modern practices, reliance on conventional processing methods, and the lack of quality control measures. As most coastal communities still practice the traditional sun-drying methods at the shore, it leads to unhygienic conditions, thus resulting in a significant product loss from microbial spoilage, contamination, and insect infestation. This negatively affects the overall yield, quality, and safety of the final

product. In addition, as mentioned above, the industry still relies on low-grade fish as raw materials for dried fish production, creating a lot of safety issues at the end. Lack of quality standards is a serious challenge in protecting consumer health and the industry's reputation. Implementation of modern processing techniques (Ex: modernized drying techniques) in the dried fish industry may support addressing these challenges while introducing stringent quality controls. However, the industry lacks processing, storage, and transportation facilities that can influence the efficiency of production and product quality.

As Table 2 shows a declining per capita consumption of dried fish over the years, a correlation may exist between product quality and consumer preference. Implementation of quality regulations for dried fish is crucial to restoring consumer confidence and increasing demand. This increase in demand will encourage domestic producers to enhance their production practices. In addition, inland dried fish production in Sri Lanka has received less attention than the marine dried fish sector. However, it offers significant potential for development due to the network of reservoirs, tanks, lakes, and rivers situated in the central part of the country. Through the identification of potential water bodies, culturing of suitable fish species, providing the necessary infrastructure, and proper marketing strategies to increase the demand for inland dried fish, Sri Lanka can expand the inland dried fish industry.

Conclusion

The dried fish industry in Sri Lanka still relies heavily on conventional processing methods, resulting in significant challenges for further development. However, this industry presents immense potential for sustainable growth and development. Addressing these key issues, such as post-harvest losses, quality control, and value addition is crucial in ensuring the long-term viability of the industry, both for marine and inland dried fish production. By implementing value additions, market diversifications, and technological advancements, the industry can mitigate these obstacles. Carefully addressing these challenges and opportunities will benefit all stakeholders in the industry, especially the coastal and inland fishing communities.

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Chapter 5: Bee Keeping for Honey Production in Sri Lanka

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Abstract

Honey bee (*Apis cerana*) in Sri Lanka belongs to the family Apidae. From ancient times, the Sri Lankan honey bee has been the most valuable insect for bee production and many other human needs. This *Apis cerana is* also similar to the *Apis mellifera. Apis mellifera* produces the best honey in Sri Lanka. But the prominent one is *Apis cerana.* They have four life stages (egg, larva, pupa, and adult). Consequently, they are known as holomerabolous. Adults have special features that can gather pollen on their hairs on the body (plumose). Females that are not helpers for reproduction have pollen-collecting baskets called corbicula. And the workers have an organ that is made for laying eggs, called an ovipositor. Ovipositors become modified to stingers, and most adults are yellow and black. Bee honey and other products related to bees are used for different purposes. Mostly, bee honey is used for medicinal treatments in Sri Lanka. Such as throat infections, eye infections, thirst, and tuberculosis. Also, this can be easily provided for the patients. By considering their nutritional values and properties, the cosmetic industry also uses them for producing skin

treatments, facial washes and other treatments for skin-related products. Sri Lanka has high potential for the honey bee industry for different purposes. Sri Lanka has different agroecological regions that are suitable for bee production, which can increase family income and provide nutritional benefits. However, there has been insufficient management and utilization of natural resources for this industry.

Key Words: *Honey, Beekeeping, Medicinal treatments, Natural resources*

1. Introduction

Honey bee production is a biological process that has economic value and supplies nutrition for humans. *Apis cerana indica is a* honey bee that is involved in honey production in Sri Lanka. Most people can do this production of honey bees if they have relevant skills and knowledge of management practices of this valuable industry. As we know, most of the other agricultural industries are not environmentally friendly, but beekeeping is a sustainable and less environmentally impact industry in the world. Because bees are valuable insects for nature and by this industry, the bees can be conserved. Most of the villagers believe that farming honeybees in their home garden can bring prosperity and that removing the bees from it or letting them leave can bring bad luck (Punchihewa, 1994).

In the past, Sri Lankan people have traditionally practiced beekeeping by using natural bee hives in forest

areas where they lived. They harvested honey without harming bee colonies. Mostly, they used smoke to remove them from the bee hives and not harm their natural environmental conditions. Today, beekeeping has evolved into a modern way of using scientific processes to increase the global demand. In modern beekeeping, movable frame hives are used, along with improved breeding techniques, and carefully managing bee health and nutrition for growth. Practicing these technological management systems can improve honey bee production and supply the demand locally and internationally. At present, beekeeping is very popular in Rathnapura, Kegalle, and Kalutara areas, as these areas are covered with Rubber plantations (for honey production, bees prefer rubber plantations over others).

In Sri Lanka, the bee-keeping industry faces several challenges such as environmental impacts, pest and disease attacks, pollution caused by people, and decline in infrastructure directly affecting bee population. On the other hand, access and transportation difficulties and fluctuation of product and honey prices have become the major challenges for Sri Lankan Honey bee farmers. Sri Lankan Bee farmers are still operating in the industry on a small scale, producing about 25 metric tons annually. To meet the local demand, they additionally import about 150 metric tons annually (Punchihewa, 1994).

2. Honey Bees

Today, most flowering plants carry their generation with the help of insects or self-pollination. Bees stands out as especially important insect among the other flower nectar-dependent insects. Because of their close interaction with flowers and their body, their life cycle is also built around this relationship. Honey bees belong to the *genus Apis* and the *family Apidae.* These super-organized insects live together in a colony. Honey bees work to store honey in their well-organized waxen combs, and they are built with wax sheets in vertical patterns and create hexagonal-shaped cells side by side. They collect flower nectar and pollen, then store nectar as honey and pollen, turning it into honey-mixed paste (Department of Agriculture, 2024).

Sri Lankan Honey bees can be divided into two main categories. They are "stinging honey bees" and "stingless honey bees". These two types of bees show different kinds of behaviors to protect their habitat. Stinging honeybees protect the honeycomb from their enemies by using poisonous stings. Other bees (hive bees and stingless honeybees) protect their nest by building them in dark, rocky places or hollow places. Honey bee production in Sri Lanka is usually carried out by *Apis cerana indica.* It involves not only honey production, but also wax production and use of bees as pollinators. The rearing of

Figure 1: Honey Bee Hive (Apis mellifera) at Sri Lanka Technology Campus, Source: Author 2024

bees is called apiculture**,** and the person who does the work is called a beekeeper or an apiarist. The place where the bees or beehives are kept is called the bee yard or the apiary. The man-made house for bees is called a hive, and it is artificially built with different designs to ensure successful production.

3. Honey bee colony

Most insects that have large numbers of members live together as a family for protection, to reproduce, collecting food, and working to meet their needs. Most insects create colonies, including bees that have a single fertile mother called the queen. Each of the members in the beehive has its duties. The queen has the responsibility to lay eggs and create a new generation for their colony. The queen mostly produces worker bees or daughters, and the collective of their immature stages is called a brood. After they become adults, they have duties such as collecting food, constructing the nest, protecting the nest, maintaining the internal temperature, storing honey, cleaning, and taking care of the young bees. The male bees have the main responsibility of producing offspring by mating with virgin queens or young female bees (Department of Agriculture, 2024).

Worker bees construct combs with wax that is produced by their wax glands, and the colony lives inside those combs. When combined, those combs can form a nest in darker places that have protection. Inside that comb, the top of the nest is filled with honey and pollen-mixed paste.

4. Principles of Beekeeping

Beekeeping mostly depends on principles that affect the generation, population, and production of honey. These environmental factors must be at an optimum level to get economic benefits.

- Honey availability and potential in the environment.
- Foraging range that supplies nectar and pollen sources.
- Potential of the population of honey bees to collect the nectar.
- Climatic potential for nectar production

If beekeepers want to achieve economic growth in this industry, they must maintain these four principles at an optimum level. However, many beekeepers lack a good understanding of these principles which can lead to a failed industry. It is important to ensure that the first and second factors can be provided properly, as the fourth factor cannot be controlled by humans. By controlling the third factor, the beekeeper can maintain the honeybee population.

Sri Lanka has a great potential for the honey production industry because the climatic conditions vary from site to site. Consequently, different varieties of honey bees can be found in different areas. *A. florea* can be found in Jaffna or Northern regions, and *A. cerana* and *A. dorsata* can be found in higher elevations like Nuwara Eliya, Badulla, Rathnapura, Kandy and Matale Districts in Sri Lanka. They found these places as their habitats because

of the suitability of the temperature (34ºC) and humidity (about 70%). If they do not have suitable conditions, the production might decrease due to climate induced stress.

Since ancient times, honey has been hunted by humans in different zones in Sri Lanka that have different plants that bear flowers throughout the year. Some fruit varieties and rubber cultivation sites, *Eucalyptus robusta* planted areas, have a high potential for honey production. Forests in dry zones have many flowering plants that provide nectar, but the forest density is too low for beekeeping practices. That can lower the production of honey in dry zone forests. Dry zone cultivations such as ginger (*Sesamum indicum*) attract honeybees during the flowering period, which can lead to high production. Minor crops such as coffee, rambutan, and cashews can produce nectar for bees, but the issue is that they produce flowers only during specific periods (Punchihewa, 1994).

Beekeepers can transport bee colonies to areas that produced flowers in previous seasons (mango, tamarind, jute, etc.) to increase honey production for that season. When beekeepers understand the seasons and areas that enable them to produce honey, the final production can increase.

5. Growth Pattern of Bee Colony

The growth of bee colonies varies according to the climatic conditions and the weather patterns. In Sri Lanka, the climatic pattern is based on the monsoon or the season. Bee colony populations also change according to the flowering of the plants throughout the year.

I. Growth Phase
II. Honey-flow Period
III. Dearth Period

Growth Phase

In Sri Lanka, the growth phase begins when the flowers bloom, and the environment is filled with flower pollen at the beginning of the year. In this phase, the number of worker bees increases, and colonies grow more than during the previous scarcity period. During this period, the internal space expands, the inside temperature rises, and the supply of the queen's pheromone is not evenly distributed. As a result, the colony naturally divides at this time. The special aspect of this phase is that male bees which were not seen in the scarcity period can be seen again, and they start mating to form new queen eggs and start to breed new queens. From that, new colonies can be formed. Honeybees start to collect nectar and deposit it in the upper part of the hives in a honeycomb. This honey season can be seen in two periods due to the distribution of the plants in Sri Lanka.

Honey-flow period

Areas where rubber (Rathnapura, Kegalle, Kalutara) is grown in the wet zone of the lowlands start collecting nectar in the February and March period. In the dry zone, nectar is collected in March and April. These are the most suitable seasons for the honey collection in Sri Lanka.

Dearth Period

This period starts with the monsoon period and the end of the honey-flow period. Also, this happens due to the dry season. In both periods, there is a food scarcity in the environment. As a result, the bee colony population growth decreases, and male bees die due to food shortage. During this dearth period, colony care is essential to protect from damages caused by enemies. Empty honeycombs can be preserved and stored by using a polythene bag with 2 openings, with two ends twisted tightly. They can be preserved in a cardboard box by putting mothballs in it and storing it in a cool and dry place. As another method, the comb racks should be stored in a place with good ventilation (Department of Agriculture, 2024).

