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CONFERENCE

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PORT ELIZABETH, SOUTH AFRICA

Environmental Biodegradation of Bio-based Materials in Biotic conditions

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CONTENTS

INTRODUCTION : *World Plastics Production, Consumption and its Post-consumer Plastic waste issues.*

SUSTAINABLE BIO-BASED MATERIALS FROM RENEWABLE RESOURCES:
Opportunities and Challenges in the Next Generation of Materials, Processes and Products

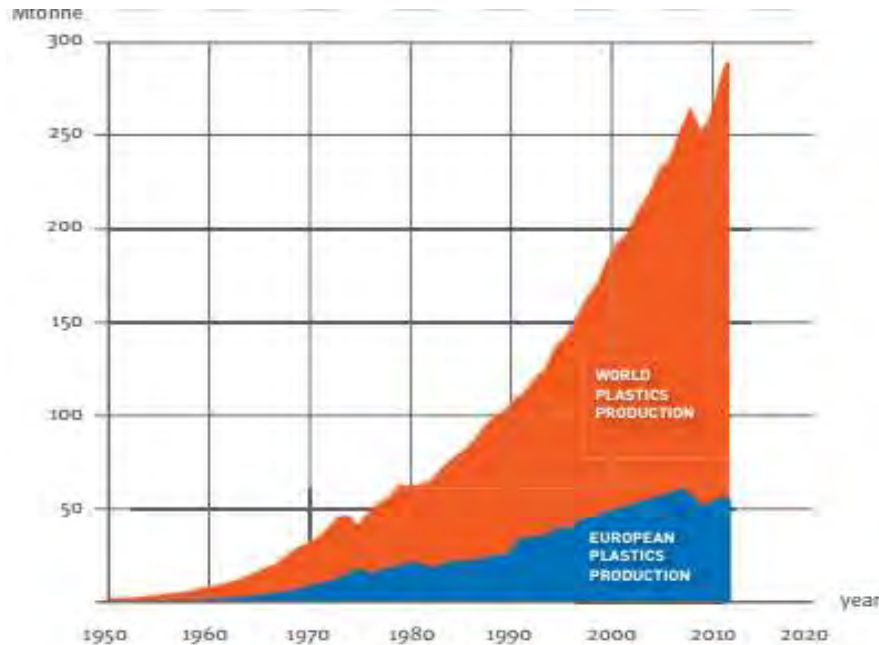
OBJECTIVES : *Value Added Biomaterials from Agricultural Biomass/crop residues*

R&D: *(i) Extraction of Biopolymers from Biomass (sugarcane bagasse and maize stalk);*
(ii) Development of Biodegradable Polymeric Materials for Packaging Applications
(iii) Biodegradability Testing of Polymeric Materials and its Products in Natural Environments

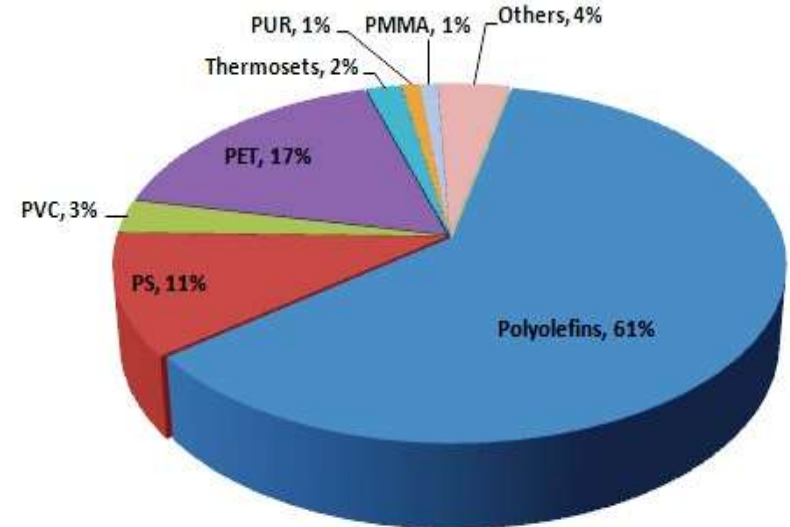
CONCLUSIONS & RECOMMENDATIONS

Annual Production & Consumption of Polymeric Materials & Plastics

World Plastics Production



Plastic shares in Packaging Market



- Worldwide demand of plastics of about 200 million tons in 2002, 275 Mtons in 2010 and 300 mtons in 2015.
- Plastic items are used in a large variety of mercantile segments, the major share (50-55%) of the overall production being held by **packaging & disposables**.

