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RESEARCH

Mapping the Cotton Industry: Key Sectors, Value Chain Tracks, and Future Prospects

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ABSTRACT

PURPOSE: The cotton industry is a highly integrated agro-industrial system, supporting rural livelihoods, industrialisation, and global trade. Despite its importance, it faces challenges from sustainability pressures, competition from synthetic fibres, and market volatility. This paper aims to map the key sectors and value chain tracks of the cotton industry while assessing prospects for competitiveness and sustainability.

DESIGN/METHODOLOGY/APPROACH: A value chain analysis framework is employed, supported by desk research and review of industry reports, trade data, and academic literature. The study maps the cotton value chain from cultivation and ginning to textile processing, garment production, and by-product utilisation, while also examining emerging sustainability and digitalisation tracks.

FINDINGS: The cotton industry comprises multiple interlinked sectors. Primary production and ginning remain dominant, but by-product use (oil, feed, biomass) and advanced textile applications are growing. Sustainability initiatives—such as organic cotton, fair-trade systems, circular textile models, and digital supply chain traceability—are reshaping competitiveness. Key challenges persist, including water stress, environmental impacts, market instability, and limited value addition in producing countries.

PRACTICAL AND POLICY IMPLICATIONS: Opportunities exist to enhance industry performance through investment in processing capacity, sustainable farming, certification systems, and integration into global textile value chains. In developing countries, cotton can drive green industrialisation, employment, and rural economic development if supported by coherent policies and partnerships.

ORIGINALITY/VALUE: By systematically mapping sectors and value chain tracks, this study provides a comprehensive overview linking production, processing, sustainability, and trade. It offers insights for academic research and policymaking, identifying leverage points for innovation and sustainable growth in the cotton economy.

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INTRODUCTION

Background and Significance of Cotton in the Global Economy

Cotton has historically been described as the "white gold" of agriculture due to its profound economic, social, and cultural significance. It is cultivated in more than 80 countries across five continents, making it one of the most widely traded agricultural commodities worldwide (International Cotton Advisory Committee) (Naim, 2024). The crop directly supports the livelihoods of over 100 million households, while an estimated 350 million people are engaged in activities across its value chain, from farming to textile manufacturing and trade (Food and Agriculture Organisation of the United Nations). For many developing countries in Africa, Asia, and Latin America, cotton serves as a strategic cash crop, providing a critical source of export earnings and rural employment (Yue *et al.*, 2025).

In industrial terms, cotton forms the backbone of the textile and apparel sector, which is one of the largest manufacturing industries globally. Cotton fibre accounts for approximately 25–30 per cent of global fibre consumption, competing closely with synthetic fibres such as polyester. Unlike many synthetic alternatives, cotton offers natural comfort, breathability, and biodegradability, characteristics that sustain strong demand in both traditional textiles and emerging technical applications, including medical fabrics, automotive interiors, and construction materials (Naim, 2024).

The global significance of cotton also lies in its contribution to international trade and economic integration. Major producing countries such as China, India, the United States, Pakistan, Brazil, and several African nations are linked through a complex network of exports, imports, and processing activities. Cotton is not only traded as a raw material but also acts as a catalyst for value-added exports through spinning, weaving, garment manufacturing, and fashion industries. Countries with integrated cotton-to-textile value chains gain substantial advantages in industrialisation, employment generation, and export diversification (Mapanga *et al.*, 2018).

At the same time, cotton is increasingly associated with sustainability and development objectives. Its production intersects with critical challenges such as water use, pesticide dependence, land management, and climate change, raising concerns about environmental and social impacts. Initiatives such as organic cotton, the Better

Cotton Initiative (BCI), and fair-trade certification schemes reflect a growing shift among consumers and policymakers towards responsible production, transparency, and traceability. As a result, cotton stands at the nexus of agriculture, industry, and sustainability, reinforcing its global importance as both an economic driver and a development challenge.

Importance of Cotton as Both an Agricultural and Industrial Crop

Cotton is unique among agricultural commodities in that it simultaneously provides fibre for the textile industry and seed for food, feed, and industrial uses. As an agricultural crop, cotton is cultivated predominantly by smallholder farmers in developing countries, many of whom rely on it as their primary source of cash income. Globally, cotton occupies approximately 2.5 per cent of the world's arable land, yet it accounts for around 7 per cent of agricultural labour in developing economies. The crop plays a vital role in rural development by generating employment across planting, harvesting, ginning, and marketing activities. In regions such as Sub-Saharan Africa and South Asia, cotton contributes significantly to household income stability, poverty reduction, and foreign exchange earnings (Khan *et al.*, 2020).

