Nano-enable sustainable materials for green economy
in conjunction with
18th National Science and Technology Development Agency (NSTDA) Annual Conference
Thailand Science Park, Pathum Thani, Thailand
March 28-31, 2023

Nano-enabling its Sustainable Resources in The Philippine Countryside

NOEL PETER B. TAN, Ph. D.
Director, Center for Advanced New Materials, Engineering, and Emerging Technologies (CANMEET)
University of San Agustin, General Luna St., Iloilo City
DOST-PCIEERD Balik-Scientist
Email: dtan@usa.edu.ph

Center for Advanced New Materials, Engineering and Emerging Technologies (CANMEET)

R&D Program of USA Office of Research and Global Relations (ORGR), 2022-2025

ARISE 2025:

Augustinian Research and Innovation for Service and Education @2025

Goal

To educate students, faculty, and the community that we serve about the importance of conducting quality research as Agustinians during this era of knowledge economy and COVID-19 pandemic.

CANMEET was established on **March 1, 2022** by the USA Board of Trustees.

The **1st and only** material science and nanotechnology research center in Western Visayas region of the Philippines.

*Home of the **Hub for Sustainable Smart Nanomaterials**, a Smart Packaging Laboratory.* It is the 5th research center under ORGR, which includes C2B2 (2017), CND3 (2017), CHIC (2018), and CFI (2019).

Vision

To become a leader in the Philippine countryside in new materials, engineering, design, and emerging technologies.

Priority research areas

Material science and engineering, sensors and actuators, synthetic polymers, automation, design, and emerging technologies.

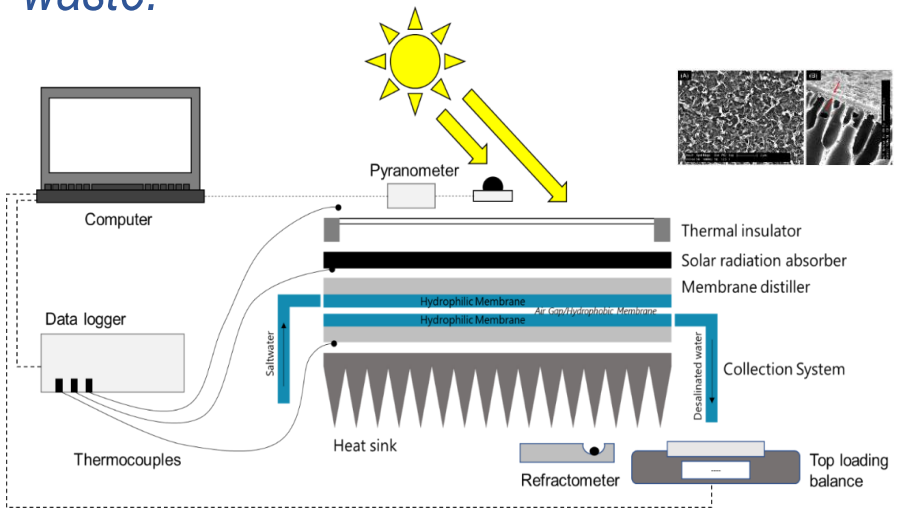
Current Capabilities of CANMEET Research Center

Bioplastics for Packaging

- Conversion of locally-sourced sustainable resources to bioplastics.
- Improvement of bioplastic properties vis-à-vis conventional plastics.
- Functionalization of bioplastics as Smart Packaging material.
- *Industrial collaboration**