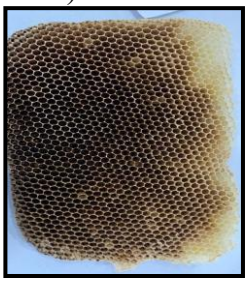

Figure 2: Empty Honeycomb
Source: Author 2024

6. Placing bee colonies in boxes

Bee colonies should be placed in boxes within the natural environment, during the season when flowers start to bloom. The most important thing is the climatic conditions in that place. Colonies can easily be placed in dry climates in the morning. Strong sunlight and high temperatures can damage the larvae in the colony. Also, if that period is rainy, do not place in that period. First, the place should be prepared to do the work properly. It is necessary to provide a protective cloth, a fume hood, banana peels for tying bee hives, a water bowl, and a sharp knife. When starting, smoke and remove the bees in the colony in the bee hives.

First, smoke near the beehive box by wearing protective cloth, which helps to pull out bees in a harmless way. Always check the temperature of the smoke, as the hot smoke can depress the bees and release cool smoke by keeping the smoker 25-30 cm away from the box. Then, remove the lid of the box after smoking and clean the base of the bee box. Examine the larvae and bees in the box and check the nectar and pollen mixed nectar deposition. Remove the old hives and install new hives by checking the bees and larvae. If you want to increase the space of the box, add a new honey box if needed. Every year for these colonies, a new queen must be born and control the colony's growth. It can maintain the nectar collection rate and can increase production (Punchihewa, 1994).

Figure 3: Clean the base of the bee box
Source: Author 2024

Figure 4: Bee Box
Source: Author 2024

7. Manufacture of bee boxes

The Department of Agriculture in Sri Lanka, currently recommends two types of bee boxes:

1. Box with six frames
2. Box with eight frames

When manufacturing boxes, different types of wood can be used like Ginisapu, Burutha, Hal, Pinus, Cyprus, Mango, Wanasapu, Maara, Teak, Milla, etc.
Parts of Bee boxes:

- **Roof -** This protects the lower parts of the box, and four slots are installed for the air circulation.
- **Top Cover –** This can close the top of the box and there are 5 holes covered with wire mesh to prevent enemies from entering.
- **Honey boxes 1 and 2 –** These should be the same length and width as the folding box but at half the height. In these boxes, 6 or 8 honey frames can be placed.
- **Larvae Box –** This is a four-sided box with a bottom and no cover with grooves on two wide sides.
- **Fly Frame –** Used for making the beehive.
- **Gate –** Prevents the queen from leaving.

8. Problems in beekeeping

- Leaving the colony
- Lack of colonization

This can happen for several reasons such as lack of food, disease and pest damage, and climatic factors. To reduce this problem, the colony must be placed in a shady and moist place. Always check the colonies (once a week). Provide sugar liquids and pollen substitutes. Check the worms' infections at the bottom of the hive. Keep the place and surroundings clean and cover the box, protecting it from predators. If the queen is old, introduce a new queen to get efficient production.

9. Need for Beekeeping in the Country

Apiculture is primarily used for honey production, wax production, and crop pollination. In Sri Lankan agriculture, attention given to crop pollination by bees is not sufficient. It is important when planning the production of crops. Beekeeping is only done to produce honey, but by rearing Bambara bees, Danduwel bees, Kanawe bees, and other carpenter bees and wild bees, can do effective pollination for crop production. It is important to rear different bees for each crop (Punchihewa, 1994). Bees are highly effective pollinators because they have quick flying ability, special body features with specialized hair on the body, and can visit different flowers in a short period. Bees can manipulate the production in agriculture, which helps increase the production and the food supply in the country.

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10. Economic Importance of Beekeeping in Sri Lanka

- Beekeeping can generate additional income. When starting beekeeping, there is an initial cost for acquiring necessary equipment to start the business. But the maintenance cost is low.
- When a person receives proper training, they can maintain about 50-100 bee colonies or more than that. Under normal conditions, one colony can produce 5-6 bottles of honey.
- The market demand is high for honey and other products. Foreign exchange can also be saved by reducing the importation of honey from foreign

countries when locals can take part in the industry.

- In addition to honey production, they can also manufacture bee boxes and other necessary equipment and generate income by selling them.
- Researchers have proven that honey consumption can help body's immunity and it is a quick energy source.
- As a useful pollinator, bees can enhance the pollination of crops, increasing the yield. That can be a solution for food scarcity in the future.
- In Sri Lanka, there are many agro-ecological zones with different varieties of plants, which are beneficial for obtaining honey and pollen throughout the year.

Beekeeping should be practiced, and the process must be learned to achieve consistency in production. Engaging with the process helps gaining knowledge about bees. When the industry is aligned with engaging with nature, it has high potential for generating a good income.

11. Discussion

In Sri Lanka, beekeeping industry mainly uses the *Apis cerana* bee variety. From traditional bee keeping practices to modern technology, beekeeping has evolved worldwide. However, in Sri Lanka, the use of technology in this industry has not increased steadily. Bee keeping not only provides benefits for local markets, but also for

exporters and it also support the national economy (Chamila, 2012).

In this chapter, we have discussed about the bee production in Sri Lanka and how it affects the economy and the environment. For this industry to be sustainable, suitable techniques can be used to enhance the production. In addition to the benefits, there are also challenges faced by the Sri Lankan people such as climatic impacts, lack of technology knowledge, lack of infrastructures and resources. If the government, policy makers, researchers and other markets can support and address these challenges, it will enhance the value of the industry and contribute to the overall economy of Sri Lanka through agriculture (Sittampalam, 2019).

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Chapter 6: Curd Production in Thissamaharama

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Abstract

Curd production in Thissamaharama, Sri Lanka, is an integral part of the region's culinary heritage, economy, and cultural identity. This study explores the historical evolution of curd-making, traditional and modern production techniques, and its economic significance through an analysis of the challenges faced by local producers, such as quality control, climate conditions, and market competition. This research highlights both the obstacles and opportunities within the industry. The findings suggest that adopting technological advancements, sustainable practices and expanding market reach can enhance the industry's resilience and growth. By preserving traditional methods while embracing innovation, curd producers in Thissamaharama can ensure the sustainability of this time-honoured craft.

Keywords: *Thissamaharama, Curd production, Milk, Clay pots, Traditional livelihood*

Introduction

Curd, a staple dairy product made through the fermentation of milk, is deeply embedded in the culture and daily life of many regions across the globe. In Sri Lanka, curd is produced particularly in Thissamaharama, a town in the Hambantota District of the Southern Province. Curd production is not only a significant aspect of local cuisine but also a vital component of the regional economy and cultural heritage.

Figure 1: Curd for sale in claypots
Source: Author 2023

This study provides an extensive analysis of curd production in Thissamaharama, including historical context, traditional and modern production techniques, economic impact, challenges, and prospects.

Historical Context of Curd Production in Thissamaharama

Tissamaharama, in the southern area of the island, an ancient city known for its rich cultural and historical heritage, has a long-standing tradition of dairy farming. The town's agricultural practices and dairy production can be traced back several centuries. Historically, the region's economy was predominantly agrarian, with dairy farming being a natural extension of local agricultural practices. The tradition of curd-making in Thissamaharama is deeply rooted in the broader South Asian tradition of dairy products. In ancient times, dairy farming was an essential aspect of rural life, and curd was an integral part of the local diet. Historical records and archaeological findings suggest that the methods of dairy farming and curd production have evolved over millennia, reflecting changes in technology, culture, and trade practices.

Evolution of Techniques

Traditional techniques of curd production in Thissamaharama have evolved. Early methods involved rudimentary tools and practices, with the process primarily relying on local knowledge and practices passed down through generations. As the region developed, technological advancements and cultural exchanges led to modifications in production techniques, incorporating new materials and methods while retaining traditional practices. The historical evolution of curd

production in Thissamaharama mirrors the broader changes in dairy farming and food processing in Sri Lanka. From ancient practices to modern techniques, the production of curd has adapted to meet changing needs and standards while preserving its cultural significance. The production process has been passed down through generations, primarily in rural areas, where it is made from buffalo or cow's milk. The production of curd in Sri Lanka is a craft that involves natural fermentation, and it is often enjoyed as a healthy and tasty food item, typically served with treacle (a type of sweet syrup) or used in savoury dishes.

Overview of Curd Production in Sri Lanka

Curd production in Sri Lanka has been an essential part of its food culture, particularly in rural communities. Traditionally, the curd is made by indigenous methods that use natural fermentation, and it's produced in clay pots, giving it a distinct flavour and texture. Curd in Sri Lanka is considered a nutritious food, rich in protein, calcium, and beneficial probiotics due to the fermentation process. It is a staple in Sri Lankan diets, consumed by people of all ages and used in various culinary preparations.

Traditional Curd Production Techniques

Traditionally, curd production in Thissamaharama begins with sourcing fresh milk from local dairy farms. The region’s climate and grazing conditions contribute to the

high quality of milk. Local dairy farmers primarily use indigenous breeds of cows, known for their milk's rich balance of fat and protein, which is essential for producing high-quality curd. Ensuring milk quality is crucial for producing good curd. Traditional practices involve regular monitoring of the cows' health, clean milking practices, and immediate processing of the milk. Farmers use traditional methods such as hand-milking and maintaining cleanliness to ensure that the milk remains free from contaminants.

After milking, the milk is boiled in large, open vessels. This step is essential for eliminating bacteria and preparing the milk for fermentation. Traditionally, boiling is done over a wood or gas fire, and the milk is heated to about 85°C (185°F). The boiling process also helps concentrate the milk, improving the texture and flavour of the final curd product. Once boiled, the milk is allowed to cool to around 45°C (113°F). This cooling step is critical for ensuring that the fermentation process occurs at the right temperature. Traditional cooling methods involve placing the milk in clay vessels and letting it sit in a cool, shaded area.

Traditionally, the inoculated milk is placed in clay vessels for fermentation. These vessels are believed to contribute to the unique flavour and texture of Thissamaharama curd. The fermentation process typically lasts between 6 to 12 hours, depending on ambient temperatures and desired consistency. Once the curd reaches the desired consistency, it is carefully transferred to containers for storage. Traditional

packaging materials include clay pots, which are valued for their ability to maintain freshness and enhance flavour.

Types of Milk Used

In Sri Lanka, curd is mainly produced using buffalo milk. Buffalo milk is preferred because of its higher fat content, which results in a creamier texture and richer taste. In some cases, cow's milk is also used to produce curd, but the end product might differ slightly in texture and flavour. Fresh buffalo or cow's milk is collected from the animals. The milk is usually obtained from small-scale local dairy farms, ensuring the milk is fresh and of good quality. The milk is filtered to remove any impurities. The milk is then heated to a near-boiling temperature. This step is crucial as it helps kill any unwanted bacteria and prepares the milk for fermentation.

A small amount of previously made curd (the starter culture) is added to the cooled milk. This starter culture contains beneficial bacteria that facilitate the fermentation process. The inoculated milk is then poured into traditional clay pots. These clay pots play an essential role in giving the curd its characteristic flavour and texture, as the porous nature of the clay allows for better air circulation during fermentation. The pots are kept in a warm place to allow the milk to ferment. The fermentation time usually takes anywhere from 6 to 8 hours, depending on the ambient temperature. The bacteria present in the starter culture will ferment the

lactose (milk sugar) and turn the milk into curd. The longer the curd ferments, the thicker and tangier it becomes. After fermentation, the curd is allowed to cool at room temperature before being stored in a cool place. In rural areas, curd is often stored in earthen pots, which help maintain its temperature and texture. This traditional storage method also enhances the taste of the curd.

