Biodegradable products - alternatives to plastics

Dr Pratima JEETAH
Senior Lecturer
Department of Chemical and Environmental Engineering
University of Mauritius

OUTLINE

01 **Problem Statement**

Plastic issue in Mauritius and around the world

02 **Status of Plastic in Mauritius**

Statistics on plastic consumption worldwide, plastic packaging and plastic ending into our oceans

03 **Technical challenges, enforcement & best practices**

04 **Vision and alternative to plastics**

05 **Conclusion and recommendations**

01 Problem Statement

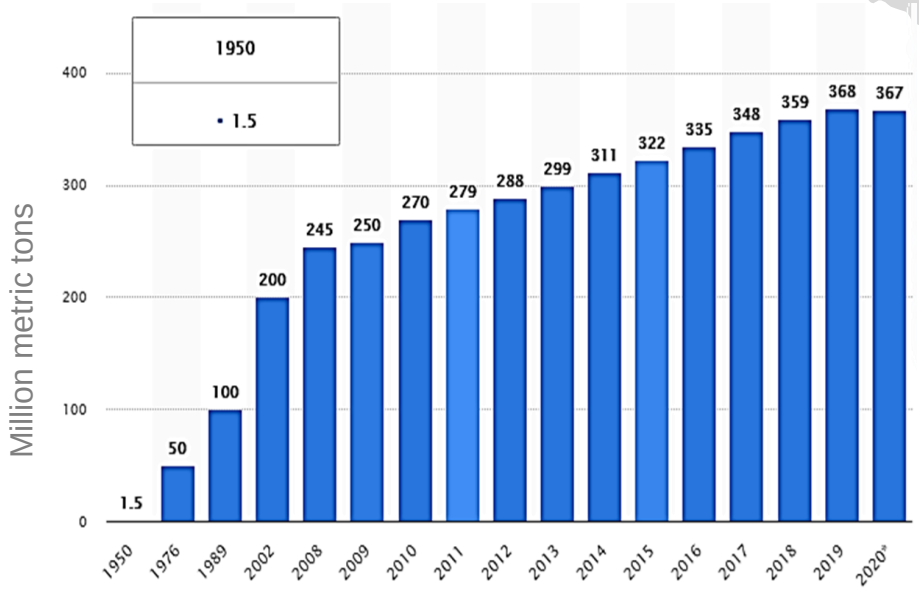
Annual consumption of plastics

The total worldwide production of virgin plastics so far has exceeded 8300 million metric tons and if the present tendency persists, approximately 12,000 Mt of plastic waste will be generated by 2050.

White pollution problem
- × Add up to the landfill stress
- × Formation of microplastics
  - × Induces the death of millions of living organisms

Worldwide

367 million metric tons in 2020



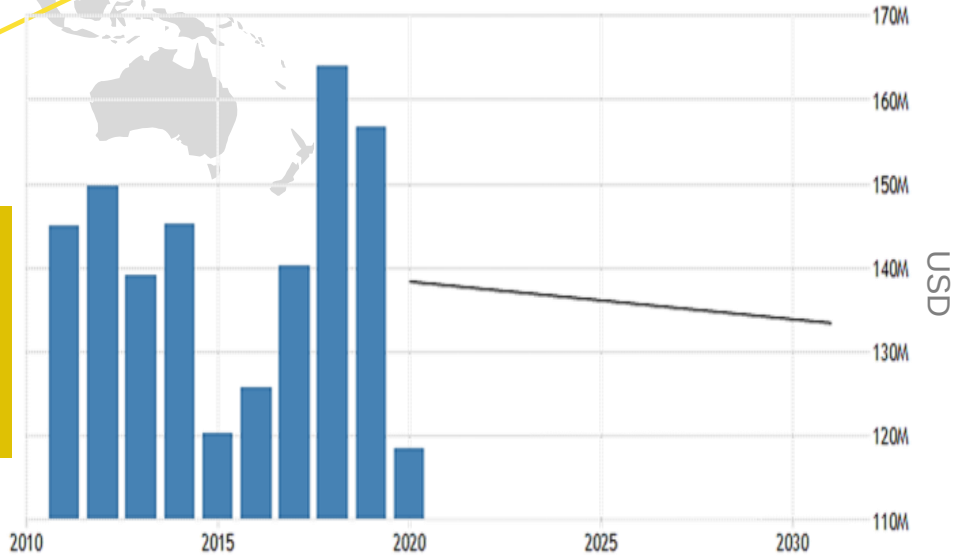
Source: https://www.statista.com/

Major drawback of plastics: Its persistence in the environment & immunity to biodegradation

Mauritius

USD 118.45 M in 2020

USD 133M –Projected value in 2030



Source: https://tradingeconomics.com/mauritius/imports/plastics

Plastic Impacts

- Plastic pollution is harming land life, and corporations whose products or packaging contribute to this harm incur major reputational costs.
- Plastic pollution has a negative visual impact on industries like tourism that rely on clean landscapes.