As an industrial crop, cotton is central to the textile and apparel industries, which together constitute one of the largest manufacturing sectors worldwide. Cotton lint is processed into yarn, fabrics, and garments, forming the foundation of a global textile value chain valued at over USD 500 billion annually. In addition to fibre, cottonseed represents an important industrial by-product, processed into edible oil, protein-rich animal feed, and raw materials for cosmetics, pharmaceuticals, and biofuels. This dual-use characteristic—providing fibre for industry and seed for agro-industrial processing—positions cotton as a cornerstone of both agricultural and manufacturing economies (Naim, 2024).

Moreover, cotton's integration into global trade further amplifies its significance. Approximately 80 per cent of global cotton production enters international markets in raw or processed form, linking producers in Africa, Asia, and the Americas with textile industries in Europe, China, India, and beyond. The capacity of cotton to generate value-added exports through textiles and apparel strengthens its role within industrialisation strategies in many developing countries. Consequently, cotton functions not only as an agricultural commodity but also as a strategic industrial input, bridging rural production systems with global manufacturing and trade networks.

Rationale for Studying Sectors and Value Chain Tracks

The cotton industry is characterised by a complex and multi-layered value chain that extends from primary production to textile manufacturing and global trade. Each sector within this chain—cultivation, ginning, spinning, weaving, apparel production, and by-product processing—contributes differently to economic growth, employment creation, and international competitiveness. However, in many cotton-producing countries, particularly in Africa and parts of Asia, the industry remains predominantly concentrated at the level of primary production, with limited downstream value addition. This structural imbalance often results in lower returns for farmers and the loss of potential opportunities for industrial development.

Examining the sectors and value chain tracks of the cotton industry is therefore essential for identifying bottlenecks, inefficiencies, and opportunities for upgrading. Value chain analysis enables a clearer understanding of how benefits are distributed among stakeholders, from farmers and ginners to processors and traders, while also revealing structural constraints such as inadequate ginning capacity, weak textile infrastructure, and continued dependence on raw cotton exports. By systematically mapping these tracks, policymakers and researchers can design targeted interventions aimed at enhancing local value addition, improving competitiveness, and strengthening linkages between agriculture and industry.

In addition, global shifts towards sustainable production systems, circular economy models, and traceable supply chains have increased the importance of analysing the cotton value chain as an integrated whole. Initiatives such as the Better Cotton Initiative (BCI) and organic cotton certification schemes place greater emphasis on transparency, environmental performance, and social responsibility, thereby reshaping how cotton is produced, processed, and traded internationally. Understanding these evolving value chain tracks allows stakeholders to anticipate market trends, align with emerging sustainability standards, and access higher-value niche markets.

Finally, the rationale for this study is strengthened by cotton's relevance to the achievement of the Sustainable Development Goals (SDGs). Cotton production and processing intersect directly with SDG 1 (no poverty), SDG 8 (decent work and economic growth), SDG 9 (industry, innovation, and infrastructure), and SDG 12 (responsible consumption and production). Analysing the industry's sectors and value chain tracks therefore provides a robust foundation for developing policies and practices that position cotton not only as an agricultural commodity, but also as a catalyst for industrialisation, rural development, and climate resilience.

Research Problems

Despite its global significance, the cotton industry continues to face persistent challenges across its value chain. In many producing countries, particularly in Sub-Saharan Africa and South Asia, the sector remains heavily concentrated on primary production and the export of raw lint, with limited domestic processing capacity and weak integration into higher-value textile and apparel markets. This structural imbalance constrains income generation, limits industrial development, and exposes farmers to price volatility and fluctuations in global markets.

At the same time, the industry is under increasing pressure to respond to sustainability imperatives, including water scarcity, pesticide dependence, labour standards, and the impacts of climate change. Although initiatives such as the Better Cotton Initiative (BCI) and organic certification schemes have gained prominence, the benefits associated with these sustainability pathways are unevenly distributed across regions and value chain actors. These challenges underscore the need for a comprehensive mapping of cotton's sectors and value chain tracks in order to identify critical leverage points for enhancing competitiveness, advancing sustainability, and promoting inclusive development.