Note: Based on preliminary estimates by European Market Research & Statistics Working group. Includes thermoplastics, thermosets, adhesives, coatings and dispersions. Fibers are not included

Source: Plastics Europe 2015, WG Market Research & Statistics

The “White Pollution”



Environmental Impact of Plastics

- Most of the petroleum based plastics are not biodegradable and persists in landfill for many decades.
- Plastics are not only to polluting the environment but actually harm many living organisms.
- Plastics are cheap to produce but very expensive to clean the environment.
- In South Africa, 90% of the waste generated is still disposed of to landfill (dumpsites) including plastics.



www.epa.com 2013

DST 2014. SA RDI waste road map
<http://www.wasteroadmap.co.za/>

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CURRENT SITUATION IN SOUTH AFRICA

Plastics | SA

Tonnages recycled and diverted from landfill in SA - all plastics (2011 - 2015)



- SA is leading countries in the world with mechanical recycling.
- SA currently only uses mechanical recycling and no other energy from waste plant yet operational.
- Approximately 55% of all polymer goes into packaging.
- 20% all plastics manufactured were recycled in 2015
- SA Plastics Industry announced **Zero Plastics to Landfill by 2030**.

**Mechanical recycling refers to recover plastics waste via mechanical processes (grinding, washing, separating, drying, re-granulating and compounding), and converted into new plastics products, often substituting virgin plastics*

Plastic Bag Recycling Contamination



Glance of the article:

The carrier bags from the municipal plastic waste stream and the contamination levels normally exceed the weight of the plastic bag because of the level of filler (CaCO_3) added to the bags (25-30%) to reduce the manufacturing cost.

Sunday Times, April 9, 2017

Giant Pollution Mass at Sea

When an oceanic garbage patch the size of Texas dumps some of its treasures along the West Coast this summer, By Marsha Walton -- CNN



YOU

Environment

'World Environment Week' began on a positive note

- ▲ To overcome the problems due to plastic wastes.
- ▲ To substitute non-degradable petroleum based polymers with biodegradable plastics.
- ▲ To introduce bioplastics from renewable resources into market.

Plastic Cleanup Costs APPROXIMATELY \$1 Billion Dollars ...

Nov. 2003



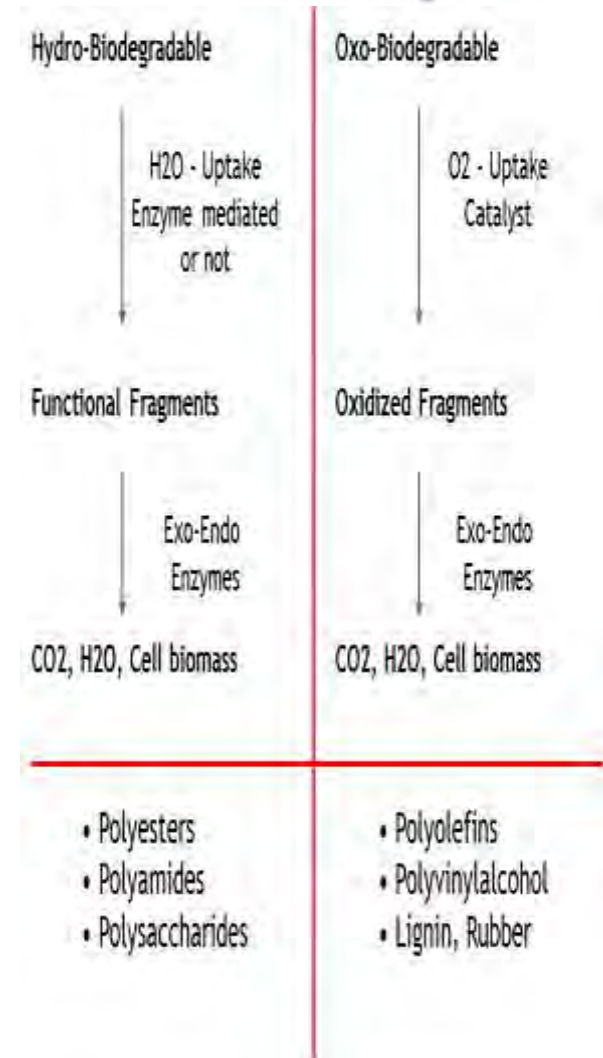
Environment Day, one hopes to cultivate more people and contribute to the growing consciousness about how a burgeoning population and modern civilization is damaging even the toughest eco-systems of a fragile earth.