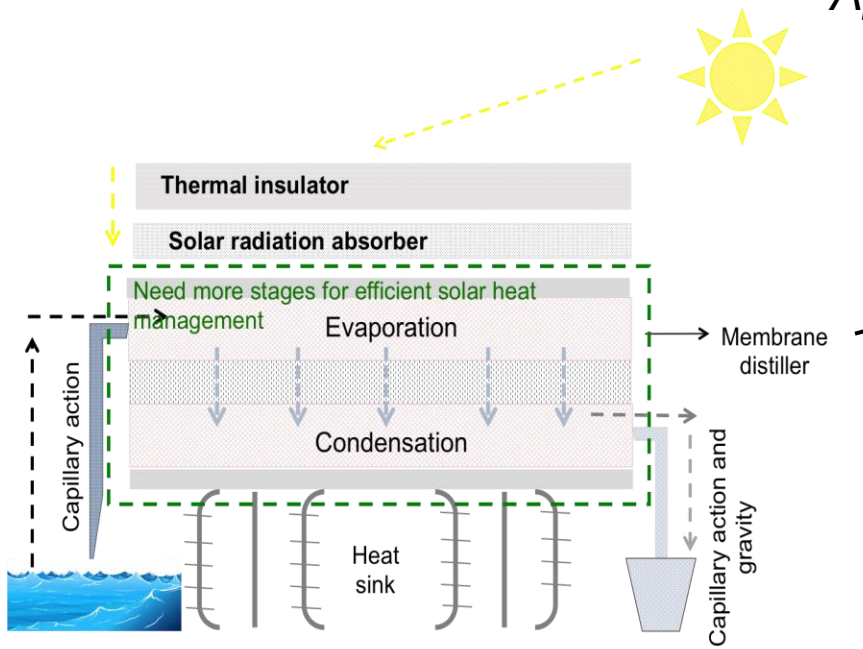
Functional Membrane Development

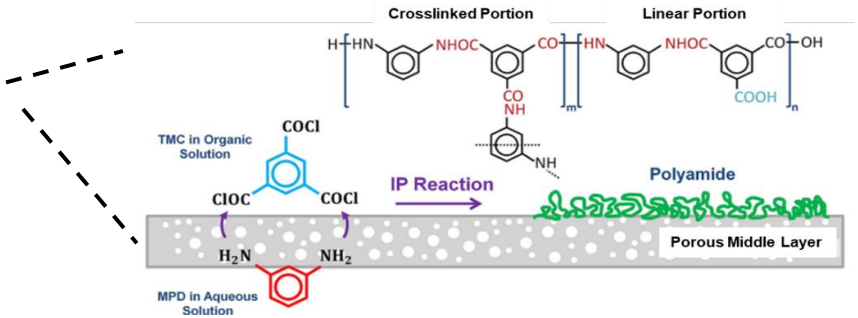
- Nano-membrane development for solar-driven water evaporation (SWE) for seawater desalination
- *Membrane development for alternative energy production (e.g., H_2) from industrial waste. **



Seawater desalination using a passive solar-driven membrane system: Nano improvement of the membrane layers

(A Department of Science and Technology –Philippine Council for Industry, Energy, and Emerging Technology Research and Development (DOST-PCIEERD) Regional Research Institution (RRI) – Approved Project 2022)