Research Objectives

The primary objective of this study is to systematically map the cotton industry by identifying its key sectors and value chain tracks, from primary production to final textile and garment markets.

The study seeks to clarify how different stages of the cotton value chain—cultivation, ginning, spinning, textile manufacturing, garment production, and by-product utilisation—are interconnected and contribute to overall industry performance.

A further objective is to examine emerging tracks within the cotton industry, particularly those related to sustainability, circularity, and digitalisation, and to assess how these tracks influence competitiveness in global markets. Additionally, the study aims to identify structural bottlenecks and opportunities within the cotton value chain, with particular attention to challenges faced by producing countries in capturing greater value and enhancing long-term sustainability.

LITERATURE REVIEW

Global Cotton Production and Value Chain Structure

Cotton remains one of the most significant natural fibres globally, underpinning agricultural livelihoods, industrial processing, and international trade. Global cotton production and consumption patterns are shaped by agronomic conditions, technological advancements, and market demand (Khan *et al.*, 2020). According to Khan *et al.* (2020), cotton production is concentrated in a few major producing countries, while consumption is driven largely by textile and apparel industries, highlighting the inherently globalised nature of the cotton value chain.

The cotton value chain encompasses multiple interconnected stages, including input supply, cultivation, ginning, spinning, weaving, garment manufacturing, and retail. Kabish *et al.* (2024) emphasise that value addition increases progressively along the chain, with upstream actors—particularly smallholder farmers—often capturing the least economic benefit. This structural imbalance is a persistent challenge in developing-country cotton sectors, where limited access to finance, technology, and markets constrains competitiveness (Mapanga *et al.*, 2018).

Ginning and Skill Gaps in the Cotton Sub-sector

The ginning sub-sector plays a pivotal role in determining fibre quality and downstream value creation. Asia (2008) identifies significant skill gaps in ginning operations, particularly in South Asian contexts, where outdated machinery, inadequate technical training, and weak quality control systems undermine efficiency and fibre quality. These skill deficiencies not only affect productivity but also reduce the ability of ginners to meet international quality standards, thereby limiting market access.

Such operational constraints resonate with broader findings on value chain inefficiencies in developing economies. Mapanga *et al.* (2018) argue that weak coordination among value chain actors, coupled with infrastructural and institutional barriers, hampers effective value chain management. The lack of skilled labour at critical processing stages such as ginning exacerbates these challenges and perpetuates low value capture upstream.

Environmental Sustainability in Cotton Value Chains

Environmental sustainability has emerged as a central concern in cotton production and processing. Bevilacqua *et al.* (2014) provide a comprehensive environmental analysis of a cotton yarn supply chain, demonstrating that significant environmental

impacts arise from energy use, water consumption, and chemical inputs, particularly during cultivation and spinning stages. Their life-cycle-based assessment underscores the need for integrated environmental management across the entire value chain rather than isolated interventions.

Expanding on this perspective, Mellick *et al.* (2021) examine sustainability from fibre to fashion, highlighting how environmental and social sustainability increasingly influence value creation and consumer perceptions. They argue that sustainability initiatives can enhance brand value and resilience in global cotton textile and apparel value chains, although implementation remains uneven due to cost pressures and governance gaps.

Technological innovation, including high-performance computing and artificial intelligence, offers new opportunities to address environmental challenges. Naim (2024) highlights the potential of advanced computational tools to optimise resource use, improve environmental monitoring, and support data-driven decision-making in sustainable production systems, including agriculture and textiles.

Labour Risks and Social Dimensions of Cotton Value Chains

Beyond environmental concerns, social sustainability—particularly labour conditions—has gained prominence in value chain research. Boersma *et al.* (2022) analyse downstream labour risks in the Australian cotton industry, revealing that labour vulnerabilities often extend beyond national borders through global value chain linkages. Their findings demonstrate how power asymmetries and outsourcing practices can obscure responsibility for labour conditions, complicating governance and accountability.

These social risks align with broader critiques of global value chains, where transparency and traceability remain limited, especially in downstream segments such as textile manufacturing and garment production (Mellick *et al.*, 2021). Addressing labour risks therefore requires coordinated governance mechanisms that span multiple stages and geographies.