Environmental Biodegradable Polymeric Materials and Plastics

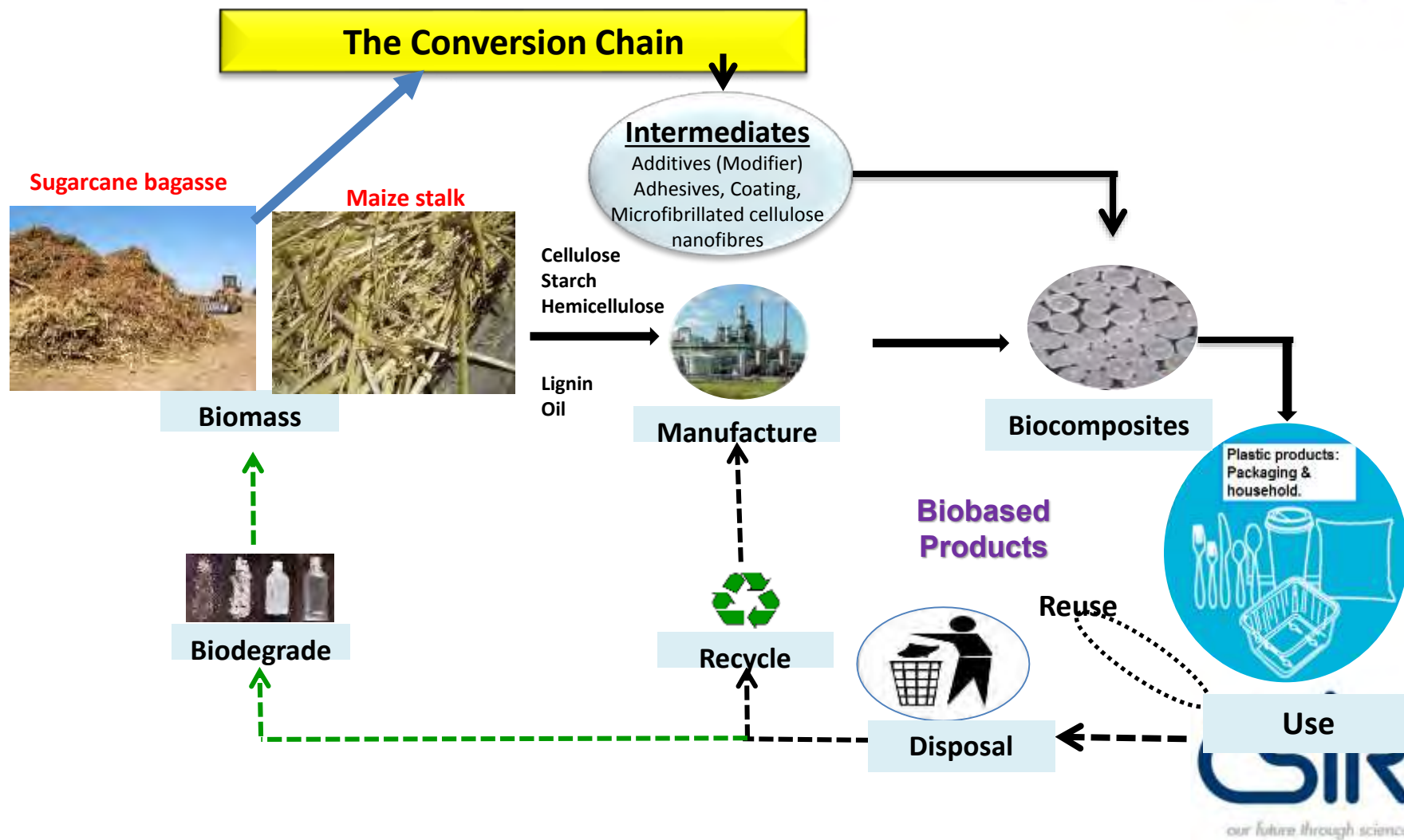
Materials and Items should maintain the **necessary functional properties during its lifespan** and at the same time **after service life when materials are discarded should undergo accelerated biodegradation in a defined time frame without releasing toxic substances to environment.**

According to ASTM, European & ISO standards, Environmental Biodegradable Plastics are defined as follows:

- ❖ **BIODEGRADABLE PLASTICS** : a plastic in which the degradation results from the action of naturally occurring micro-organisms such as bacteria, fungi and algae.
- ❖ **COMPOSTABLE PLASTICS**: a plastic that undergoes biological degradation during composting to yield carbon dioxide, water, inorganic compounds and biomass at a rate consistent with other known compostable materials and leaves no visually distinguishable or toxic residues