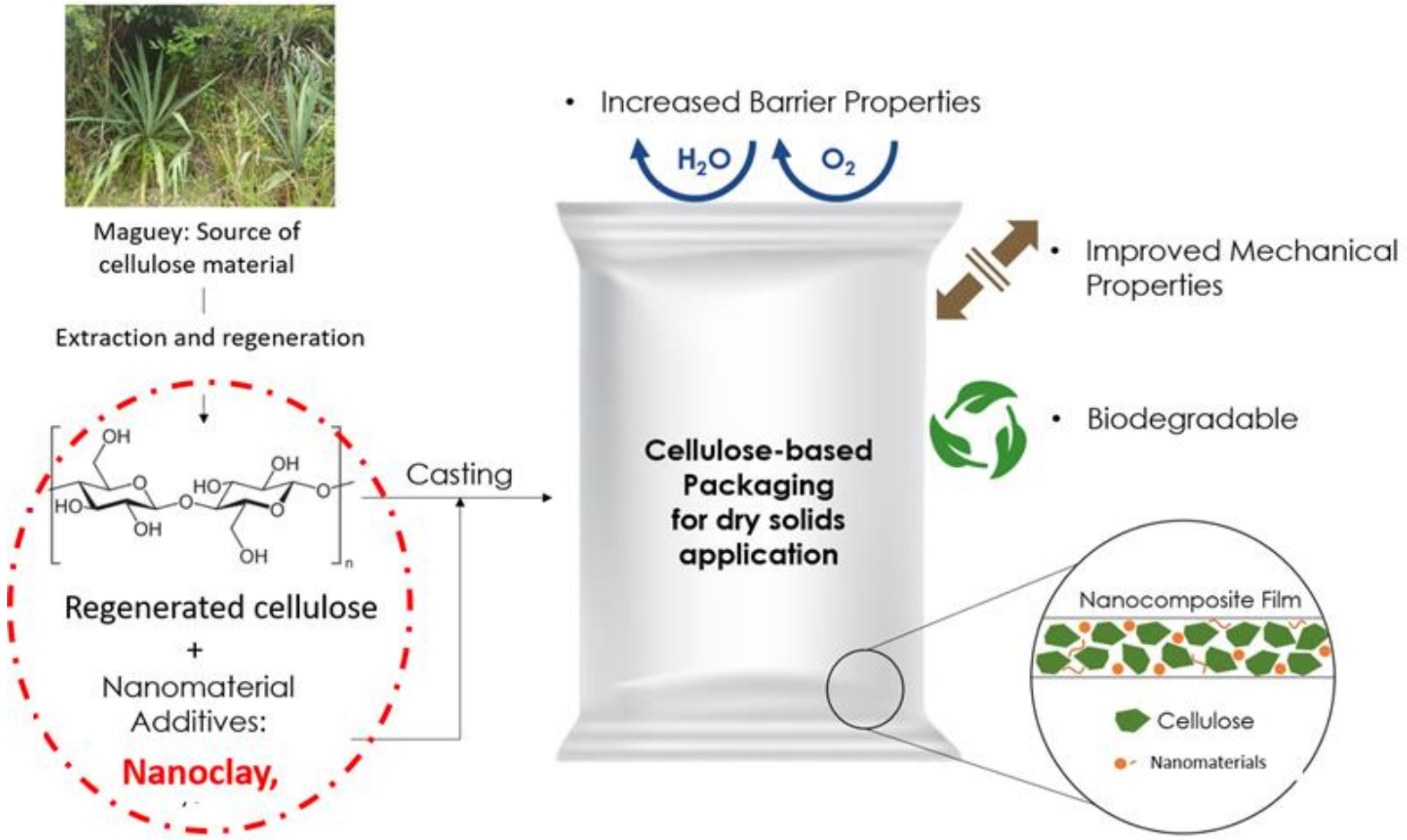


Hybrid seawater desalination system using solar energy and no mechanical pumps to produce safe water

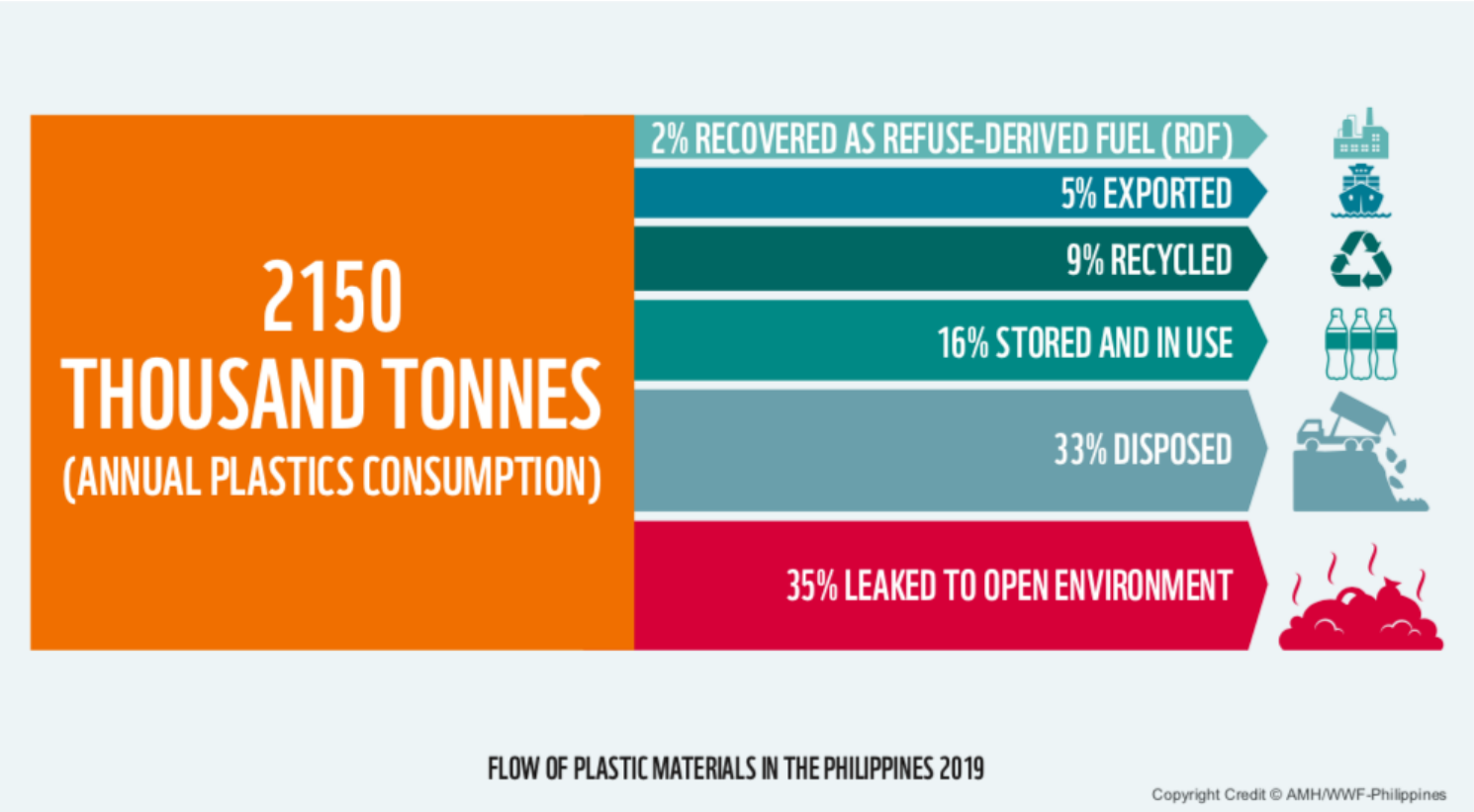
Improvement of the membrane distiller to ***produce surface nanomembranes*** improving productivity and quality of distilled water.