Curd Production in Tissamaharama, Sri Lanka

Tissamaharama, located in the Southern Province of Sri Lanka, is well known for its agricultural activities, and curd production is an important traditional industry in the area. The town and its surrounding regions are famous for producing high-quality curd, often made from buffalo milk, which has a rich history and cultural significance. The curd produced in Tissamaharama is known for its distinct texture and flavour, often attributed to the local farming practices and natural fermentation methods used in the area.

Tissamaharama's curd industry is deeply rooted in its rural community. The area has a long history of buffalo farming, and milk from these buffaloes is the primary ingredient used to make curd. Tissamaharama curd is a key component of the local economy, and the product is highly valued both by locals and tourists. The process of making curd in Tissamaharama follows traditional methods, which have been passed down through generations. The curd produced here is usually sold in earthenware pots, a practice that has been maintained due

to the unique properties of clay, which contribute to the curd's texture and flavour.

The Role of Clay Pots in Tissamaharama Curd Production

The use of **clay pots** is a hallmark of curd production in Tissamaharama. These earthenware containers are more than just a traditional element; they play an essential role in shaping the texture and flavour of the curd. Clay pots help regulate the fermentation process due to their porous nature, which allows air circulation and helps maintain an even temperature during fermentation. Additionally, the mineral composition of the clay can impart subtle flavours to the curd, contributing to its distinct taste. The curd produced in these pots often has a creamy, smooth texture with a slightly tangy flavour. Traditional storage involves keeping the curd in a cool place to prevent over-fermentation. In Thissamaharama, this often means placing the curd in a shaded, cool area or using traditional cooling methods. Modern refrigeration has been adopted by some producers to extend the curd's shelf life and maintain its quality.

Figure 2: Production process of completed curd in a clay pot
Source: Author 2024

Serving and Consumption of Tissamaharama Curd

Curd in Tissamaharama is typically served as a snack or dessert, often accompanied by treacle. Kithul treacle, made from the sap of the kithul palm, is the most common type of treacle served with the curd. The sweet, rich syrup contrasts wonderfully with the tangy and creamy curd, creating a delicious combination that is loved by both locals and tourists. Besides being enjoyed with treacle, curd is also used in savoury dishes, often as a side dish or to cool down spicy curries. The curd is also an important component of various traditional meals, such as rice and curry, or as a natural digestive aid after a heavy meal.

Marketing and Branding

The development of local brands and marketing strategies has helped increase the visibility and popularity of Thissamaharama curd. Producers are leveraging social media and online platforms to reach a broader audience and promote their products. With the growing demand for traditional dairy products, Thissamaharama curd producers are exploring export opportunities. Branding and marketing efforts focus on highlighting the authenticity and quality of Thissamaharama curd to attract international markets.

Economic Impact of Curd Production

Curd production supports a range of jobs in Thissamaharama. From dairy farmers and milk suppliers

to curd makers and distributors, many people are employed directly in the curd industry. This provides a significant source of income for local families and contributes to the regional economy. The curd industry also creates indirect employment opportunities in related sectors such as transportation, packaging, and marketing. These jobs contribute to the overall economic development of Thissamaharama. The sale of curd generates revenue for local businesses and contributes to the local economy. Curd is sold in markets, grocery stores, and restaurants, creating a trade network that benefits the community. As demand for Thissamaharama curd grows, the local economy benefits from increased sales and business opportunities. The export of curd to other regions or countries can further boost the local economy, providing additional revenue streams for producers.

Curd production in Thissamaharama contributes to tourism by showcasing traditional food products and cultural practices. Tourists visiting the region are often interested in experiencing local dairy products and learning about traditional production methods. Curd-making practices help preserve local cultural heritage. By maintaining traditional methods while adopting modern innovations, producers ensure that cultural practices are passed down through generations.

Challenges in Curd Production

Maintaining consistent quality and flavour can be challenging due to variations in milk quality. Factors

such as feed quality, cow health, and environmental conditions can affect milk composition. Fermentation conditions, including temperature and time, play a critical role in determining the final product's texture and flavour. Variability in these conditions can lead to inconsistencies in curd production. The climate in Thissamaharama, characterized by high temperatures and humidity, can impact the fermentation process and shelf life of curd. Producers may need to invest in climate-controlled environments or modify production techniques to adapt to these conditions. Environmental factors such as water scarcity and waste management are also important considerations. Sustainable practices and environmental management are essential for the long-term viability of curd production. Economic pressures, such as fluctuating milk prices, can impact the profitability of curd production. Producers may face challenges in managing costs and maintaining competitive prices. Competition from larger dairy companies and commercial curd producers can affect the market share of local producers. Strategies for differentiation and branding are essential to staying competitive.

Ensuring that producers are well-informed about modern practices, food safety standards, and market trends is crucial for the growth of the curd industry. Training programs and educational initiatives can help enhance the skills and knowledge of curd producers. Education and training can also promote the adoption of best practices in production, hygiene, and quality control. This contributes to improving the overall quality and

consistency of curd. Adopting sustainable practices in curd production is crucial for long-term viability. This includes managing resources efficiently, reducing waste, and implementing environmentally friendly practices. Ensuring economic sustainability involves managing costs, exploring new markets, and adopting innovative practices to stay competitive. Diversifying product offerings and exploring export opportunities can contribute to economic growth.

Future technological advancements can further enhance curd production processes. Innovations such as automated systems, advanced fermentation techniques, and improved packaging can contribute to higher efficiency and product quality. Ongoing research and development efforts can lead to discoveries in dairy processing and curd production. Collaborations with research institutions and industry experts can drive innovation and improve production practices. Expanding into new markets, both locally and internationally, presents opportunities for growth. Developing marketing strategies, building brand recognition, and targeting new customer segments can increase market reach. Understanding consumer trends and preferences is essential for adapting to market demands. Offering new varieties of curd, improving packaging, and highlighting health benefits can attract consumers and drive sales.

Modern Innovations in Curd Production

With the advent of modern technology, many curd producers in Thissamaharama have adopted advanced

equipment to streamline the production process. Automated temperature controls and refrigeration units have replaced traditional tools, improving efficiency and hygiene. Modern practices emphasize hygiene and quality control. Quality control measures include regular testing of milk and curd samples for bacterial contamination and adherence to food safety standards. Modern producers use temperature-controlled environments to regulate the fermentation process more precisely. This helps in achieving a consistent texture and flavour in the curd. Advanced fermentation vessels with temperature control features have also been introduced. Automation in curd production includes the use of machines for milk boiling, cooling, and inoculation. This reduces labour intensity and increases production efficiency. Automated systems help maintain consistency in the production process, leading to a more uniform product.

Cultural Significance of Curd in Sri Lanka

Curd holds significant cultural importance in Sri Lanka, especially in rural communities. It is often served as a part of traditional meals, particularly during festivals, religious ceremonies, and family gatherings. Curd and Treacle is one of the most iconic ways of consuming curd in Sri Lanka, with "kithul treacle," a sweet syrup made from the sap of the kithul palm tree. This combination is a favourite dessert and a snack, enjoyed for its unique blend of flavours. Curd plays an important role in several Sri Lankan customs and rituals. For instance, it is common to offer curd to newborns and newlyweds as a

symbol of good health and prosperity. Curd is also used in savoury preparations, such as being mixed with rice or served alongside spicy curries.

Developing cultural tourism initiatives related to curd production can attract visitors and promote local traditions. Workshops, tours, and tastings can enhance the cultural experience for tourists and support local businesses. The good bacteria in curd help strengthen the immune system by fighting off harmful bacteria. Curd is rich in water content, which helps in keeping the body hydrated, particularly in hot climates like Sri Lanka. Preserving traditional curd-making practices while incorporating modern innovations helps maintain cultural heritage. Efforts to document and share traditional knowledge contribute to cultural preservation. The probiotic nature of curd makes it a healthy food choice, providing numerous health benefits. Curd is rich in probiotics, which aid in improving gut health and digestion. It is an excellent source of calcium, which is essential for bone health, and protein, which helps in muscle building and tissue repair.

Economic Importance of Curd Production in Tissamaharama

The curd industry in Tissamaharama provides significant economic benefits to local farmers and producers. The production of curd contributes to the livelihood of many families in the region, especially those involved in buffalo farming. Local farmers who raise buffaloes and cows depend on the curd industry for income. By selling

milk to curd producers or making their own curd, these farmers can generate a steady income.

Challenges in Tissamaharama Curd Production

Despite its economic importance, there are several challenges that curd producers in Tissamaharama face. Maintaining consistent quality can be difficult, especially with traditional methods that rely heavily on local resources such as buffalo milk and natural fermentation. Variations in milk quality or environmental factors can affect the consistency of the curd. The lack of proper refrigeration and storage facilities can lead to spoilage, particularly in the hotter months. Many curd producers in rural areas lack access to modern preservation technologies, which limits the shelf life of the product. The growth of mass-produced dairy products in supermarkets presents competition to traditional curd producers. Imported curd and dairy products may sometimes be less expensive, which challenges the local producers in Tissamaharama. Small-scale producers often face challenges in expanding their market access. Without proper marketing and distribution channels, local curd may struggle to reach wider urban markets.

Conclusion

Curd production in Thissamaharama represents a rich tapestry of tradition, innovation, and economic impact. From its historical roots to modern practices, the production of curd reflects the region's cultural heritage and adaptability. While challenges such as quality

consistency, climate, and economic pressures exist, opportunities for growth and sustainability are abundant. By embracing technological advancements, sustainable practices, and market expansion, curd producers in Thissamaharama can continue to thrive and contribute to the local economy. The preservation of traditional practices and the promotion of cultural heritage further enhance the significance of curd production in the region. The future of curd production in Thissamaharama holds promise, with potential for continued growth, increased market visibility, and the preservation of cultural traditions. Through innovation and dedication, the curd industry can ensure its place as a vital component of the region's culinary and economic landscape.

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Chapter 7: Revitalizing Kithul Jaggery: Economic Strategies and Marketing Innovations for Sustainable Village Development

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Abstract

Kithul (*Caryota urens*), a prominent member of the Arecaceae family, is a multipurpose palm native to the tropical regions of South and Southeast Asia, including Sri Lanka, India, and parts of Myanmar. This majestic tree is well-adapted to humid climates and thrives in mid-elevation zones, particularly in Sri Lanka, where it has been cultivated for centuries. Known for its ecological significance and economic value, *Caryotaurens* serves as a cornerstone of rural livelihoods, providing raw materials for various traditional products. The sap of the Kithul palm is particularly prized for its use in producing Jaggery, a culturally significant and artisanal sweetener deeply embedded in Sri Lankan culinary traditions. Beyond its role in food production, the tree also contributes to ecological conservation, with its fibrous leaves and timber used for handicrafts and construction. Its ability to grow in diverse conditions further underscores its role in sustainable agriculture, making it an indispensable resource for rural economies. This chapter examines the Kithul Jaggery industry, a vital

component of rural livelihoods for generations, now facing challenges like outdated harvesting methods, environmental vulnerabilities, and limited market access. Based on qualitative research in Meemure and Kothmale, it identifies key barriers to sustainability and proposes strategies for revitalization, including modernizing techniques, improving branding and packaging, and integrating ecotourism. Grounded in sustainable development theory, the study emphasizes Kithul Jaggery's potential for ecological and socio-economic development. It outlines a roadmap for addressing production inefficiencies, leveraging cultural heritage, and introducing technological and marketing innovations, ensuring the craft's resilience while preserving its artisanal essence.