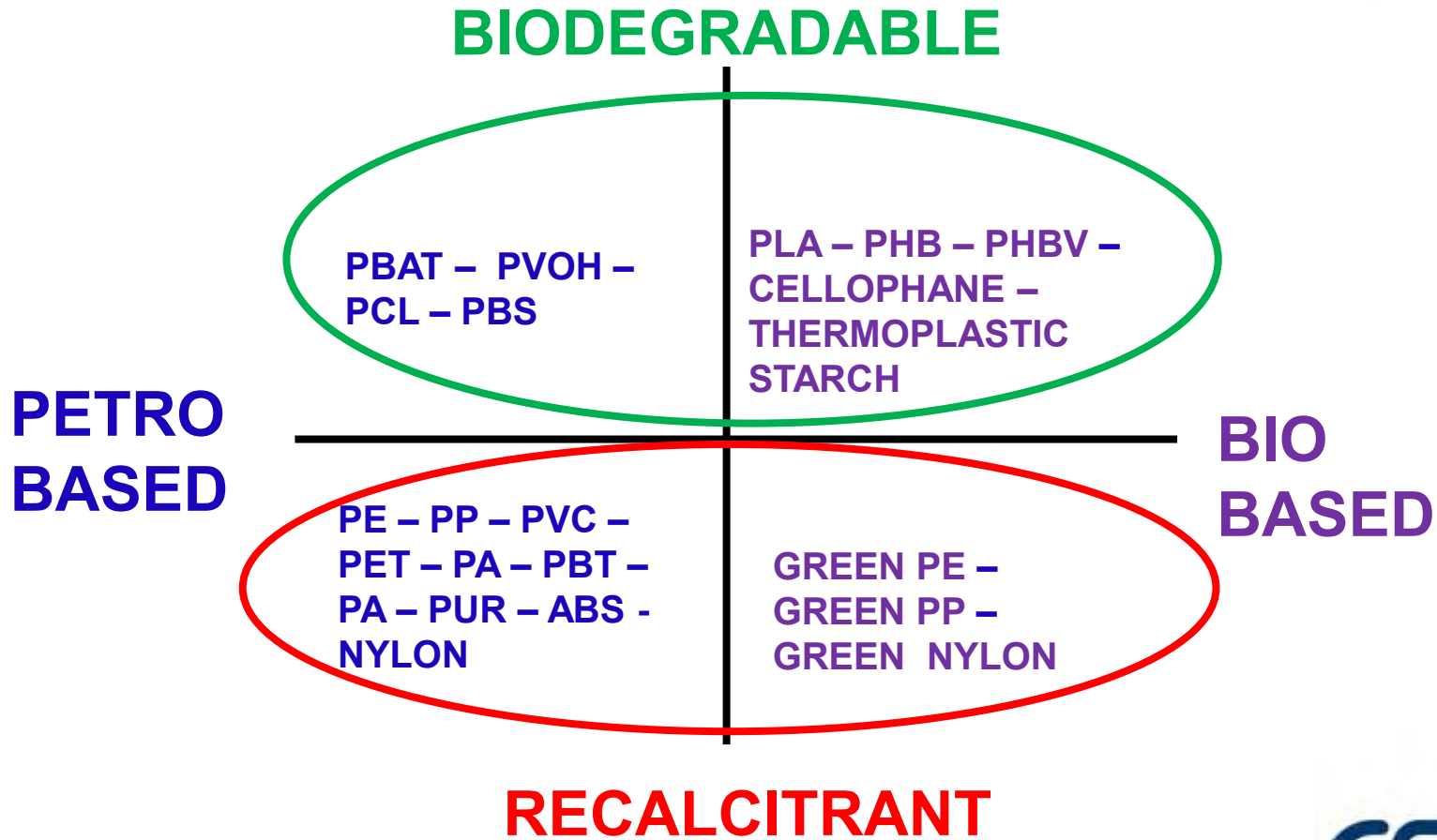
R&D Overview: Utilization of Non-Food Agricultural Biomass for Bioplastics and Its Biobased Composite Products



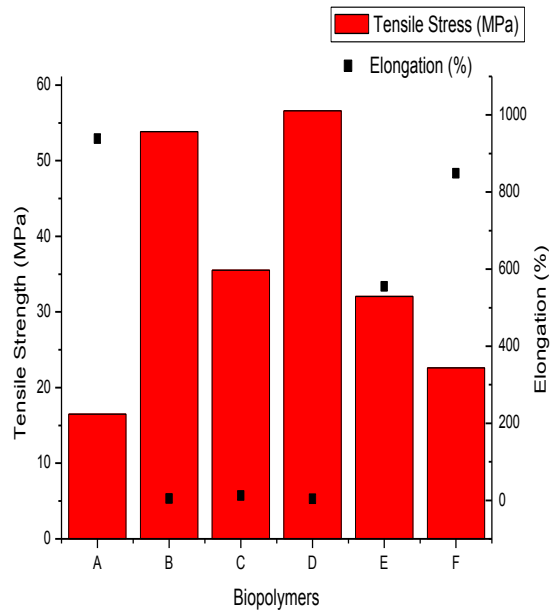
Challenges in the Biobased/Biodegradable Polymers

- Low mechanical and thermal properties
- Not suitable for conventional processing
- Low scale up production
- 3 to 5 times expensive than conventional plastics
- Contamination in plastics recycling when biopolymer mixed with non-biodegradable plastics