- Also, not all plastic debris is visible. Microplastics, typically less than 5mm in diameter, can infiltrate the food chain as animals mistake them for food. Cosmetics and personal care goods that end up in water systems can also include microplastics.

- If plastic continues to accumulate in the oceans, the fish sector and stores selling seafood will face reputational and possibly operational damage.

- Chemicals used in plastics to make them durable are also causing concern. When plastics are dumped or left in the environment, chemicals may seep into soil and water supplies. The long-term implications on human and animal health remain unknown.

- Plastic production, use, and disposal emit greenhouse gases that impact natural adaptation and resilience mechanisms. Plastic waste, for example, has been linked to diseases on coral reefs, which not only support marine life but also protect coastal communities and industries from hurricanes. Destruction of resilience mechanisms threatens local fishing and tourism economies.

02 Status of Plastics

Status of Plastics

Plastic statistics

50% of this 367 million metric tons of plastics produced worldwide is single-use plastic & only 9% has ever been recycled.

367 Million metric tons of plastics produced in 2020 which is set to double by 2034

Plastics in our oceans

5.25 trillion macro and micro pieces of plastic in our ocean & 46,000 pieces in every square mile of ocean, weighing up to 269,000 tonnes

Plastic packaging

Plastic packaging is the biggest culprit, resulting in 80 million tonnes of waste annually from the US alone

Plastic bags

The world uses over 500 billion plastic bags a year which is 150 for each person on Earth.

03 Technical challenges, enforcement & best practices

Technical Challenges

Since the 1960s, plastic production and consumption have increased by a factor of twenty. Today, 40% of global plastics production is used for packaging and 95% for single-use.

While plastic demand is expected to increase, the global waste management system is inefficient, with less than a fifth of plastic waste recycled. Because plastic does not decompose, it pollutes natural systems such as rivers and oceans.

The production, use, and disposal of plastics all contribute significantly to greenhouse gas emissions. According to the Center for International Environmental Law, plastic emissions could account for 10% to 13% of the remaining carbon budget by 2050. (in the context of the 1.5 degree goal of the United Nations Framework Convention on Climate Change Paris Agreement).

Regulations and consumer habits are changing as the environmental impacts of plastic become more apparent. Plastic pollution's detrimental effect on the marine environment has been highlighted, putting businesses and investors at risk.

Solutions

As governments adopt circular economy policies, future investments can solve plastic pollution and other associated issues.

Design, reuse, repair, and recycling are all possible answers in the circular economy.

However, solutions must be evaluated in the context of the entire plastics value chain. Effective solutions demand cross-chain collaboration.

When investing in solutions, investors should analyse the entire value chain.

Solutions

DESIGN

Products can be developed to minimise plastic use to a minimum or eliminate the need for it completely.
Substitutes to fossil fuel feedstock for primary plastic manufacture can be examined, including:

- Bio (plant)-based plastic Bio-based biodegradable plastic (oil-based biodegradable)
- Edible packaging as an alternative to single-use plastic packaging (uses bio-based plastic)
- Use of plastic waste and ocean plastics for products

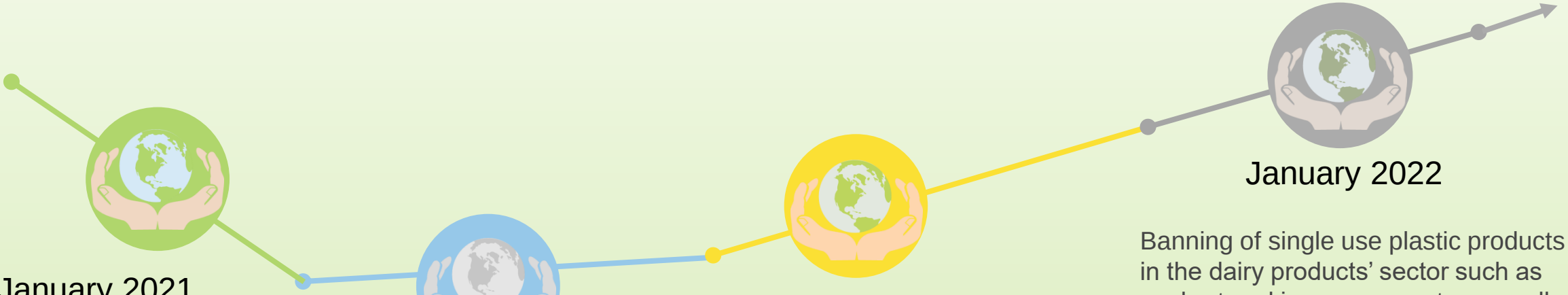
The circular economy. Source: Adapted from Anthesis

