Sreeram Kalarical Janardhanan
Luis A. Zugno *Editors*

Emerging Trends in Leather Science and Technology

Springer

Sreeram Kalarical Janardhanan · Luis A. Zugno
Editors

Emerging Trends in Leather Science and Technology

Springer

Editors
Sreeram Kalarical Janardhanan
CSIR-Central Leather Research Institute
(CLRI)
Chennai, Tamil Nadu, India

Luis A. Zugno
International Union of Leather
Technologists and Chemists Societies
(IULTCS)
Basel, Switzerland

ISBN 978-981-99-9753-4 ISBN 978-981-99-9754-1 (eBook)
https://doi.org/10.1007/978-981-99-9754-1

This Springer imprint is published by the registered company Springer Nature Singapore Pte Ltd.
The registered company address is: 152 Beach Road, #21-01/04 Gateway East, Singapore 189721, Singapore

Paper in this product is recyclable.

Foreword by Dr. Michael Redwood

A long time ago we used to learn that the leather industry was somehow "special". It battles with "inelasticity" because its raw material supply cannot grow to meet demand. The raw material is complex, impacted not only by species but by climate, husbandry, age and sex. The processing is difficult with different layers and sections often requiring separate treatment and the science is not always fully understood.

As a natural material surface defects can sometimes be difficult to sell and making every part of every piece perfect for its intended purpose is not easy. There is a great deal of skilled craft associated with making a piece of leather that is both beautiful and high performance.

Yet while leather itself is certainly special the factories that make and use it are buffeted by the winds of geopolitics and changing trends as much or more than any other material. Perhaps what has been really special has been leather's ability to endlessly adapt to serve a changing world over many millennia.

In the beginning, hides and skins were all that was available for covering and containing the multitude of items needed for the daily life of early humans. They were excellent in the raw but with a little treatment, they could be protected from the most aggressive bacteria and made more suited for various purposes. This is tanning. And the thrill for the tanner is the magic and mystery of managing the chemistry and the physical structure, along with mixing art and science.

The arrival of textiles, pottery, glass, paper and metals took end uses away from leather but increasing populations and the growth of society put new, more sophisticated demands on leather. Improved husbandry also means that supply will never catch up with demand.

The discovery and exploitation of plastics changed this balance and now no end uses exist where leather cannot be replaced, but usually elegance and functionality are sacrificed. Now we are learning the environmental damage caused by plastics and we better understand the role leather can play to fight climate change and biodiversity loss. Leather needs the world, and the world needs leather.

Hides and skins are present in nearly every part of the globe and have been traded internationally since the earliest days. As we face the challenges of climate change,

poverty and diminishing natural resources using hides and skins well becomes essential. We must add value, make good use of the many jobs leather creates and teach the world the value of producing things that last when looked after and repaired.

I have had a long and happy career working with leather and am very honoured to have worked with many and met most of those involved in the production of this Monograph. It is both timely and prescient.

October 2023

Dr. Michael Redwood
Spokesman for Leather Naturally
ILM Opinion Writer
Leather Conservation Trustee
London, UK

Preface

Leather is a unique commodity that links the product of rural farmers to the fashion world. Leather and its products are among the most widely traded products worldwide, as they are produced from a renewable and readily available resource, a byproduct from the meat industry. A key factor for the development of the leather sector is undoubtedly the strong raw material base. But when talking about sustainability in the leather industry, it does not only mean the sustainable manufacture of leather goods alone. An ideal leather industry network comprises of the following: Livestock (cattle, buffalo, sheep, pig and goat), slaughterhouses, raw hides and skin collection, tanning industry, leather goods manufacturing industries, export market and other allied industries. The other small industries that can co-exist within this network would include glue and manure manufacturing industries, processing of meat into various by-products, etc.

Production and supply have gradually moved from industrialized to developing countries and emerging economies, which are fast becoming the most important suppliers of value-added leather products. It is fascinating to note that more than half of the world's supply of leather raw materials comes from developing countries. As such, leather processing is an important economic activity in several developing countries, and it coincides with the fact that the availability of this raw material is high in developing countries. It is estimated that the international trade of this important material exceeds US$ 80 billion annually and is expected to continue growing alongside the increase in population and urbanization of developing countries. From the above, it is evident that the leather sector occupies a very important place in the economic development of a country on account of its substantial export earnings, the potential for the creation of employment opportunities and favourable conditions for its sustained growth.

However, one of the major challenges of leather processing operations is the potential environmental impact that could have devastating socio-economic consequences. Pollution from the tanneries has a negative long term impact on the growth potential of a country, irrespective of immediate economic benefits. Polluted water, air and soil affect peoples' health and damage the ecological processes that sustain the production of food.