Nano-enabled bioplastic from regenerated cellulose

(A Department of Science and Technology –Philippine Council for Industry, Energy, and Emerging Technology Research and Development (DOST-PCIEERD) Regional Research Institution (RRI) – Approved Project 2022)



The Plastic Problem



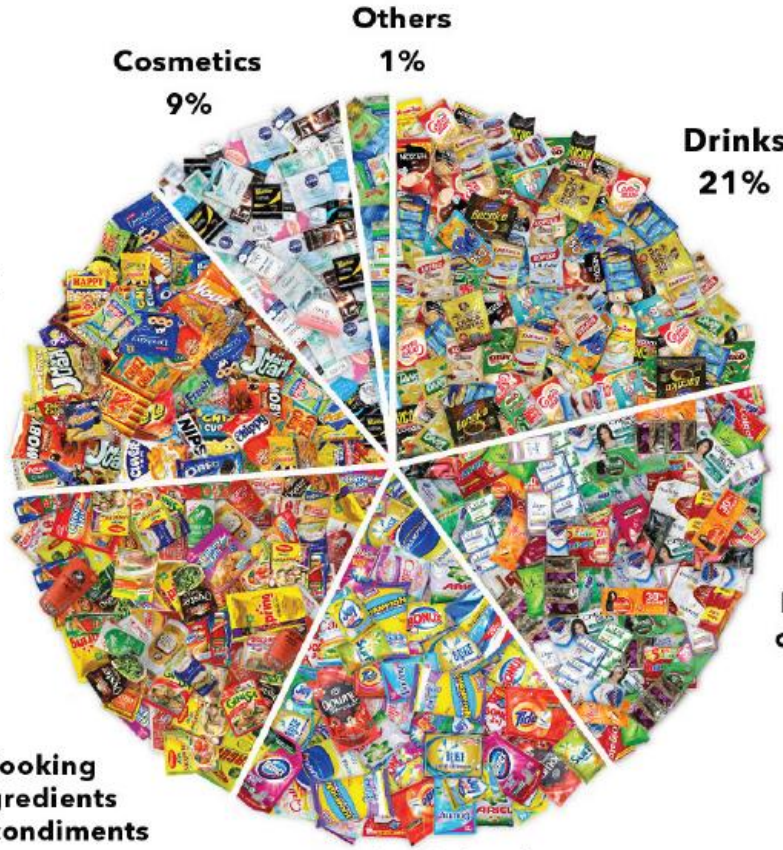
Source: https://verafiles.org/articles/new-wwf-philippines-report-plastic-packaging-pushes-business

Photo credits to: Amy Slack (Source: https://www.sea-circular.org/country/philippines/)

~ 48% of plastic produced are used in PACKAGING

“ Sachet Economy”

The Plastic Problem



Source: 2019. Global Alliance for Incinerator Alternatives. Plastics Exposed: How Waste Assessments and Brand Audits are Helping Philippine Cities Fight Plastic Pollution.

The average Filipino uses **591** pieces of sachets, **174** shopping bags and **163** plastic *labo* bags yearly.