ASSESSING ALTERNATIVE MATERIALS

Life Cycle Assessment (LCA) to compare the environmental impacts of plastics with other materials across the value chain

Government Policy of Zero Plastic by 2030

Under the Environment Protection (Control of Single use Plastic Products) Regulations 2020



15 January 2021

Banning of single-use plastic products such as plates, bowls, straws, beverage stirrers, lids, trays/barquettes, cups, forks, spoons, receptacles to hold food for instant consumption amongst others had been banned

Ban since March 2021

Roll-on bags, pocket type bags to contain snacks and candied fruits

Ban since April 2021

Autonomous non-biodegradable straws and attached plastic straws to juice bricks

January 2022

Banning of single use plastic products in the dairy products' sector such as yoghurt and ice cream sector as well as plastic trays used to package fresh, pre-cooked and cooked meat products, cheese and seafood are being restricted as well

These bans are part of the Government's 2020-2024 effort to shape Mauritius as a plastic-free island

04 Potential natural fibres to be used as alternative to plastic products

Potential novel natural fibres

AVOCADO SEED

Bioplastic

Biopolymer produced from avocado seed as alternative to conventional packaging

ALGAE

Bioplastic

Biodegradable plastic materials from algal cellulose such as *Sargassum obovatum* and *Padina gymnospora*

BAGASSE

Paper and biopolymer

Paper and plastic composites produced from bagasse fibres

BANANA PEELS AND STEM

Paper and biopolymer

Packaging materials, paper composites produced from banana peels and stem

Paper cups

From non-wood lignocellulosic fibres

Recyclable paper cup made from Mauritian hemp and waste pineapple peels and coated with beeswax. Resulting thickness: 0.7 mm and capable of holding water.

Pulp & paper as an alternative to plastic cups

PI: Dr P. Jeetah; Paper published: Feasibility of producing biodegradable disposable paper cup from pineapple peels, orange peels and Mauritian hemp leaves with beeswax coating.