Keywords: *Kithul, Jaggery, Meemure, Kothmale, Sustainable development*

1. Introduction

The Kithul Jaggery industry, deeply embedded in Sri Lanka's cultural and economic fabric, faces significant challenges that threaten its sustainability. As a product tied to both traditional craftsmanship and rural livelihoods, Kithul Jaggery represents more than just a commodity; it symbolizes the potential for community-based economic growth and sustainable agricultural practices. However, despite its cultural importance, the industry is under strain due to outdated harvesting techniques, limited access to modern technologies, and a

lack of formal marketing strategies, making it difficult for producers to compete in larger markets.

This study seeks to address these challenges by integrating insights from both producers and industry stakeholders, offering a comprehensive analysis of the current state of Kithul Jaggery production. Unlike previous reports that primarily focus on cultural or biochemical aspects, this research combines field-based qualitative inquiry with practical recommendations for enhancing production efficiency and expanding market access. The primary aim is to identify key barriers to industry sustainability and propose actionable strategies for improvement. In doing so, the study also explores the potential for balancing traditional methods with modern innovations, ensuring that the cultural heritage of Kithul Jaggery production is preserved while fostering economic growth.

The significance of this research lies in its alignment with theories of sustainable development and community-based economic models. Kithul Jaggery production has the potential to play a pivotal role in both ecological conservation and rural economic revitalization. This study's theoretical and practical implications extend beyond the immediate context, contributing to broader discussions on the sustainability of small-scale industries in Sri Lanka. The hypotheses guiding this research propose that targeted interventions such as improving harvesting techniques, increasing access to competitive markets, and supporting producers with better technological resources can significantly enhance the

sustainability of the Kithul Jaggery industry. The field observations and interviews conducted in this study provide an in-depth understanding of the production landscape, highlighting both the industry's challenges and its growth potential.

The importance of addressing these challenges cannot be overstated, given the central role Kithul Jaggery plays in Sri Lankan culture and economy. The industry faces pressing issues, including inefficiencies in harvesting methods, environmental constraints on production, and a lack of formal marketing and branding strategies. Previous research, such as the work of Perera et al. (2015), has highlighted the artisanal nature of Kithul sap extraction and its role in rural livelihoods, yet little has been done to address how the industry can evolve to meet modern market demands. Gunasekara (2017) further pointed to inefficiencies in traditional harvesting techniques, noting that limited access to modern technologies has contributed to declining productivity. Additionally, Silva and Fernando (2019) emphasized the environmental vulnerability of Kithul trees, exacerbated by climate change, as a significant challenge to production sustainability.

Figure 1: Traditional Kithul Jaggery-making process
Source: Author 2024

While these studies provide valuable insights, they largely focus on the cultural and environmental dimensions of Kithul Jaggery production. Few have explored practical solutions for modernizing the industry, especially in terms of market access and branding. This study fills that gap by offering a more holistic view, integrating both the production process and the economic challenges faced by producers. By conducting field interviews with producers in regions such as Meemure and Kothmale, this research updates and expands upon earlier findings, providing new insights into how the industry can adapt and thrive in the face of modern challenges. It also offers fresh perspectives on sustainability, combining traditional practices with innovative approaches to ensure the long-term viability of the industry.

This research is grounded in the theoretical framework of sustainable development, specifically focusing on how small-scale industries like Kithul Jaggery production can contribute to both ecological preservation and socio-economic development in rural communities. The central research question guiding this study is: What are the primary challenges faced by Kithul Jaggery producers, and how can targeted interventions improve the industry's sustainability and economic potential? This question is explored through a qualitative research design, with data collected through direct engagement with producers and stakeholders in the field. The study employs a thematic analysis to identify recurring issues, such as inefficiencies in production, limited market access, and environmental concerns.

The study's hypotheses are based on both empirical evidence and the theoretical principles of sustainable development. The primary hypothesis posits that targeted interventions, such as the introduction of improved harvesting techniques and enhanced market access, can significantly boost the industry's sustainability. A secondary, more exploratory hypothesis suggests that the integration of modern technologies with traditional practices can not only increase production efficiency but also help preserve the cultural significance of Kithul Jaggery. By engaging directly with producers, the research provides practical insights into how these challenges can be addressed, offering potential solutions that align with both the preservation of tradition and the demands of modern markets.

In conclusion, this study aims to provide a comprehensive understanding of the current challenges facing the Kithul Jaggery industry while offering practical solutions for its revitalization. By addressing both the production inefficiencies and market constraints identified through field interviews, the research contributes to the broader discourse on sustainable small-scale industries. Ultimately, the findings have the potential to inform policy recommendations and industry practices that will support the future viability of Kithul Jaggery production, ensuring that this culturally significant industry can thrive for generations to come.

2. Method

This qualitative study focused on exploring the Kithul Jaggery industry through direct engagement with local producers and stakeholders in two prominent production regions of Sri Lanka. Participants included producers of varying ages, encompassing both younger individuals actively involved in the industry and older generations who have transmitted their knowledge through family traditions. The younger generation has learned the craft from their elders by observing and participating in production from a young age.

Participants were selected from regions known for Kithul Jaggery production. Upon explaining the nature of the research, participants volunteered to be interviewed. The recruitment process was facilitated by the researcher's visits to the rural areas, which simplified participation. All interviews were conducted in person at the participants' locations, the data collection process involved face-to-face; one-on-one interviews conducted at the producers' locations. Thematic analysis was used to identify key themes such as sustainability, production efficiency, and market access.

The study employed a purely observational research design, avoiding any experimental manipulations or conditions. Data collection took place naturally within the participants' environments, providing a genuine perspective on the industry. The research was conducted across two distinct geographical areas, allowing for an examination of regional differences in Kithul Jaggery

production. Observations were made of the participants' daily operations, and data were collected through semi-structured interviews based on a set of predefined questions.

Ethical considerations were addressed by obtaining consent from participants before the interviews. Participants were informed about the purpose of the research, their right to privacy, and the option to withdraw from the study at any time. The study aimed to capture authentic data on production efficiency, sustainability, and the challenges faced by Kithul Jaggery producers.

3. Results

The results of this study underscore a strong desire among Kithul Jaggery producers to embrace new technologies and strategies that can improve both production efficiency and market access. Through detailed interviews and observations, it became evident that while producers are enthusiastic about modernizing their traditional practices, many are hindered by limited access to resources and expertise. A significant finding was the widespread lack of formal marketing or branding strategies, which hampers their ability to compete in larger markets. Although the producers are open to adopting new methods, they identified critical gaps, particularly in areas such as technological training and market accessibility. These results suggest that addressing these deficiencies through targeted interventions could significantly contribute to the

revitalization of the Kithul Jaggery industry, promoting sustainable economic growth while preserving its rich cultural heritage.

The recruitment phase of the study took approximately one month, during which time producers were identified and interviewed. To capture a comprehensive picture of the industry, the study included not only Kithul Jaggery producers from Meemure and Kothmale but also sugar-based jaggery producers for comparative analysis. This approach revealed regional variations in production methods and challenges. However, the recruitment process presented difficulties, primarily due to the remote locations of participants, which required extensive travel. Communicating with these producers was often challenging, as many lacked consistent phone access. Nevertheless, these interviews provided valuable insights into the unique problems facing Kithul Jaggery production in different regions.

One challenge encountered during the interviews was the producers' unfamiliarity with technical terms like ‘sustainability’ and ‘economic growth’. A young producer from Meemure, expressed, “We love this industry; it's part of our life. But prices keep rising for everything. To survive, we must raise the price of our Kithul Hakuru, but then people don’t buy it because there are cheaper, artificial alternatives.” This quote highlights the economic struggles that producers face despite their passion for the craft. Although they lacked formal knowledge of sustainability, many were already practicing it intuitively. These findings resonate with

broader studies on traditional industries, where producers often adopt sustainable practices without being aware of the terminology (Gunasekara, 2017; Silva & Fernando, 2019). Ancillary analyses comparing production processes across regions revealed interesting variations. For example, the Kithul producers in Meemure reported a higher sap yield than those in Kothmale, indicating that regional environmental factors could be influencing production efficiency. This difference mirrors observations in other agricultural industries, where climate and local conditions significantly impact output (Perera et al., 2015). These findings emphasize the importance of considering geographical differences when proposing solutions for improving the efficiency of Kithul Jaggery production.

Figure 2: Setting the Stage for the Final Product

Source: Author 2024

While the study did not involve direct interventions, the producers expressed a strong desire for external support. They were particularly interested in receiving assistance from the government or agricultural experts to modernize their practices without compromising their traditional methods. The potential for collaboration with external specialists was frequently mentioned, reflecting the producers' openness to integrating new knowledge with their inherited skills. Baseline data showed that most producers were highly experienced, having learned the craft from previous generations.

In Kothmale, however, younger individuals were less involved, reflecting a trend of youth migration away from traditional industries. In contrast, in Meemure, younger members of the community were actively participating in production, which may contribute to the region's higher productivity. This generational divide mirrors broader trends observed in rural economies, where the younger generation often seeks opportunities outside of traditional sectors (Silva & Fernando, 2019). These findings collectively provide a nuanced understanding of the challenges and opportunities within the Kithul Jaggery industry. By addressing the gaps in technological and marketing expertise and providing support to sustain traditional practices, there is potential to foster a more sustainable and competitive future for this unique industry.

4. Discussion

The findings of this study support the original hypothesis that the main challenge facing the traditional Kithul Jaggery industry is not the production process itself, but rather the lack of market access. Producers are confident in their abilities to carry out the traditional, artisanal methods of Kithul Jaggery production, and they prefer to maintain these methods as they are deeply rooted in the cultural and historical fabric of their communities. However, the challenge lies in finding and accessing markets where these products can be sold at a fair value. This aligns with previous research that has highlighted market access as a key factor in the sustainability of small-scale rural industries in Sri Lanka.

Similar to earlier findings by Perera et al. (2015) and Gunasekara (2017), this study reveals that while inefficiencies in harvesting techniques exist, the main concern for producers is the ability to sell their products rather than the need for external interventions or significant technological upgrades. The producers expressed confidence in their methods, and the study found that they believe new technology, while helpful, is not a priority. Instead, they seek support in opening new markets, better branding, and creating a sustainable ecosystem around the Kithul Jaggery production process. One of the significant insights that emerged from this study is the potential to integrate tourism with Kithul Jaggery production to promote and expand the industry. Meemure, one of the regions where data was collected, is already a popular tourist destination. By combining the

cultural and historical significance of Kithul Jaggery production with eco-tourism, the industry could attract more attention from both local and international visitors.