BIODEGRADABLE VS BIO BASED PLASTICS

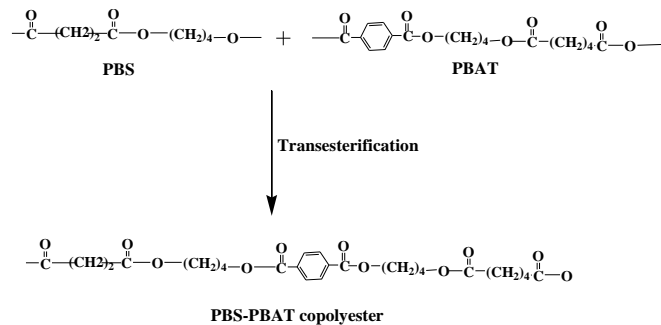
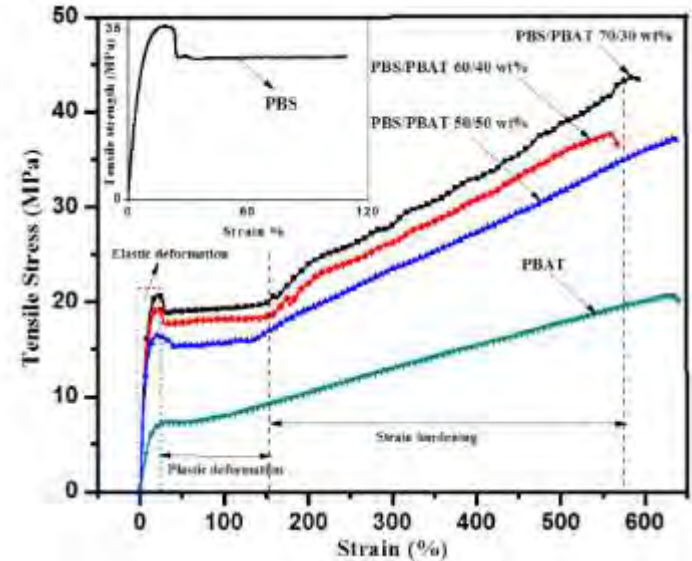


R&D : Performance of Biobased/Biodegradable Polymers

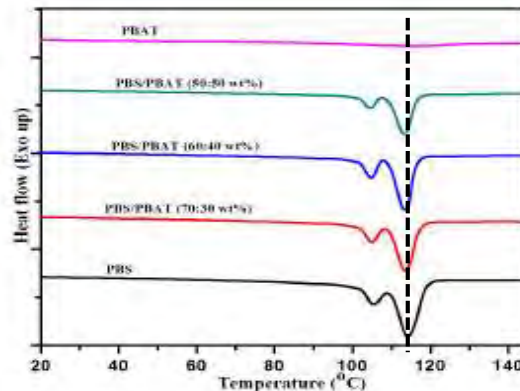


BIOPOLYMERS

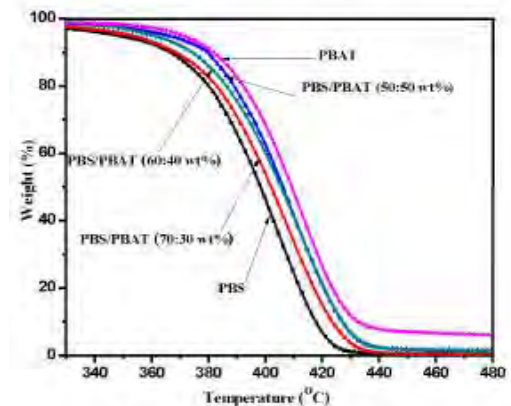
- A- PBAT (BASF)
- B- PLA 3052 (Nature works)
- C- PLA 1001 (Cereplast)
- D -PLA 3001 (Nature works)
- E- PBS 1020 (Showa polymers)
- F- PBS 3020 (Showa polymers)