Demand for leather goods is growing, but so is the criticism of its severe environmental impacts, which is driving a keen interest in sustainable alternatives. On this account, the three important aspects of the leather producing industry are environmental sustainability, ethical and social sustainability and economic sustainability. Because of the heterogeneity of this sector and also as sustainability has become unavoidable for any industry nowadays, it becomes essential to analyze several issues and factors that can facilitate the attainment of sustainability in the leather industry.

In addition, the leather goods industry has a history with very distinct shifts in end uses and materials from the use of leather products for specific functional purposes to the current market of luxury goods. Raw materials used in the leather goods industry are as diverse as the products. Leather remains important, but the use of materials such as nylon, polyester, polyurethane fabric and even polypropylene is growing. The leather clothing market is highly volatile because the demand for such products depends largely on consumers' disposable income and, on fashion trends. Historically, leather garments have been less of a luxury and more of a necessity, as other materials were not available for protection against cold. In many regions of the world, leather garments became the primary cold-weather outerwear. However, rising wealth and the emergence of excellent synthetic fabrics for waterproof and insulating garments at affordable cost have steadily weakened the position of leather in the traditional outerwear market in most countries.

Significant changes have also occurred in the industries that supply machinery, components, software and chemicals to the footwear and other leather product industries. The demand for leather footwear has increased over the years. The growing demand for leather footwear, as well as the fact that this demand competes for raw materials with other products, appears to be a significant business opportunity for developing countries including the African continent. The footwear industry is a valuable source of employment for developing countries. It is estimated that 10 million people are employed worldwide in the direct production of footwear and there are significant additional numbers employed in the support industries. Despite the value of the industry in improving the living standards of people in the developing world, there is little coordinated information on the industry as a whole available, particularly in developing countries.

The range of synthetic materials used in the leather goods industry is very wide. Increasingly, materials are being used in combination with leather to achieve a certain look or price range. Synthetic materials can be found in all types of leather goods, in luxury items as well as in economical casual articles. As a rule, the quality of non-leather materials follows the trends of the respective market segments. Today, significant progress has been made to make it possible to manufacture accessories at more competitive prices. In addition, one of the more challenging issues in the leather

sector is the design of leather products and accessories. Today digital techniques and artificial intelligence are playing a major role in designing of a wide array of leather products. To sum it up, *"Emerging Trends in Leather Science and Technology"* is a very challenging subject and a comprehensive publication addressing all such major issues is not available in the market for reference by the scientists, technologists, policymakers and other stakeholders from both Global South as well as Global North.

This book has been developed in the above backdrop; thus, its major goal is to channel the concurrent knowledge from the leading scientists and technologists working in the field to the scientific public in developing countries. The contents of the book will also be a very valuable source of information for academics, researchers, industrialists and business communities in developed countries. The monograph will also be a very useful handbook for early career researchers and engineers involved with leather related research and consultancy, irrespective of their location.

The concept of developing such a book emerged during the discussion between Dr. Amitava Bandopadhyay, Director General, NAM S&T Centre, New Delhi and Dr. S. K. Janardhanan, Director, CSIR-Central Leather Research Institute (CLRI), Chennai in early 2021. Since 2018, the NAM S&T Centre has been collaborating with CSIR-CLRI and has so far organized two International Workshops on "Sustainability of Leather Sector" and "Trends in Materials, Design, Innovation and Intelligent Manufacturing of Footwear and Leather Products" for the benefits of scientists, technologists and policymakers from the developing countries.

This book contains 17 chapters that cover various challenges and opportunities of leather manufacturing, product making, environmental management, country status and policies, which the developing world needs to understand, manage and improve in regard to their processing, manufacturing infrastructure and export requirements to achieve sustainability. The chapters in the Monograph have been contributed by scientists and experts from 12 countries, namely Australia, Croatia, Ethiopia, France, Germany, India, Kenya, Switzerland, Türkiye, UK, United States and Vietnam to share their knowledge and expertise in various facets of leather and leather product making and related subjects.

We would like to express our heartfelt gratitude to all the authors who have kindly accepted our invitation to write the chapters, revise the contents based on reviewer's comments and submit the final version well in time in spite of their busy schedule.

We would also like to thank Dr. P. Thanikaivelan, Chief Scientist, CSIR-CLRI for his significant contributions in taking this publication project forward. We are also thankful to Dr. T. Ramasami, Former Director, CSIR-CLRI and former Secretary, Department of Science and Technology, Government of India for his guidance and support during this publication project. Thanks are also due to Dr. Amitava Bandopadhyay and his team at the NAM S&T Centre for all the support rendered towards publication of this Monograph.

We are grateful to Dr. Michael Redwood, Spokesman for Leather Naturally, ILM Opinion Writer and Leather Conservation Trustee for writing the "Foreword" of this book in spite of his extremely busy schedule. We also express our gratitude to Dr. Loyola D'Silva, Executive Editor, Springer Nature, Singapore and his team for making this endeavour a success.