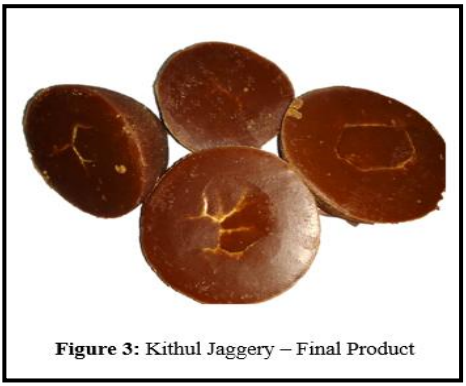

Figure 3: Kithul Jaggery – Final Product

Source: Author 2024

Tourists could engage in the production process-learning how to tap the Kithul flower, witnessing the traditional methods of jaggery preparation, and interacting with local communities. This could enhance the cultural value of the product while simultaneously expanding its market reach. Furthermore, the study highlights the need for better packaging and branding. Currently, the lack of proper, environmentally friendly packaging limits the product's ability to reach global markets. With safer and more hygienic packaging solutions, Kithul Jaggery could not only be preserved for longer periods but also appeal to international consumers who seek authentic, traditional products with a rich cultural story. By packaging not only the product but also the stories of the people and the heritage behind its production, the industry can create a unique brand identity that resonates with consumers.

Moreover, enhancing the branding of Kithul Jaggery would not only uplift the producers but would also positively impact the entire ecosystem surrounding the industry. From Kithul tree owners to those who transport the sap, provide labour, or design packaging, everyone in the value chain would benefit. A sustainable village-based economy could be established, generating profits for all stakeholders and revitalizing the rural economy. This is in line with the sustainable development theory that emphasizes the importance of small-scale industries in promoting economic growth and preserving cultural heritage. However, several limitations of this study should be acknowledged. The sample size was limited to two primary regions, and while the findings offer significant insights, a more extensive study covering additional areas may provide a more comprehensive understanding of the challenges and opportunities in the Kithul Jaggery industry.

Looking forward, future research should explore agricultural innovations to increase the sap yield from Kithul trees without compromising the traditional methods of production. Additionally, studies could focus on understanding how to best incorporate ecotourism into Kithul Jaggery production and assess the economic and social impacts of such integration. Training programs that focus on marketing strategies and business development for local producers would also be beneficial, ensuring that these communities can thrive in a competitive market while preserving their cultural heritage.

Conclusion

In conclusion, the findings of this study underscore the importance of market access, cultural preservation, and innovative branding in revitalizing the Kithul Jaggery industry. While technological advancements in the production process may not be essential, there is a clear need for interventions that open up new markets and enhance the value of the product. By doing so, the industry can not only sustain itself but also flourish, attracting younger generations and promoting a more vibrant village-based economy. The integration of tourism and the adoption of environmentally friendly packaging solutions could further expand the reach of Kithul Jaggery, creating a sustainable future for this culturally significant industry.

Acknowledgement

I would like to express my gratitude to the local Kithul Jaggery producers in Meemure and Kothmale, especially Mr. Siriwardhana, for their cooperation and invaluable insights during this research. Special thanks to Dr. Dimithri Jayagoda for his guidance and support throughout the study. I also appreciate the feedback and encouragement from friends and colleagues who contributed to the completion of this case study.

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Chapter 8: Sesame Cultivation in Sri Lanka

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Abstract

Sesame farming has greatly improved agriculture and contributed significantly to Sri Lankan culture. The features of the sesame plant are covered in this chapter, especially in Sri Lanka's arid and intermediate regions. People in Sri Lanka use sesame according to their traditions, customs, and beliefs, including medicinal, culinary, and religious applications. This chapter includes information on post-harvest handling, pest control, and cultivation techniques among Sri Lankan farmers. The demand for sesame oil on the global market has increased due to the economic trend of sesame exports, which is discussed in this chapter. By conserving sesame, the chapter encourages sustainable practices, integrated pest management, crop rotation, soil conservation methods, and monetary and legislative measures that support these practices.

Keywords: *Sesame, Medicinal, Global market, Crop rotation*

1. Introduction

Figure 1: Sesame - Queen of Oil Seed
Source: Author 2024

One of the first oilseeds was sesame (*Sesamum indicum L.*). The title "Queen of Oil Seed" refers to it. Because of its exceptional quality, sesame is often known as the "Queen of oilseed crops" (Deepthi et al., 2014). Sesame seeds are primarily used for oil extraction, the confectionary industry, culinary and medicinal purposes; as a result, demand for sesame has increased by nearly 80% over the last decade (Hansen, 2011), and the international market for sesame seeds has grown significantly (Olowe and Adeniregun, 2011, Boureima et al., 2012). It has been cultivated in the Asian region for more than 5,000 years (Bisht et al., 1998). Africa is where it was originally tamed. Tropical and subtropical climates are where it is grown. Research on sesame undertaken in several different countries has demonstrated that it requires a relatively high temperature and restricted soil moisture (or low rainfall) to produce sufficient yields (Bahrami et al., 2012, Fazeli et al., 2006, Fazeli et al., 2007). India, Burma, Nigeria, Pakistan, China, Bangladesh, and Sri Lanka are among the countries where sesame farming has been introduced. It is an annual plant cultivated in Sri Lanka's arid and

intermediate zones. Because of its excellent nutritional value, it has a large export market in Sri Lanka. Typically, it is referred to as "Thala" in Sinhala, and in the northeast region of Sri Lanka, they are known as “Ellu” in Tamil. The plant is commonly grown in districts such as Anuradhapura, Monaragala, Kurunegala, Hambantota, Mullaitivu, Vavunia, Puttalam, Jaffna, and Mannar due to optimal temperature conditions for growth.

2. Botany

Leaf

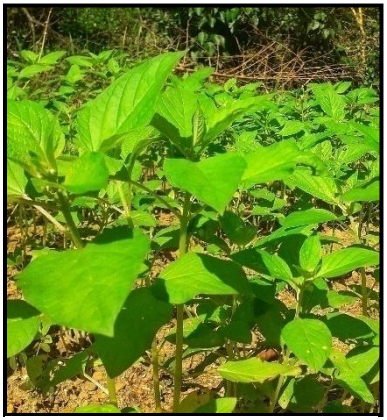

Figure 2: Sesame Leaves
Source: Author 2024

Based on the cultivar and environmental conditions, sesame grows approximately 1.5 to 2 meters in height and bears broad leaves. There are significant variations in terms of size, shape, growth pattern, blossom colour, seed size, colour, and composition. The majority of leaf colours are drab, light green with a hint of yellow, or dark green. They are mucilaginous and hairy leaves. The large, edged bottom leaves have teeth pointing outward. Occasionally, a variety's leaf arrangement will be different, alternating or opposite below and alternating above. To allow for the greatest amount of solar penetration, the upper leaves are

lanceolate and narrower. The breadth of the leaf ranges from 3 to 17.5 cm, while the length of the petioles is 1 to 5 cm, and their width is 1 to 1.7 cm.

Flower

Figure 3: Sesame flowers
Source: Author 2024

Usually flowers with short peduncles, the blossom colour ranges from white to almost purple. Red, black, purple, or yellow should be the colours surrounding the flowers. Although insects frequently cross-pollinate seeds, sesame is a self-pollinating crop. After opening early in the day, flowers were shed in the evening. Shortly after the flower opens, the anthers open and release pollen, which is only viable for a day. There have been reports of insect pollination causing up to 50% outcrossing. The stigma is still receptive one day before the flower opens and again one day after.

Root system

It is a well-developed root system supporting an upright, branching, primarily annual, or long-season plant. It differs greatly in size, form/shape, growth habit, flower colour, seed size, colour, and content. It is an erect, branched, annual or long-season plant with a robust root system. It tolerates drought and is adapted to warm oceans. It requires proper soil conditions, such as good soil moisture, to produce optimally. The conditions of the soil influence a plant's growth rate.

Stem

The stem may have hairs or be smooth. With a predominant darkish-green hue, stem colours vary from light green to purple. The stem is square in cross-section, erect, and has distinct longitudinal furrows; it is occasionally rectangular and seldom wide and flat. Varietal features are determined by the degree, kind, and height of branching; seed rate, rainfall, day length, and variety all have an impact on branching. The same is classified as a C3 plant. It also undergoes photorespiration in conditions of high light intensity and warmth which employs the Calvin cycle for photosynthesis.

Figure 4: Sesame seed capsules
Source Author 2024

Seed

Broken-down capsules produce small, ovate seeds with smooth or rough coats. The pigment

composition of the seed coat determines the colour of the seeds (white, yellow, brown, red, or black). Sesame seeds are about 3 to 4 mm long, 2 mm wide, and 1 mm thick (Kalaiyarasi Ramu, 2018).

3. Cultivation

Figure 5: Sesame cultivation
Source: Author 2024

Sesame seeds are grown in Sri Lanka's intermediate and arid climates. The Yala season normally extends from April until September. Sesame grows well in this season, although it may also be cultivated in the Maha season if irrigation is available from March to April. It thrives in temperatures between 25^0C and 30^0C, and the early stages need a little rain. Rainfall is supposed to be kept to a minimum during the pod-bearing and blooming stages of germination. Owing to the changing climate, it has already experienced severe drought conditions in the recent past (Gunda et al., 2016). Adverse drought events forecasted to occur in the dry region challenge the country's food security in the coming decades. Additional investigation of sesame has shown that it favors relatively high temperatures and low water content in the soil (or low precipitation) for adequate production (Bahrami et al., 2012; Fazeli et al., 2006; Fazeli et al., 2007).

Sesame can thrive in dry locations where other crops may not yield well. Identifying the agronomic practices of sesame farmers is crucial. Sesame is drought-tolerant and adaptable to warm waters. For optimal production, sufficient soil conditions, such as enough soil moisture, are required. The rate of growth is influenced by the state of the soil. It needs well-drained, sandy loam soil. At the same time, salty soils are not desired for sesame cultivation; hence, properly drained soil is advised in Sri Lanka.

In the 1970s, growers preferred white-seeded varieties for higher oil quality (Abeysinghe, 1974). However, Malee (brown seeded Sesame) was later discovered to have a higher oil percentage (53%), as well as a higher yield (Department of Agriculture, 1998). According to the Department of Agriculture (1998), the Malee cultivar can withstand stem and root rot disease. There was no information available on the drought resilience or susceptibility of Sesame cultivars growing in Sri Lanka.

Certain varieties are suggested in Sri Lanka. The names are Uma Malee and ANKSE3. Broadcasting requires 7 kg of seed per hectare, whereas row planting requires 5 kg. The Malee cultivar has the best yield, followed by Uma and ANKSE3. The Department of Agriculture of Sri Lanka has improved and recommended the varieties Uma, Malee, MI1, MI2, and MI3 (Department of Agriculture, 1998). The distance that exists measures 30×15, and 2 to 3 seeds are planted per hill. After 2 weeks, thinning out is done on the excess plants and one plant per hill.

The first month or so of the crop is when weed control in sesame is most important. It is best to remove weeds in the first two weeks of the thin-out phase and around four weeks after seeding, whether by hand or with machinery. When row spreading is done properly, weed management is straightforward. Sufficient moisture levels in the soil are crucial for the germination of seeds. If the soil is not sufficiently moist, water the seeds every four days for the first three weeks after planting and then every ten to twelve days until the seeds are fully developed.

Pest and disease management

Certain diseases can cause stem and root rot in sesame plants, resulting in a brownish coloration on the plant and yellowish leaves. To mitigate this issue, management practices should be implemented. The bacterial diseases that mostly harm sesame are leaf spots, stem and leaf blotch, and *Cercospora* leaf spots. On susceptible varieties, wilt is equally devastating. Sesame diseases of note also include blight, charcoal rot, stem anthracnose, mildew, and phyllody. Remove the infected plants from the field. If the infection is severe, consider crop rotation with maize or a legume, and improve drainage in the field. Avoid draining infected fields into healthy fields, and proper land preparation methods help to control the pests and disease spreading.