Climate Change, Genetics, and the Future of Cotton Production

Climate change poses significant threats to the future viability of cotton production, particularly in water-scarce regions. Yue *et al.* (2025) assess future cotton production in China's Tarim River Basin under climate model projections, finding that water availability and adaptive management strategies will be decisive factors in sustaining

yields. Their study underscores the importance of integrating climate modelling and water governance into long-term cotton sector planning.

At the same time, advances in cotton genetics and genomics offer pathways to enhance resilience and productivity. Zhang *et al.* (2025) highlight the role of genetic diversity and genomic tools in improving cotton's tolerance to biotic and abiotic stresses. These innovations are critical for adapting cotton production systems to climate variability while maintaining fibre quality and yield.

Synthesis and Research Gaps

The reviewed literature demonstrates that cotton value chains are shaped by complex interactions among economic, environmental, social, and technological factors. While significant progress has been made in understanding production dynamics, sustainability impacts, and governance challenges, gaps remain in integrating these dimensions holistically. In particular, limited empirical research links upstream skill development, such as in ginning, with downstream sustainability and labour outcomes.

Future research should therefore adopt interdisciplinary and systems-based approaches to enhance equitable value distribution, environmental performance, and resilience across global cotton value chains.

RESEARCH METHODOLOGY

The study adopts a qualitative value chain analysis framework supported by desk-based research and comparative literature review. Data were collected from a range of secondary sources, including academic journals, industry reports, international trade statistics, and publications from development organisations and cotton industry bodies. The methodology involved mapping the cotton value chain by categorising activities into core production and processing stages, auxiliary services, and emerging innovation tracks. Comparative analysis was applied to examine variations across regions and production systems, particularly between developed and developing country contexts.

In addition, thematic analysis was used to synthesise findings related to sustainability, environmental impacts, labour considerations, and digital supply chain innovations. This integrative approach enables a holistic understanding of the cotton industry's structure, dynamics, and evolving competitive landscape in cotton industry.

RESULTS

The findings reveal that the cotton industry comprises multiple interlinked sectors and value chain tracks, with primary production and ginning forming the foundational

stages. While these upstream segments remain dominant in many producing countries, downstream activities such as spinning, textile manufacturing, and garment production generate significantly higher value. The analysis shows that limited processing capacity in many cotton-producing economies constrains value addition and reinforces dependence on raw fibre exports. At the same time, by-product utilisation— including cottonseed oil, animal feed, and biomass—has emerged as an increasingly important track, enhancing resource efficiency and contributing to circular economy objectives. Table 1 shows the comparative analysis of cotton production in developed and developing countries.

Table 1: Comparative Analysis of Cotton Production on Developed and Developing Countries.

Aspect	Developed Countries	Developing Countries
Production Scale	Large-scale and mechanised farms.	Small holder-dominated and labour-intensive.
Processing Capacity	Advanced ginning, textile, and garment industries.	Limited processing; focus on raw cotton exports.
Technology Adoption	High (precision agriculture, mechanisation).	Low to moderate; traditional methods prevalent.
Market Access	Integrated into global markets; high value-added exports.	Reliant on intermediaries; limited access to high-value markets.
Sustainability Initiatives	Widespread adoption of certification and traceability.	Emerging adoption; uneven implementation.
Economic Impact	Strong contribution to industrialisation and employment.	Key source of rural income, but limited industrial impact.

Source: Compiled by author

The comparative analysis highlights stark contrasts between developed and developing country contexts in cotton production and value chain integration. Developed countries tend to rely on large-scale, mechanised farms with advanced processing capacity and strong access to global markets, allowing greater value addition. In contrast, developing countries are largely dependent on smallholder farmers, with limited ginning and textile infrastructure, restricting the capture of downstream benefits. Sustainability initiatives are more widespread in developed contexts, whereas developing regions show uneven adoption. Understanding these differences is critical for designing targeted interventions that enhance competitiveness,

promote sustainability, and increase value addition in underdeveloped segments of the global cotton industry. Table 2 shows the comparison between cotton production in selected developed and developing countries.