Paper enveloppes and bags

From non-wood lignocellulosic fibres

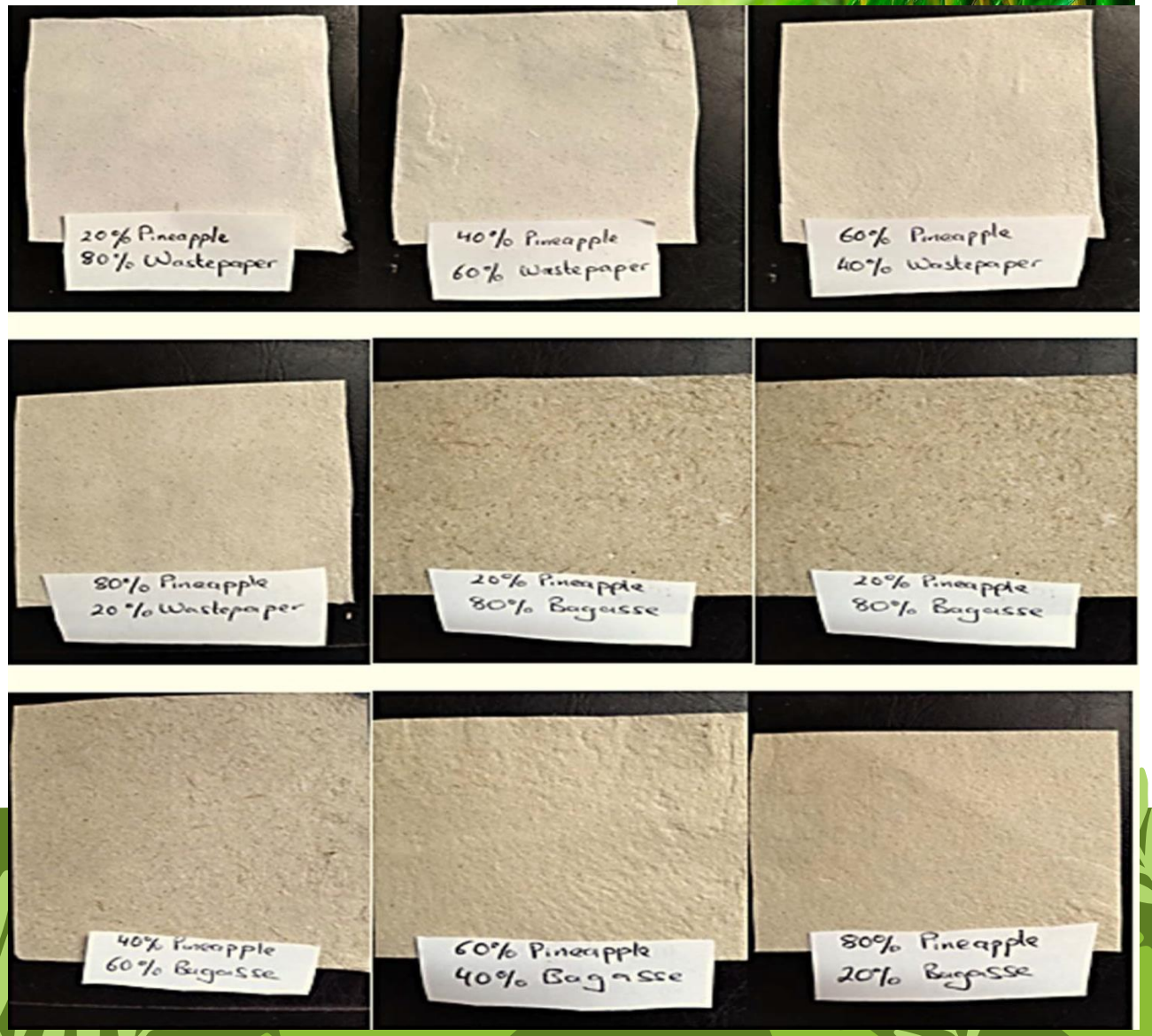
100% and mixed with wastepaper in different ratios with handle of paper bags made from banana fibres

PI: Dr P. Jeetah; Paper publishe.

Wrapping paper for packaging

From non-wood lignocellulosic fibres

Wrapping paper which can absorb the grease were made from pineapple leaves and paper /bagasse composites



Paper sheets

From non-wood lignocellulosic fibres

Paper produced from Arundo Donax, Mauritius hemp, elephant grass, PALF, coconut husk & Vacoas

Acknowledgment : I would like to thank the University of Mauritius for having funded this project.

PI: Dr Pratima Jeetah; Project code: QB003; RFS-B

Paper published: Jeetah P, Jaffur N (2021) Coconut Husk, a Lignocellulosic Biomass, as a Promising Engineering Material for Non-wood Paper Production. J Nat Fibers.