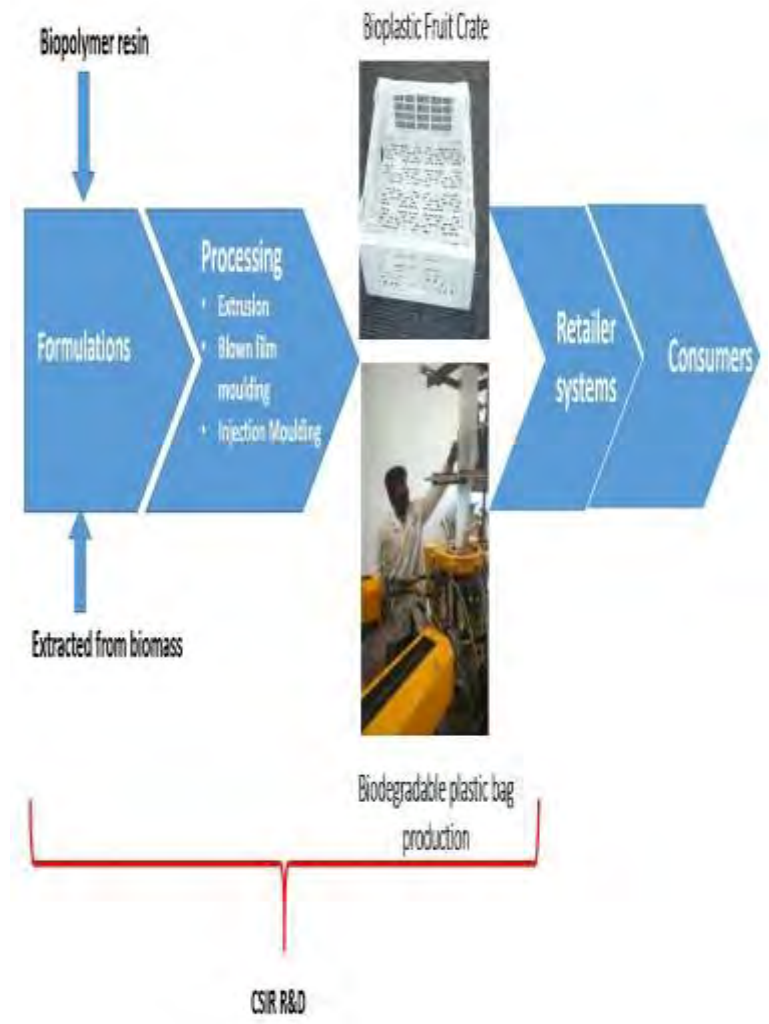
DSC



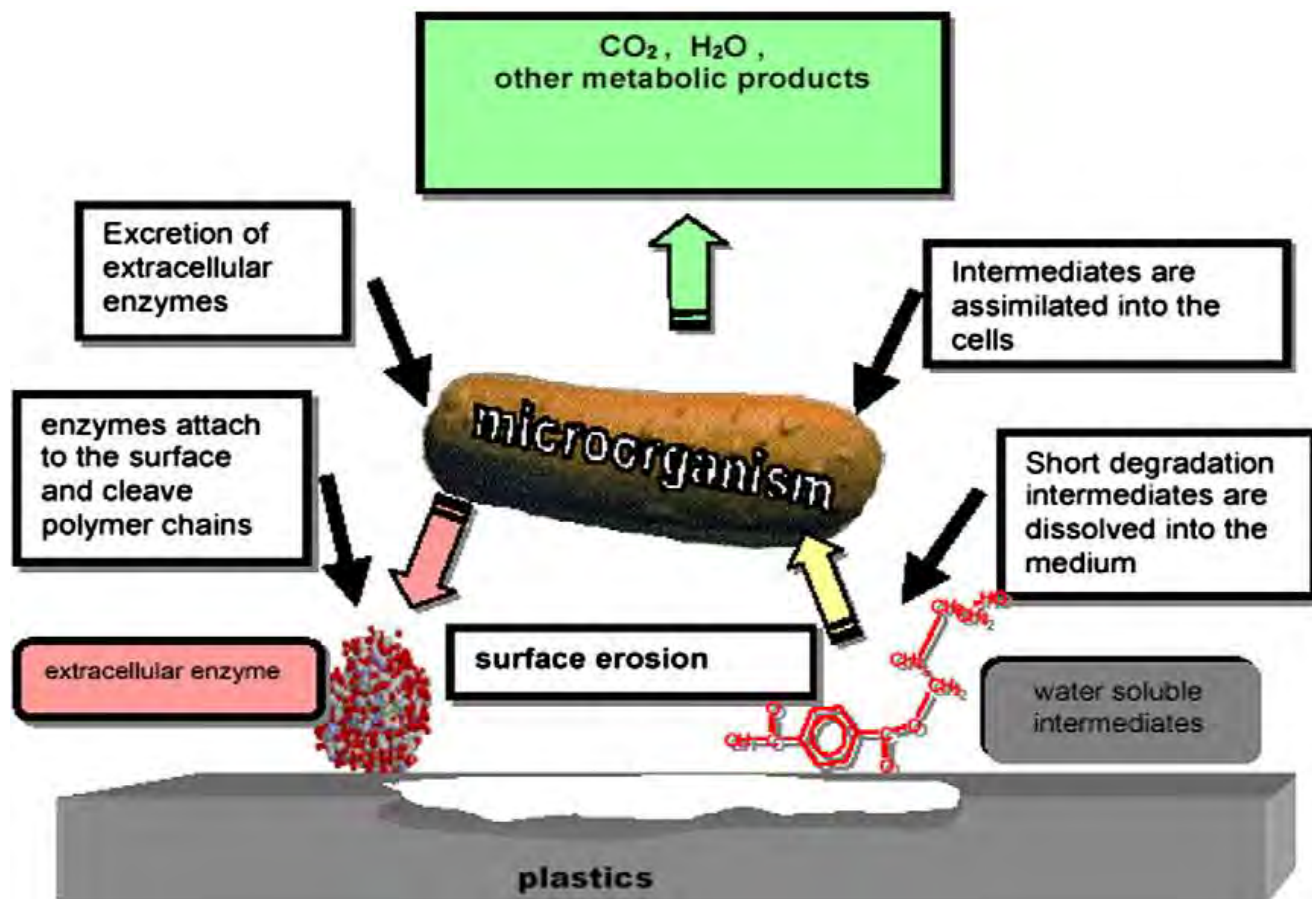
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R&D OVERVIEW: AGRICULTURAL BIOMASS FOR BIOPLASTICS AND ITS BIOBASED PRODUCTS