Table 2: Cotton Production in Selected Developed and Developing Countries

Country	Category	Area Harvested (Million ha)	Production (Million bales)	Key Characteristics
USA	Developed	4.1	17.0	Highly mechanised, advanced ginning and textile industry, strong exports.
Australia	Developed	0.3	4.0	Large-scale farms, mechanised and focus on high-quality cotton.
India	Developing	12.0	36.0	Small holder-dominated, labour-intensive and limited processing capacity.
Pakistan	Developing	3.1	14.0	Predominantly small holder farmers and raw cotton exports dominate.
Brazil	Developing	1.6	8.0	Mix of medium and large farms, growing textile processing sector.

Source: (ICAC). *Cotton statistics 2024*

The table 2 illustrates differences between selected developed and developing cotton-producing countries. Developed nations like the USA and Australia operate highly mechanised, large-scale farms with advanced processing and strong integration into global markets. By contrast, developing countries such as India, Pakistan, and Brazil rely predominantly on smallholder farmers and have limited downstream processing capacity, resulting in lower value addition. These disparities highlight the need for targeted policies and investments to strengthen value chain integration and competitiveness in developing regions. Table 3 shows cotton production statistics selected Arab countries.

Table 3: Cotton Production in Selected Arab Countries

Country	Area Harvested (ha)	Production (bales, 480 lbs)	Key Characteristics
Sudan	420,000	400,000	Small- to medium-scale farms, mostly rainfed, ginning limited and raw cotton exports dominate.

Country	Area Harvested (ha)	Production (bales, 480 lbs)	Key Characteristics
Egypt	230,000	2,400,000	High-quality long-staple cotton, mechanised farms, integrated spinning and textile industry.
Syria	140,000	200,000	Small holder farmers, affected by conflict and limited processing.
Morocco	110,000	150,000	Medium-scale farms, moderate processing capacity and mainly lint exports.
Tunisia	50,000	60,000	Small-scale farms, focus on local textile industry and limited exports.

Source: (ICAC). *Cotton statistics 2024*

Cotton production selected Arab countries varies considerably in scale and quality. Sudan produces a moderate volume of cotton with limited processing capacity, making raw lint exports the primary source of value. Egypt stands out as the region's leading producer, with high-quality long-staple cotton and well-integrated textile and spinning industries. Other countries, including Syria, Morocco, and Tunisia, rely largely on small- to medium-scale farms, with limited industrial processing and moderate contributions to exports. These statistics highlight regional disparities in production and value addition, underlining the need for targeted investment and development strategies to enhance competitiveness and local processing in Arab cotton-producing countries.

The research objectives of this study are designed to address the structural complexity and evolving dynamics of the cotton industry within a global value chain context. By focusing on the systematic mapping of the cotton industry's key sectors and value chain tracks, the study seeks to move beyond fragmented analyses that isolate production, processing, or trade. Instead, the objectives emphasise an integrated perspective that recognises the interdependence of cultivation, ginning, textile manufacturing, garment production, and by-product utilisation. This comprehensive scope is essential for understanding how value is created, distributed, and constrained across the cotton economy.

A central analytical objective is to examine how emerging sustainability and innovation tracks are reshaping competitiveness within the cotton industry. By explicitly incorporating dimensions such as organic production, certification systems, circular textile models, and digital supply chain traceability, the research acknowledges that competitiveness is no longer driven solely by cost efficiency or yield performance. Rather, it is increasingly influenced by environmental stewardship,

social accountability, and technological capability. Analysing these dimensions enables the study to assess whether sustainability-oriented practices function as constraints or as strategic opportunities for value upgrading, particularly for cotton-producing countries.

The objectives also reflect a strong developmental and policy-oriented focus. By identifying key bottlenecks—such as water stress, environmental impacts, market volatility, and limited downstream value addition—the research aims to generate insights relevant to industrial policy, investment planning, and international development strategies. In doing so, the study positions cotton not merely as an agricultural commodity, but as a potential platform for green industrialisation, employment creation, and rural economic transformation. The analytical framing of the objectives therefore supports both academic inquiry and practical decision-making, reinforcing the relevance of the research to stakeholders across the cotton value chain.