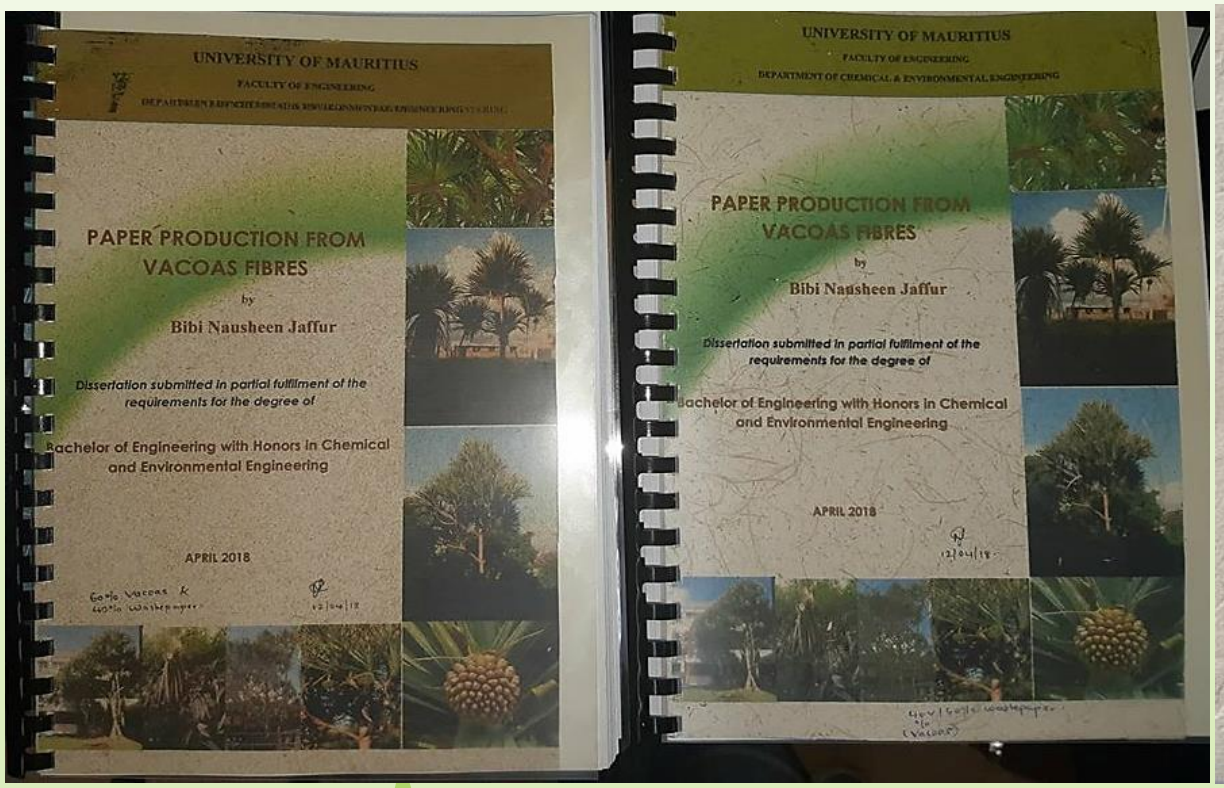
Jaffur N, Jeetah P (2019) Production of low cost paper from Pandanus utilis fibres as a substitution to wood. Sustain Environ Res.

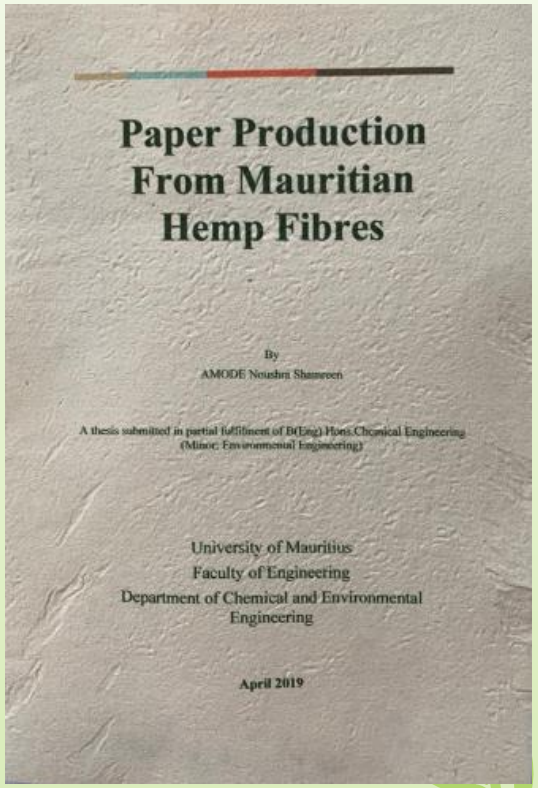
Printable & writable paper

From non-wood lignocellulosic fibres

Paper produced from *Pandanus Utilis* and *Arundo donax*

Paper produced from *Furcraea Foetida*





CONCLUSION

Biobased plastics/paper must have a smaller negative impact on the environment than the oil-based feedstock they are replacing.

In principle, biodegradable plastic/paper minimise garbage production.

The magnitude of plastic pollution could be reduced if the ways in which it is produced, used and disposed of more closely align with the concept of a circular economy.

Additionally, the design must address the complete life cycle of a product – not just the feedstock – including how it is disposed of (collected, sorted, and handled) at the end of its useful life.

RECOMMENDATIONS

- Biodegradable Plastics such as Polyhydroxyalkanoates (PHAs)
- Incorporating additives such as Prodegradant concentrates in conventional plastics to boost degeradability
- Promising new biopolymer, called liquid wood; pulp based lignin which is biodegradable
- Conversion of casein, the principal protein found in milk, into a biodegradable material that matches the stiffness and compressibility of polystyrene

THANK YOU FOR YOUR ATTENTION