Biodegradation of Plastics



Certification bodies, Standard and Logos for Biodegradable Polymer Products

Certification Body	Reference Standard	Logo
DIN Certco (Germany)	EN 13432:2000	
AFOR (UK)	EN 13432:2000	
Keurmerkinstituut (Netherlands)	EN 13432:2000	
COBRO (Poland)	EN 13432:2000	
ABA (Australia)	EN 13432:2000	
Vincotte (Belgium)	EN 13432:2000	
Jätelaito-syhdistys (Finland)	EN 13432:2000	
Certiquality / CIC (Italy)	EN 13432:2000	
Avfall Norge (Norway)	EN 13432:2000	
BPI (USA)	ASTM D 6400-04	
BNQ (Canada)	BNQ 9011-911/2007	
JBPA (Japan)	Green Pla identification system	

BIODEGRADATION TESTING FACILITY FOR BIO-PRODUCTS : Environmental claims for biobased/degradable products

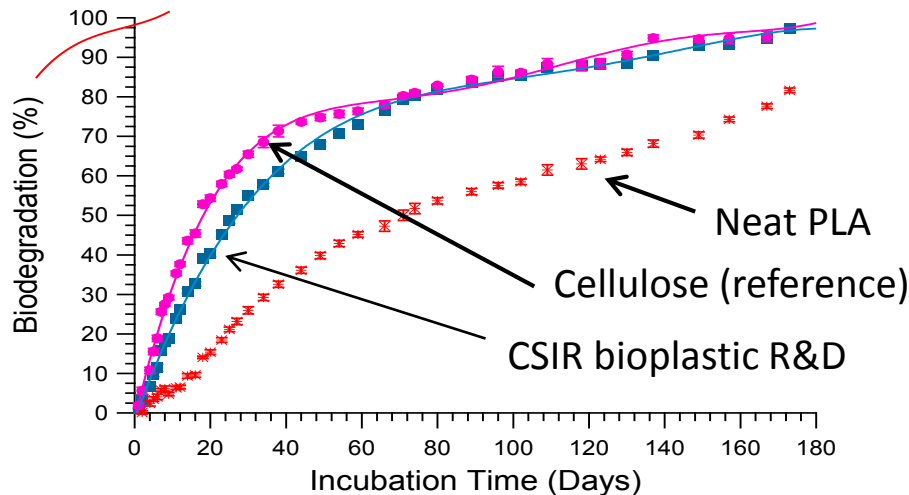
Biodegradation testing Facility at CSIR, Port Elizabeth



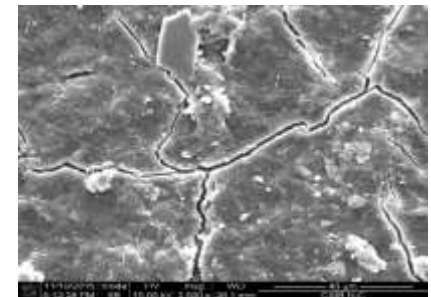
0 day

17 days

30 days



After biodegradation in water medium



After biodegradation testing in microscopy



➤ **Completion of carbon cycle in short span**

CERTIFICATION OF BIOBASED/BIODEGRADABLE PLASTICS PRODUCTS

An example

Approaching biobased markets



Environmental Label

Product
CSIR 100% biodegradable plastic bag

Company
CSIR-SA

- 100% of renewable raw materials (ASTM D6866)
- Recyclable (EN 13430)1
- Recoverable as energy (EN13431)
- Biodegradable (2-4) in soil (ASTM D5988), marine water (and compostable (ASTM D5338)

Facultative claim

- **Intended use : carrier bags**

This label will be prepared by CSIR lab services facility (ISO 17025) in accordance with international standard Environmental label Rules