The results further indicate that sustainability-oriented tracks are reshaping competitiveness within the cotton industry. Organic cotton production, fair-trade and certification schemes, water-efficient farming practices, and circular textile models are gaining prominence in response to environmental pressures and changing consumer preferences. Digitalisation, particularly in the form of supply chain traceability systems and data-driven farm management, is also emerging as a critical enabler of transparency and market access. However, persistent challenges remain, including water scarcity, environmental degradation, price volatility, and unequal value distribution along the chain. These bottlenecks limit the capacity of many developing countries to fully leverage cotton as a driver of sustainable industrialisation and inclusive economic growth.

LIMITATIONS

This study is subject to several limitations that should be acknowledged when interpreting its findings. The analysis relies primarily on secondary data drawn from academic literature, industry reports, and international statistics, which may vary in quality, scope, and timeliness across regions. As a result, some country-specific dynamics and informal value chain activities may not be fully captured. In addition, the qualitative nature of the value chain analysis limits the ability to quantify causal relationships between sustainability initiatives, competitiveness, and economic outcomes. The absence of primary field data and stakeholder interviews further constrains the depth of insight into firm-level decision-making and local institutional contexts, particularly in developing countries.

RECOMMENDATIONS

Future research should seek to complement value chain mapping with primary data collection, including surveys and interviews with farmers, processors, traders, and policymakers, to provide more granular and context-specific insights. Quantitative modelling approaches could be employed to assess the economic and environmental impacts of different value chain upgrading strategies, such as investment in processing capacity or adoption of sustainable farming practices. There is also scope for longitudinal studies to examine how digitalisation, climate adaptation, and changing trade policies influence the evolution of cotton value chains over time. Comparative analyses across regions would further enhance understanding of best practices and transferable policy lessons.

PRACTICAL IMPLICATIONS

The findings of this study have important practical implications for policymakers, industry actors, and development partners. For cotton-producing countries, strategic investment in ginning efficiency, downstream processing, and by-product utilisation can enhance value addition and reduce dependence on raw fibre exports. Promoting sustainable farming practices, certification schemes, and digital traceability systems can improve market access and competitiveness while addressing environmental and social concerns. For the private sector, integrating sustainability and transparency into business models offers opportunities for differentiation and risk mitigation in increasingly demanding global markets. Collectively, these measures can support more resilient, inclusive, and sustainable cotton value chains.

CONCLUSIONS

This study has demonstrated that the cotton industry operates as a highly integrated and multi-layered agro-industrial system, in which value creation extends well beyond primary production to include processing, manufacturing, and by-product utilisation. By mapping the key sectors and value chain tracks, the analysis highlights the structural imbalances that persist within the industry, particularly the limited value addition captured by many cotton-producing countries. The findings underline that while cultivation and ginning remain central, emerging tracks such as advanced textile applications, circular economy practices, and sustainability-driven market segments are increasingly shaping competitiveness in global cotton markets.

In conclusion, the study emphasises that the future viability of the cotton industry depends on its ability to address environmental pressures, market volatility, and

shifting consumer expectations while strengthening linkages across the value chain. Sustainability, digitalisation, and strategic upgrading are not peripheral concerns but central determinants of long-term resilience and growth. With appropriate policy support, investment in processing capacity, and alignment with global sustainability standards, cotton can serve as a catalyst for green industrialisation, employment generation, and rural development. The research therefore reinforces the importance of an integrated value chain approach in guiding both academic inquiry and practical interventions within the global cotton economy.

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BIOGRAPHY

Elsayed Elhassan Abdalla Elsedig is a seasoned expert in food, beverage, and herbal manufacturing technology, with decades of hands-on experience in extraction, evaporation, and drying techniques. His journey in this specialised field began in the 1990s when he had the opportunity to study under Mr Hardjo, a distinguished student of Professor Dr Schmutterer, widely regarded as "The Father of Modern Neem". This mentorship in Indonesia provided a solid foundation for his expertise in both traditional and modern processing methods. Over more than two decades, Mr Elhassan has honed his skills in a variety of extraction and drying technologies, mastering the use of diverse equipment and methodologies. His extensive practical experience is complemented by rigorous scientific research, with a particular focus on key Sudanese agricultural products such as gum Arabic, hibiscus, and baobab. In collaboration with biochemistry researchers, he has contributed significantly to advancing the understanding and processing of these valuable natural resources. Through his dedication to innovation and knowledge-sharing, Mr Elhassan has established himself as a respected figure in the field, seamlessly blending traditional techniques with modern scientific advancements to enhance the manufacture of food, beverage, and herbal products.