Harvesting, drying and storage

Figure 6: Dried Sesame seeds
Source: Author 2024

The timing of sesame harvesting is critical. Sesame plant parts should undergo colour changes during harvesting. The lower pods should turn brown and the leaves yellowish. The plants are then cut with sharp tools, like knives, and tied into small bundles. The bundles are first left in the open sun for a few days to dry. They tie places on upright sticks with three or four sticks tied in the shape of a triangle. When drying sesame in adverse weather conditions, they use covers, sacks, or other protective materials. Then thrashing happens. Traditionally, farmers trash sesame with their feet to separate seeds from capsules. In some places, farmers use woven mats to prevent soil particles or unwanted materials from mixing with the floor.

After threshing the seeds with mixtures, winnow them with a basket or tray to remove unwanted debris. Ultimately, the cleaned seeds are placed on mats or the floor to air dry under sunlight directly. To protect the dried seed from pests and diseases, it is stored in bags and sacks.

4. Utilization of sesame

Raw seeds are pressed to produce cooking oil, which contains unsaturated fatty acids, antioxidants, and proteins. Both seeds and oil have various applications, including culinary, medicinal, and cultural uses (Adu-Gyami et al., 2019; Anastasi et al., 2017; Elleuch et al.). Sesame seeds are immensely beneficial even after they have been pressed to obtain oil, and hence, oil cakes, the residue of the seed hulls, are used to feed livestock.

The majority of sesame seeds are produced directly to produce oil by the farmer or within the production area, but they can be purchased at different phases of production for multiple purposes, such as meal, paste, sweet treats, and bread items (Salunkhe et al., 1991). To improve the nutritional balance of healthy food products, amino acids can be added to recipes that lack them in other sources of vegetable protein, such as soy, sesame meal, or flour (Prakash, 1985; Quasem et al., 2009).

Sesame oil

Sesame oil extraction is a traditional practice in Sri Lanka, particularly in the Jaffna district. They collect and clean the dried sesame seeds to remove dust and impurities. After that, they roasted the seeds in a pan. The seeds are then ground using stone mills in Tamil 'Chekku'. When rotating the stone manually, the seed paste extracts oil by pressing the seeds well. Then, use a clean cloth (preferably a white cloth) to filter the oil to remove particles and debris, and let it settle in containers

for a few days. After that, sediments are removed by a final filtration.

To extract sesame oil, farmers in Sri Lanka used bullock-driven presses in the past. During this process, a long beam was used to attach a mortar and pestle, and the other end was connected to a cow. The cow rotates around the mortar pestle in a circular motion, breaking and crushing the seed while applying pressure to extract oil.

Cooking

Oil has been used in cooking throughout the past, as Jaffna and other Northern Province villages are well aware. The market is filled with different types of oil. Sesame seed oil is the main option that Northern Province housewives have always had. The national cooking traditions of Sri Lanka encompass a plethora of delectable dishes. Every province in Sri Lanka, like every other nation, has its distinct natural ingredients that are proportionately combined to create a delicious culinary symphony that entices us all. With an influence on daily menus, these primarily rural ingredients have gradually found their way into large, multicultural cities. Sesame oil is primarily used for cooking, but it's also used to flavor and season salads and, in particular, to make "thalaguli", a traditional sweet made with ginger balls. It is called as gingelly balls or gingelly rolls, thala bola, or thalakerali. They are all talking about the same candy. These are formed into various shapes, such as rolls or balls.

Figure7: Gingelly balls "Thala bola"
Source: Author 2024

Thala bola or thalaguli, a traditional local sweetmeat made with sesame seeds, kithul jaggery, fresh coconut, and a small bit of salt, and 'Ellu pa', which is made exclusively in the Jaffna Districts. Ellu pa is made for women to keep regular menstrual cycle especially for teenage girls and drinking raw sesame oil has been their traditional habit since ancient times. In terms of its supposed advantages for menstrual health, there are customs that suggest eating foods made with sesame, such as ellu pa, and consuming raw sesame oil may support regular menstrual cycles, particularly in teenage girls. These beliefs have their roots in Sri Lankan cultural customs and traditional practices that have been passed down through the years.

It is noteworthy, though, that these beliefs might not have scientific support because they are grounded in cultural customs. Eating elu pa and drinking raw sesame oil are traditional customs in Sri Lanka, especially in the Jaffna region and among the Tamil population in general. These customs have cultural significance connected to traditional culinary traditions and health beliefs. Traditionally, it is used because of its antioxidant

qualities, it was used to preserve certain foods, such as mango and lemon pickles.

Religious purpose

Particularly among Hindus and Buddhists, sesame oil is used for religious purposes to light lamps during ceremonies. Through this oil lamp light, they believe in positivity and prosperity in their home and Temple.

Medicinal values

In Ayurveda, it is crucial to the healing process; it involves massaging and using oil pulling in addition to balancing the body's doshas. Specifically utilized in the skin care industry to promote hair growth, relieve muscle tension, moisturize skin, keep the scalp healthy, and prevent dandruff. Sesame oil contains inflammatory qualities that make it useful for treating minor wounds and skin irritations.

Sesame oil is applied mechanically to wooden utensils and other tools or equipment as a lubricant for a variety of purposes. The SSO, extracted from high-grade seeds and more purified than normal edible oil, is used in the preparation of many pharmaceuticals and cosmetics, perfumes, soaps, paints, and insecticides. Sesame's significant antimicrobial qualities have been investigated for use in the formation of disinfectants, antiseptics, bactericides, viricides, repellents, and anti-tubercular agents (Nyongesa et al., 2014).

5. Constraints

Sesame growth in Sri Lanka is also impacted by low soil fertility and a lack of available nutrients. However, there are other reasons, such as pests and diseases, and poor water management. Numerous insect pests' prey on sesame seedlings, foliage, flowers, pods, and stems. These are the main reasons for declining yields and a global production deficit of, on average, 25%. Sesame production worldwide is limited by the inability to find adaptable varieties, capsule shattering, inconsistent ripening, poor crop stand establishment, lower fertilizer responses, numerous branching, inadequate harvest index, unreliable growth habits, and susceptibility to diseases.

Climate variations in Sri Lanka, such as intense rain and wind, can seriously harm sesame cultivation. Because sesame is susceptible to salinity, waterlogging, and chilling its sustainable production is limited. When grown on soils with inadequate drainage, sesame growth and yield experience a reduction after two to three days of standing water. Plant growth, the number of leaf axils per plant, seed yield, and net photosynthesis are all greatly decreased by waterlogging. Sesame goes up better in terms of extreme conditions, with little need for pesticides and only small portions of fertilizer, water, and litter; this is due to the enhanced natural tolerance to insects and diseases. Nonetheless, the yield varies greatly based on the cultivars, cultural practices, and growing conditions. It is primarily grown in semi-arid and arid regions that receive rainfed conditions and experience

mild to severe water deficit stress. In all of its growing regions, it is mostly susceptible to drought during the vegetative stages, and because of drought stress, it has a low production potential in semiarid regions.

On the other hand, grain loss during postharvest handling, which includes processing, transportation, storage, packaging, and marketing, is referred to as postharvest loss. It takes place in the interval between harvest and utilization. Farm size, total amount of grain produced, weather, stacking days, pile transportation distance, distance from the sesame farm, and grain transportation method were the main factors influencing sesame postharvest losses.

6. Yield, exports, and demand of Sri Lankan sesame

The conditions and agricultural practices used in Sri Lanka affect the annual yield of sesame. Under ideal circumstances, the average yield of sesame is roughly 1,800 kg per hectare, according to the Sri Lankan Department of Agriculture. When it comes to exports, Japan, Taiwan, and Singapore are the main destinations for Sri Lankan sesame seeds, and together they have accounted for the majority of the total export value in recent years. Sesame seed exports from Sri Lanka brought in an average of $1,522 per ton in 2022,

Figure 8: Sesame in collection center
Source: Author 2024

indicating a notable upward trend in recent times.

As per the Export Development Board of Sri Lanka, one notable aspect of the nation's export assortment comprises Ayurvedic products, such as sesame oil. (SL Export Portal). Global demand for Sri Lankan sesame oil-based ayurvedic treatments is growing, partly due to consumers' growing inclination toward natural health products (Daily FT 2024). It shows that there is significant demand for Sri Lankan sesame oil on the international market, especially for its use in Ayurvedic medicine. This establishes the product as a valuable export with room to grow.

7. Preserving sesame to improve sesame sustainability

We should adopt certain policies and procedures to preserve sesame in Sri Lanka. Utilizing natural predators, monitoring pest populations, and only using pesticides when necessary to reduce environmental impact are all part of integrated pest management, or IPM. Putting crop rotation techniques into practice can help break the cycles of pests and diseases, enhance soil fertility, and lower the chance of soil erosion. Methods like mulching, terracing, and contour ploughing can help retain soil structure, reduce soil erosion, and increase water retention—all of which are essential for the sustainable cultivation of sesame.

Here are some initiatives that have been implemented to support farmers and improve sesame cultivation in rural

Sri Lanka. To assist farmers in increasing sesame cultivation, several financial schemes and assistance programs are available in Sri Lanka. To increase agricultural productivity and provide farmers with financial support, the Central Bank of Sri Lanka (CBSL) offers a range of refinance programs, interest subsidies, and credit guarantee programs. According to the Central Bank of Sri Lanka, these programs are part of a larger effort to boost food security, lessen poverty, and encourage regional growth.

The Climate Resilient Integrated Water Management Project (CRIWMP) supports the Department of Agriculture's efforts to promote sesame cultivation, such as the Gingelly Cultivation Field Day in the Mannar District. Farmers who participate in this project receive technical assistance, high-quality seeds, and funding. One such instance involved the Department of Agriculture (Department of Agriculture Sri Lanka) (Np Gov Lk) providing sesame seeds and holding training sessions for 67 beneficiaries.

8. Discussion

Sesame seeds have numerous beneficial effects on agriculture, as well as being highly nutritious, medicinal, and antioxidant. With its suitable climate, Sri Lanka holds strong potential for sesame cultivation aimed at addressing global market needs. However, because they continue to use traditional farming methods, Sri Lankan farmers face difficulties like low soil fertility, inadequate pest and disease management, and poor water

management. Sesame has economic value in both local and international markets due to its cultural significance. To encourage sesame cultivation in Sri Lanka, new business ventures, smart technology, loan facilities, insurance schemes, transportation, and storage facilities productivity will improve. Introducing sesame food products such as 'Thala Bola', 'Ellu Pa' will encourage the consumption of sesame while also increasing awareness of its values to conserve and respect our tradition worldwide. Specifically, in Ayurvedic products, Sri Lanka can leverage international markets to expand its sesame industry while satisfying local demand. A greater understanding of the benefits of the crop, the demand for it worldwide, the potential of the nation, sustainable growing methods, the availability of locally improved varieties, and marketing techniques will also inspire farmers to cultivate sesame and boost the country's production of the sesame.