1

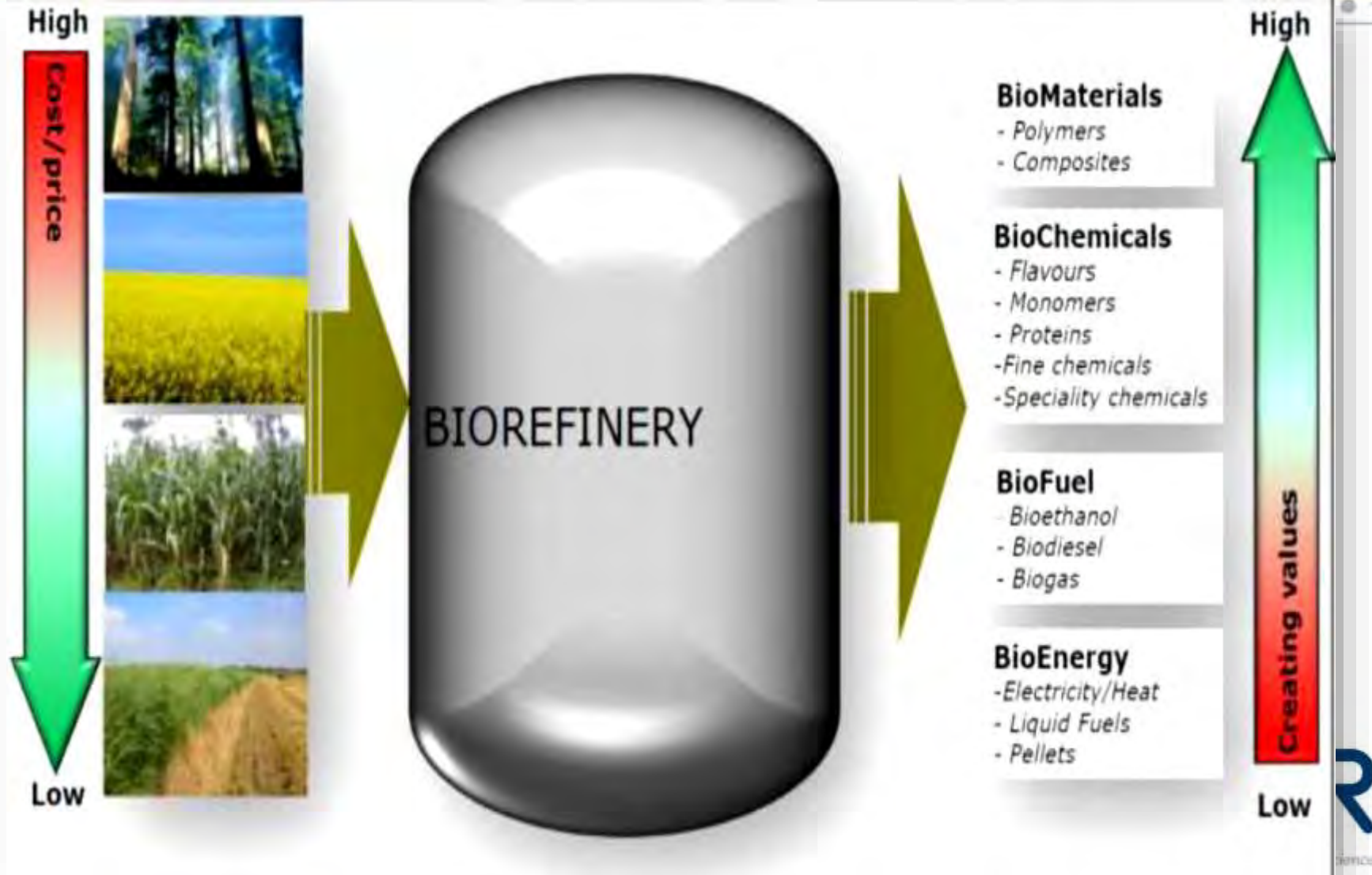
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3

4



How to reduce production cost and scaling up? Opportunities and potential economic benefits in SA



Conclusions and Recommendations

- The trend of plastic production & consumption and mounting of environmental concern caused by plastic waste, are in favour of an increasing acceptance and diffusion of EDPs.
- The improved utilization of agricultural undervalued by-products in biomaterial formulations by green technology research (renewable, recyclable and reusable) has opportunities to create new biomaterials for uses in packaging and other sectors.
- Fossil & Renewable resources can be used as cost-effective feedstocks for production of EDPs
- EDPs will replace conventional commodity plastics in those segments where recycling or feedstock recovery is difficult and heavily penalized from an economical standpoint
- Biobased polymer and biocomposite materials from non-food agricultural ligno-cellulosic biomass have a potential role to play in the development of the bioeconomy due to their potential to address environmental concerns regarding plastic waste and economy challenges.

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- CSIR





Thank you

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