Chennai, India — Sreeram Kalarical Janardhanan
Basel, Switzerland — Luis A. Zugno

Introduction

Leather and its products are one of the most traded goods globally due to their greater durability, good hydrothermal stability, good mechanical properties and resistance to chemical, biological and environmental degradation. The leather industry is a multi-billion dollar global business which has emerged as an important economic activity in several developing countries. The global leather goods market is projected to grow from USD 468.5 billion in 2023 to USD 738.6 billion by 2030, exhibiting a Compound Annual Growth Rate (CAGR) of 6.7% during the forecast period. The process of leather manufacturing involves several stages, including the procurement of raw hides and skins, tanning and processing of the hides and production of finished leather products.

The leather manufacturing industry has faced criticism in the recent years due to concerns over animal welfare, severe environmental impacts and poor working conditions in some countries. Efforts are being made to resolve these issues through improved sustainability. The closedown of manufacturing units, supply chain disruption and economic slowdown during COVID-19 pandemic in 2020, had also severely impacted the global economy of leather industry. However, as the infection rate and spread was reduced, gradually everything returned to track and improved the sustainable consumer spending.

In spite of the implementation of several advanced processing techniques and treatment systems, leather industry is still facing serious challenges from the public and the government authorities. Hence, there is an urgent need to revamp the existing leather processing methods for the sustainability of the leather industry in the future.

Some of the environmental concerns associated with leather production are sourcing of raw materials, use of hazardous chemicals, improper waste management and high water usage as well as air and water pollution. It is crucial for the industry to prioritize these environmental concerns and take necessary actions to address them in order to ensure a more viable future for leather production. Addressing these challenges requires collaboration between industry stakeholders, including manufacturers, suppliers, consumers, R&D institutions and regulatory authorities, to implement measures that promote sustainability, ethical practices and responsible operations throughout the leather supply chain.

In order to address the above mentioned issues, the *Centre for Science and Technology of the Non-aligned and Other Developing Countries (NAM S&T Centre), New Delhi* has brought out this Monograph for dissemination of relevant knowledge and information to the scientists, researchers and managers from the leather sector and other stakeholders interested in the leather industry. The book through its seventeen chapters underscores the various challenges and opportunities of leather manufacturing, product making, environmental management and policies regarding leather processing, which the developing world needs to understand, manage and improve in regard to its processing, manufacturing infrastructure and export requirements to achieve sustainability. The book intends to provide information on smart as well as sustainable leather manufacturing practices to the professionals from the developing countries.

The book brings together scientific communities from Australia, Croatia, Ethiopia, France, Germany, India, Kenya, Switzerland, Türkiye, UK, United States and Vietnam to share their knowledge and expertise to provide a detailed insight into the leather manufacturing and processing, current trends in leather science and technology and policies related to the improvement of leather trade.

I am immensely grateful to Dr. Michael Redwood, Spokesman for Leather Naturally, ILM Opinion Writer and Leather Conservation Trustee, UK for kindly agreeing to write the *Foreword* of this book in spite of his very busy schedule.

I am thankful to Dr. Loyola D'Silva, Executive Editor, Springer Nature, Singapore for his kind support and guidance towards bringing out this Monograph and Ms. Niraja Deshmukh, Production Editor, Springer Nature, India for managing all the technical and administrative tasks for the publication process.

I would like to express my sincere gratitude to the Editors of this book, Dr. S. K. Janardhanan, Director, CSIR-Central Leather Research Institute (CLRI), Chennai, India and Dr. Luis A. Zugno, Secretary and Former President, International Union of Leather Technologists and Chemists Societies (IULTCS), Switzerland, for their initiatives and efforts and sharing their valuable time in reviewing the papers for this book and taking charge of the project. I am especially thankful to Dr. P. Thanikaivelan, Chief Scientist, CSIR-Central Leather Research Institute, Chennai, India for coordinating the entire publication project. The publication of this book would not have been possible without his support throughout the process.

I also acknowledge the valuable support of the entire team at the NAM S&T Centre and am especially thankful to Mr. Madhusudan Bandyopadhyay, Senior Adviser for his support and guidance; and Mr. Pankaj Buttan, Data Processing Manager; Ms. Nidhi Utreja, Former Programme Officer and Ms. Abhirami Ramdas, Research Associate for their contributions in taking this publication project forward and bringing it to a successful conclusion.

I also record my appreciation for the assistance and support rendered by my colleague Mr. Rahul Kumra, Assistant Administrative Officer towards bringing out this Monograph.

I believe that this Monograph would serve as a valuable resource material for scientists and researchers from R&D institutions, professionals from the leather

sector, owners of leather industries, technical institutions, government officials, policymakers and students who are actively engaged in the area of leather science and technology.

Amitava Bandopadhyay, Ph.D.
Director General
NAM S&T Centre
New Delhi, India

Contents