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Chapter 9: Sugarcane and Sugar Industry in Sri Lanka

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Abstract

Sugarcane is a fibrous crop with high nutritional value that grows in tropical and subtropical regions. This perennial crop contributes to the country's economy and, more importantly, to the sugar industry. Sugarcane is widely cultivated in Sri Lanka due to the continued demand for its direct use as table sugar and alternative production for food and beverage, biofuels, feed for livestock, paper production, and organic fertilizer production. The climatic requirements for the growth of sugarcane are provided by the dry and intermediate zones of Sri Lanka. Recently, the supreme plantations of Pelwatte and Sevanagala were taken to the government under Act No. 43 of 2011 on Underperforming and Underutilized Assets. This was a turning point in the sugar industry in Sri Lanka, where it led to a crisis in the production of sugar. Besides, this production is not even sufficient for local consumption; therefore, 90% are imports. Cultivation and production, along with sustainability, are observable in the sugar industry of Sri Lanka, but in addition, maximum resource utilization in the industry should be developed with technology.

Keywords: *Sugarcane, Jaggery, Sugar, C4*

1. Introduction

Figure 1: Sugarcane cultivation in Sri Lanka
Source: Author 2024

Sugar is a simple carbohydrate consumed by more than half of the population in the world. (Statista, 2024b) indicates that Brazil is the world's leading sugar producer, generating almost 45 million metric tons of sugar. During that time, total sugar production was estimated to be around 183 million metric tons. Consumption is anticipated to increase with the rise in demand for bakery and other confectionary industries. According to the statistics given in Statista (2024b), the global consumption of sugar reached about 177.33 million metric tons in 2023–24 and is projected to increase to about 178.79 million metric tons by 2024–2025 for its usage as a sweetener, fermentation substrate, flavouring agent, and colouring agent. The increase in demand for sugar production continues as there is a development in sugar cane-based products and in-country products worldwide.

Figure 2: Sugar cane plants
Source: Author 2024

Saccharum officinarum (sugarcane) is a crop that

belongs to the grass family and is leading in the sugar production industry. Originally from warm temperate to tropical Asia, these plants have robust, jointed, fibrous stalks that are rich in sugars. Their height ranges from 2 to 6 meters (6 to 19 feet) (Carioca & Leal, 2017). Sri Lanka, being an Asian country, has a history of three decades where sugar production took place. In Sri Lanka, each person consumes roughly 30 kg (66 lb.) of sugar per year, whereas approximately 550,000 tons are required altogether (Wikipedia authors, 2024). A country's availability of natural resources such as land, soil, raw materials, climate, and other elements is essential for the development of the sugar business (Arachchige et al., 2020). The districts of Monaragala and Ampara are making significant contributions to the cultivation of sugarcane crops to boost the nation's economy and lower yearly expenditures for sugar imports (Wikipedia contributors, 2024b). The leading plantations were in Kantale, Hingurana, Pelwatta, Sevanagala, and Monaragala, but the two factories, Pelwatta and Sevanagla, are under the Ministry of Plantation Industries and Export Agriculture. (Wikipedia contributors, 2024b). This transpired due to the economic instability and political influence over the years in Sri Lanka.

2. Method

Figure 3: Sugar cane stalk
Source: Author 2024

Sugarcane, being a member of the Poaceae family's physical form and external structure comprise various features as a non-cereal crop. The main part of the crop is the stalk, which consists of nodes and internodes that make the surface of the stalk smooth with a rough and hard rind. However, the plant embodied leaves, roots, and inflorescence as the main morphological parts other than the stalk of the crop. The cane variety and the surrounding conditions affect the color of the stalk at the internodes. For instance, the internodes' color may completely change if they are exposed to the sun. The hue of the same cultivar produced in various climates might vary. Anthocyanin, a red pigment, and chlorophyll, a green pigment, are the two primary pigments that give stalks their many colors (SS-AGR-234/SC034: Sugarcane Botany: A Brief View, n.d.). The solid phase of the stalk

Figure 4: Tillering stage
Source: Author 2024

is considered the fibrous portion, while the parenchyma tissue forms the walls of storage cells that contain juice with high density and purity. The conducting vessels, which are found in every part of the plant, from the roots to the leaves, are housed inside the comparatively sturdy vascular bundles. Moreover, there is more fibre content when the vascular bundles are closer together at the rind and in the nodes ("Cane," 1982). The crop has blade-shaped leaves from the internodes and grows vigorously after it reaches the vegetative stage.

The physical features of the sugarcane change with the growth phases and its composition, which accumulate sucrose. Sugarcane is composed of four growth phases: the germination phase, the tillering phase, the grand growth phase, and the maturing and ripening phase. In sugarcane, germination refers to the vegetative bud's activation and subsequent sprouting, and after the first stage, tillering gives the crop the right number of stalks needed for a healthy harvest. The grand growth stage is the most crucial stage of the crop's growth, during which the canes develop, elongate, and increase in production. Thereafter, the final stage arises maturation and ripening.

3. Cultivation of Sugar Cane

Figure 5: Sugarcane cultivation – Ampara district, Source: Author 2024

Sri Lanka's dry and intermediate zones correspond to the climatic requirements for sugarcane cultivation. Mainly in areas such as Monaragala,

Ampara, Badulla, and Trincomalee districts, sugarcane is cultivated on 45,000 ha, while Anuradhapura, Puttalam, and Kilinochchi districts contribute another 90,000 ha. However, Pelwatta, Sevanagala, Higurana, and Passara areas also chiefly cultivate this crop and contribute to the sugar industry in Sri Lanka, while Badulla and Monaragala districts provide the harvest for the jaggery and jaggery food in smaller quantities.

The onset of rain in the Maha season from September to January and the Yala season from March to June provide the most suitable conditions for planting. Timely cultivation leads to higher yields due to less flowering of sugarcane, higher sugar content in the yield, and convenience in management practices. There is a specific list of varieties studied by the sugarcane research institute in Sri Lanka as high-yielding varieties according to their characteristics in disease resistance, drought tolerance, high sugar content, and uniform cultivation. The specialty of these introduced varieties is that many of them are locally developed varieties: SL 83 06, SL 86 13, SL 88 116, SL 88 238, SL 89 1673, etc.

Figure 6: Sugarcane cultivation - Buttala
Source: Author 2024

In cultivating this C4 plant, a series of steps must be followed to achieve a high yield. In land preparation, alley cropping hedgerow is a method used by the local farmers; therefore, the land is harrowed using a mouldboard or by tractors before sugarcane cultivation. When the harrowing is completed, the local farmers provide a period to decompose the organic materials in the field for about one week, and in the opposite direction of the first harrowing, the second harrowing takes place. The harrowing takes place on the opposite side of the slope to prevent soil erosion and to plough the field. Thereafter, a disc plough is used for ploughing for the purpose of preparing alleys for the plantation of sugarcane. Usually, alleys are at a depth of 17–22 cm, and they are prepared considering the topography of the field. The slope of the alley should be less than 1% to avoid soil erosion.

These practices enrich the soil with proper planting techniques and depth, helping to reduce land preparation costs for farmers. As modern sugar cultivation follows vegetative or sexual propagation via stem cuttings, the management of seed cane nurseries is an important activity (Nalawade et al., 2018). Good-quality sets of sugarcane are obtained for cultivation that is compliant with qualities such as healthy buds, high moisture content, adequate nutrients, a high amount of reducing sugar, and being free from pests and diseases. Based on the prevailing climatic requirements, available natural resources, and soil conditions, various planting methods are used: single-settled planting, 50% overlapping, and 100% overlapping. Moreover, based on the rainfall

distribution and quality of the planting material, planting systems are varied into the ridge and furrow system, flat system, trench system, ring pit system, and furrow irrigated raised bed technique.

Management practices involved in cultivation play a huge role in the development of crops. At present, in irrigating these cultivations, the most commonly used method is considered to be surface irrigation through furrow irrigation. There's 60% efficiency through this method and it is also the widely adopted irrigating method by the farmers. Modern technologies have opened doors to making irrigation more convenient and efficient by introducing drip irrigation and sprinkler systems for sugarcane cultivation. There can be limitations for these methods as the initial cost is high for rural farmers; therefore, the alternate row furrow irrigation or the skipped furrow irrigation method introduced by the sugarcane research institute, Udawalawe, shows efficiency and conserves water for irrigation. Fertilization is done in two phases: the basal fertilizer mixture, where urea and Triple Super Phosphate (TSP) are applied at the beginning in the required quantities per hectare, and the top dressing, done with urea, TSP, and Muriate of Potash (MOP) fertilizers after 45 days for plants and ratoon crops. For the 2nd top dressing, urea, and MOP fertilizers are used after 3 months of plants and ratoon crops, avoiding heavy rains and heavy droughts in the application of fertilizers. Fertilization is required for its economic value and commercialized cultivation in the country, and farmers are subsidized by the Sri Lankan government as

sugarcane cultivation is one of the major cultivations in Sri Lanka.

4. Sugar Industry in Sri Lanka

The country's expected annual sugar consumption in 2023 is 661,183 metric tons. Based on 2023, Sri Lanka imports 90% of its yearly sugar needs while incurring enormous foreign spending of Rs. 127 billion (User, n.d..). The country was sufficient with its production as there were more than four plantations with an efficient production process, but recent changes in the economy and government have led the sugar industry into uncertainty, where only two factories contribute to its production. Depletion in sugarcane cultivation is mainly due to a lack of a rational government strategy protecting the interests of all stakeholders, including sugarcane growers and consumers. Sri Lanka's sugar sector has now devolved into a crisis. (Sri Lanka’s Sugar Industry in Crisis, n.d.). Act No. 43 of 2011, which dealt with the restoration of underperforming firms or underutilized assets, allowed the government to seize control of the Pelwatta and Sevanagala industries on November 11, 2011.

This measure was taken in response to a report produced by a cabinet subcommittee that was tasked with examining the industrial characteristics and historical performance of the sugar sector with economic development (User, n.d.). At present, the government is concerned with its expenditure on imports of sugar; hence, there is an increasing demand for sugar in the country in terms of consumption and food-related

production. By 2030, it is anticipated that sugar consumption in Asia will account for 49% of the world's total. Overall, then, there is a great deal of room for the Asian sugar sector to grow its cane and sugar output to fulfil the rising demands of the future (Solomon & Li, 2016). However, the industry's growth in terms of output in comparison to the nation's sugar and energy needs for food and energy security, as well as its contributions to the national economy in terms of generating income and jobs, has fallen short of promise (Keerthipala, 2016).

Figure 7: Transporting of Sugar cane
Source: Author 2024

Manufacturing plants mill and obtain the nutritious juice from the sugarcane, which is then used in the technique of regaining sugar crystals. The initial raw sugar produced is termed natural brown sugar, which contains more molasses and has a higher mineral content. One hundred tons of cane provides approximately eight tons of sugar. Weekly maintenance schedules are carried out by the Pelwatte factory engineering personnel in order to

restore the plant and equipment to "standard" production levels (User, n.d.-b). The International Commission for Uniform Methods of Sugar Analysis (ICUMSA) has assigned a rating of 500 to 1,500 to Lanka Sugar Company Private Limited (LSCP) brown sugar, which falls under the category of "unprocessed agricultural products." In contrast, imported white sugar that has undergone processing has an ICUMSA rating of 40 to 100. LSCP sells two types of sugar (User, n.d.-c). Bagasse is the main byproduct formed after the extraction of juice from the cane. Additionally, the residual biomass that remains after producing sugar and bioethanol can be utilized to produce second-generation ethanol or bioelectricity. (Ali et al.., 2021b) In the Pelwatte factory, this product is also used as a common main fuel source for LSCP sugar mills: bagasse. Bagasse can be burned in large quantities to provide the sugar mill with all the heat energy it needs (User, n.d.-b). Moreover, cane tops, molasses, and filter mud are also byproducts of the sugarcane industry, which have been used in research and demonstrated that they can be used sustainably for maximum utilization, but so far, they have not been applied within the production process or thereafter.

Significance of sugarcane

Sugar Cane is a productive crop both economically and medicinally for its nutritive value, as shown by Ali et al. (2021). Antioxidant, anti-cancer, anti-fibrotic, and anti-thrombotic activities are performed by this crop for its phytochemical profile. It was also known as an energy source for human beings in the past. This fibrous-rich crop is enriched with nutrients of protein, vitamins A, B-

Complex, and C. Sugarcane juice helps your body stay hydrated and lessens heat-related weariness. You may manage your dryness by consuming the minerals, proteins, and carbohydrates this juice offers. In the field of Ayurveda, sugarcane makes up one of the healthiest drinks for jaundice patients. It aids in combating weakness, boosts immunity, gives glowing skin, and acts as a digestive tonic (Toshi, 2024).

Products made from sugarcane include ethanol, bagasse, molasses, and table sugar. In the past ten years, sugarcane has grown significantly as a biofuel crop. Sugarcane juice and molasses are fermented and distilled to produce hydrated ethanol and anhydrous ethanol, which is an additive for gasoline. If energy efficiency is increased, sugar producers could provide energy in the form of co-generated "green" electricity or fuel ethanol produced by fermenting and hydrolysing cellulose (Botha & Von Blottnitz, 2006). In Sri Lanka, filter mud is used as a commercial product of organic fertilizer by Gal Oya (PVT) Ltd. and Higurana Sugar Industry (PVT) Ltd. Moreover, water-purifying plantations are also in action. Despite the utilization of sugarcane and its residues in the manufacturing process, the country's economic role can be reconfigured through biological, chemical, and thermal conversion processes, with so-called trash becoming a raw material (Ali et al., 2021c).

Agricultural potential and potential uses of byproducts

Figure 8: Sugarcane Monocropping
Source: Author 2024

The cultivation of sugarcane continues as mono-cropping, and they are cooperative in the management and harvesting of the yield. In the study conducted by Raza et al. (2024), converting the sugarcane sole cropping system into an intercropping system in order to produce an additional net profit with less input and environmental impact is more beneficial to the farmer. Approximately 50% of the land and 20–60% of the nutrients (N and P) during sugarcane canopy development are underutilized (Raza et al., 2024b); therefore, to achieve maximum utilization of the land, other crops can be intercropped. According to studies, it is shown that in Pakistan, the yield of sugarcane increases with the intercropping of onions in the same field, while it increases cane output, which translates into

a higher total income than sugarcane planted alone (Azam & Khan, 2010). In Sri Lanka, they are mostly intercropped during the early stages of rubber farming. Local farmers typically intercrop sugarcane under immature rubber plants to generate additional revenue (Kumara et al., 2016).

Bagasse is primarily utilized domestically in sugarcane factories as fuel to create steam, with a tiny amount also being used to make pulp and board for eco-friendly production. Molasses-generated bagasse can be exported unprocessed for animal feed or processed to make rum, acetic acid, yeast, drinking alcohol[1], or alcohol for industrial use. Furthermore, it is a known fact that most of the cane tops and filter mud are disregarded as they have no market value and a set price in the market. In Sri Lanka, most of the sugar factories utilize filter mud to sell as organic fertilizer; hence, on a dry basis, filter mud has a weight percentage of roughly 1% for nitrogen and phosphate (p2O5) (Kulasekara et al., 2021). Moreover, sugarcane fibres and bagasse contribute to the production of food packaging and textile rayon fibres.

Like rice and cotton, sugarcane requires little water, but it is a thirsty crop; 390 gallons are usually required to produce 1 kilogram (2.2 pounds) of sugar from sugarcane (Arachchige et al., 2020). It is also a major limitation in Sri Lanka when cultivating sugarcane, as its quality depletes due to the less availability of water for

[1] Health Warning – No level of alcohol consumption is safe for our health (The World Health Organization)

irrigation, and villagers who live nearby are affected by the water availability for their activities when sugar cultivation demands a higher amount of water. Pest and disease management is a prime activity on these plantations, and farmers face difficulties. Sugarcanes are susceptible to fungi, which destroy the whole cultivation during heavy rain. The only solution to this is to remove the plant from its location before it spreads.

Sri Lanka is a developing country that lacks technological advances and techniques; this is observed in many sectors of the country, mainly agriculture, compared to foreign countries. Sugar plantations cause severe impacts on the environment in sugar processing due to carbon dioxide emissions and energy usage in the extraction process. Feedstocks containing sugar seem to have a greater impact on global ethanol production. Additionally, sugar-based substances have lowered production costs. (Carioca & Leal., 2017). As a solution, factories such as Pelwatte use bagasse as a biofuel. Waste materials and polluted water released into the environment are purified by the wastewater management plant. These are not available in all the plantations but in some of the actively functioning factories under LSCP. Sugarcane harvesting is a major activity in sugar cultivation. Producers have concerns regarding the ripeness of their canes for mechanical and manual harvesting. Mechanical harvesters are provided by the sugar plantations for substantial cultivation lands in the Hingurana area.

Conclusion

Figure 9: Sugarcane cultivation
Source: Author 2024

The sugar business is also a commercially and financially vital industry that serves as a significant source of income for the government during times of economic upheaval. The improvements to the industry are possible with value addition, varietal development, extension of cultivation, and continued inspection. Considering the prevailing obstacles, there are evident attempts being made to cultivate and produce sugarcane with an emphasis on sustainability. Technological innovations must be used to generate maximum resource utilization to improve the industry's prospect.

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Chapter 10: Conclusion and Way Forward

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The effectiveness of the OTOP strategy hinges on community involvement, collaboration among local stakeholders, and well-executed marketing endeavours. The product chosen must not only be unique but also viable in terms of sustainable development and economic prospects for the community. Further along in this plan, tourism is probably going to play a vital part; hence, a focus must go to attracting tourists interested in and willing to purchase these unique local products.

It is evident that Sri Lanka's traditional mask industry showcases the island's vibrant cultural heritage and ancestral craftsmanship. This study deals with the history, artistry, and current challenges of mask-making, specifically in Ambalangoda. In general, it depicts financial nonviability and lack of interest amongst the younger generations due to many reasons as its major troublesome areas. With that in mind, this study lays down for the preservation of this heritage the following: government financial support, various awareness campaigns, and educational initiatives. Using means of technology, traditional knowledge could be documented. Moreover, fostering tourism while enhancing export markets should be able to rejuvenate this industry,

keeping authenticity at the heart of that. Analysing the mask industry not only as a cultural heritage but also as an economic opportunity plays a vital role in terms of protecting the legacy of the field and sustaining the livelihoods of artisans.

As far as mangrove beverage production in Sri Lanka is concerned, as previously discussed, rural families earn income by making mangrove apple drinks and selling them in local markets and to tourists. This helps develop local entrepreneurship, fostering sustainable development. Mangroves are very important in protecting coastal ecosystems by preventing soil erosion, stabilising riverbanks, controlling floods, and replenishing groundwater. By following the rules for sustainable harvesting, these critical ecosystems will be protected while many economic opportunities are offered. Empowering communities and promoting sustainable practices with regard to this field will lead to a better future for both people and the environment.

Concerning Sri Lanka's dried fish industry, as mentioned in a prior chapter, it remains largely dependent on traditional processing methods, creating substantial obstacles to its further growth and advancement. Nevertheless, the entire industry of dried fish has immense potential for sustainable development. It is, of course, also important to address certain salient issues affecting the long-term viability of both marine and inland production, such as post-harvest losses, quality control, and value addition. These problems could be tackled efficiently by the introduction of value addition,

diversification in the markets, and the infusion of new technology into the industry. A planned effort to overcome these problems will be of great advantage to all parties concerned, particularly the coastal and inland fishing communities.

Furthermore, Sri Lanka's beekeeping industry, primarily relying on "*Apis cerana"* bee varieties, was accustomed to traditional methods with a transition towards modern technology. The use of modern technology in this area has ascended. The beekeeping industry contributed to the local market, generated exports, supported the national economy by developing sustainability techniques, and improved production with advanced technology. Despite its vast potential, the industry has been plagued by challenges like climate change, limited knowledge of hybrid technology, and small-scale infrastructure and equipment. Support from the government, policymakers, researchers, and other stakeholders in the market is critically important to address the challenges that face this industry, enhance it, and boost the economy.

As evident in the chapter, the curd production in Thissamaharama carries traditional and innovative dispositions and economic importance, showcasing the cultural legacy of the region. While facing challenges such as quality consistency, climatic conditions, and economic pressures, it also presents opportunities for growth and sustainability. Emerging technological advancements, sustainable practices, and expanded market reach would support curd producers to sustain and develop the local economy. The future of curd

production in Thissamaharama remains positive, with growth potential, more visibility in markets, and preservation of cultural traditions.

The study conducted on kithul jaggery industry highlights the importance of better market access, cultural preservation, and creative branding for the growth. Although upgrading production technology is not a top priority, finding new markets and enhancing the product's value are vital. Such initiatives can help the industry not just get by, but truly flourish, attracting younger generations and supporting a dynamic village-centred economy. Additionally, incorporating tourism and adopting eco-friendly packaging can increase the product's attractiveness. This approach can lead to a future for the Kithul Jaggery industry that is both sustainable and rich in culture.

Regarding sesame production in Sri Lanka, it is apparent that sesame has been associated with high nutritional, medicinal, and antioxidant attributes, thus making it of immense economic value to Sri Lanka due to its cultural importance. Although globally in demand, traditional farming in the country also faces challenges like poor soil fertility, pest and disease control, and water management. New business ventures to revolutionize sesame production, along with modern technology, financial support in the form of loans and insurance, and improved transport and storage will encourage sesame cultivation in Sri Lanka. Awareness campaigns for sesame-based products such as "Thala Bola" and "Ellu Pa" will help popularize and provide importance to the crop.

Enhancing the benefits of sesame, its demand, sustainable farming practices, and local varieties will motivate the farmers to grow this crop, leading to an increase in production at national levels.

Furthermore, the sugar industry is identified as an economically and financially crucial sector that provides a vital source of income for the government, especially during periods of economic instability. Growth in this industry can be realized through value addition, varietal development, expanding the area under cultivation, and continuous monitoring. Despite the existing challenges, efforts are quite evidently visible in cultivating and producing sugarcane through sustainable means. The adoption of technological advancements is essential in optimizing the use of resources and enhancing the future potential of the industry.

As evident, while the various sectors and industries discussed in different chapters face their unique challenges, there are common challenges specific to these industries, too. Providing financial support to enhance their industries, incorporating IT into their traditional fields, introducing innovative methods and technologies, giving due recognition and preserving indigenous knowledge, introducing new technology, and offering support to enhance their knowledge and skills are optimal solutions to overcome these challenges. Government support is crucial in this matter.

In conclusion, implementing OTOP in Sri Lanka could further help to achieve UN Sustainable Development

Goals (SDG), including 'No Poverty' (SDG 1), 'Zero Hunger' (SDG 2), 'Good Health and Well-being (SDG 3), 'Reduced Inequalities (SDG 10), and 'Sustainable Cities and Communities (SDG 11).

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