164 million sachets are used daily, or **59.8 billion** pieces of sachets annually throughout the Philippines

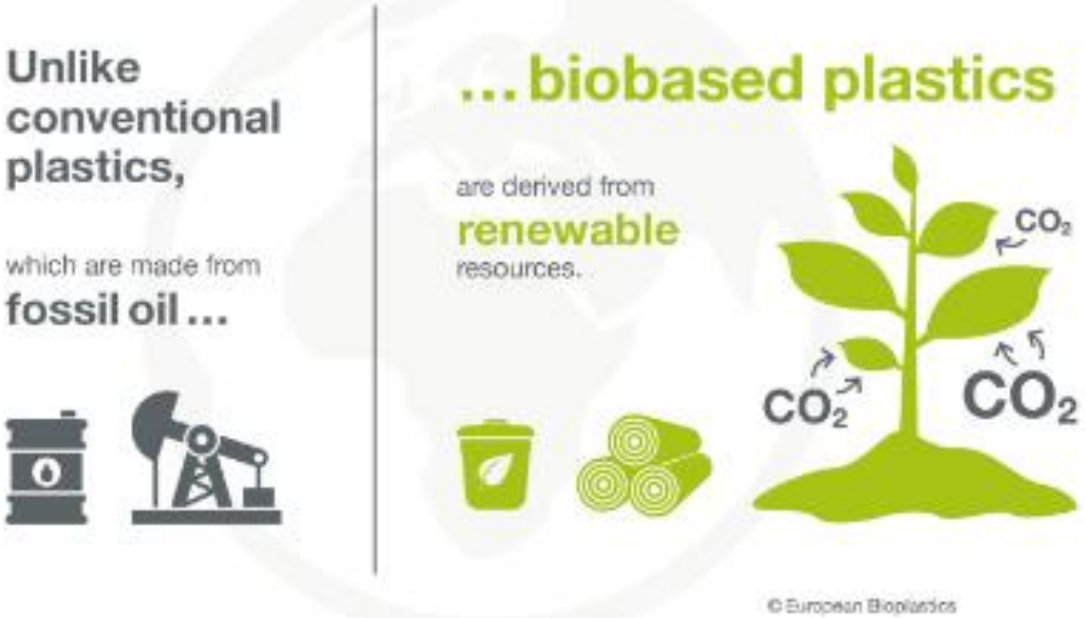
Every day, almost **57 million** shopping bags are used throughout the Philippines, or roughly **20.6 billion** pieces a year.

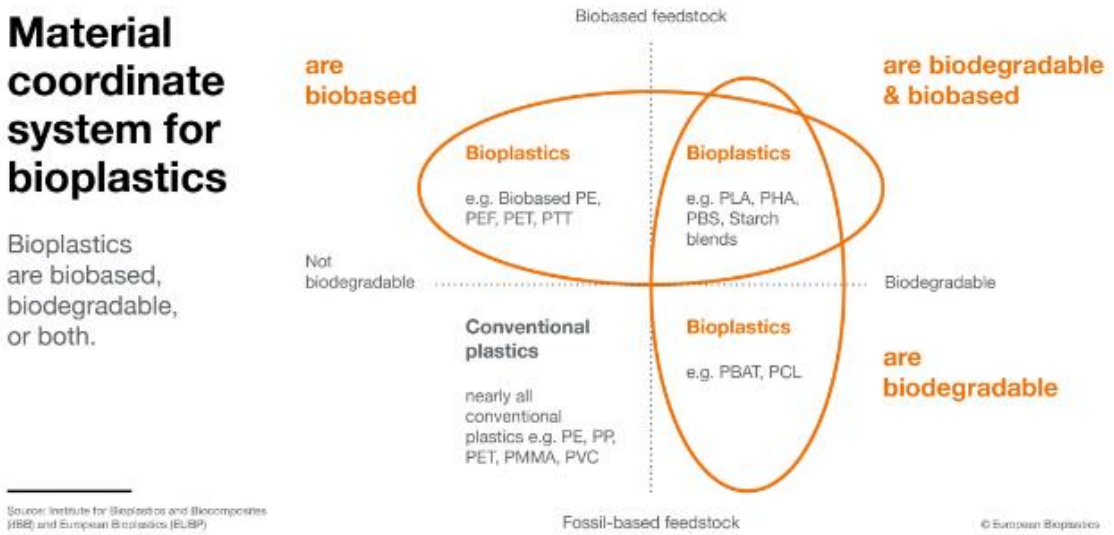
Plastic *labo* bag use throughout the Philippines is at **45.2 million** pieces per day, or **16.5 billion** pieces a year.

Around **three million** diapers are discarded in the Philippines daily, or **1.1 billion** diapers annually.

Source: 2019. Global Alliance for Incinerator Alternatives. Plastics Exposed: How Waste Assessments and Brand Audits are Helping Philippine Cities Fight Plastic Pollution.

The Critical Role of Bioplastic in the Plastic Problem

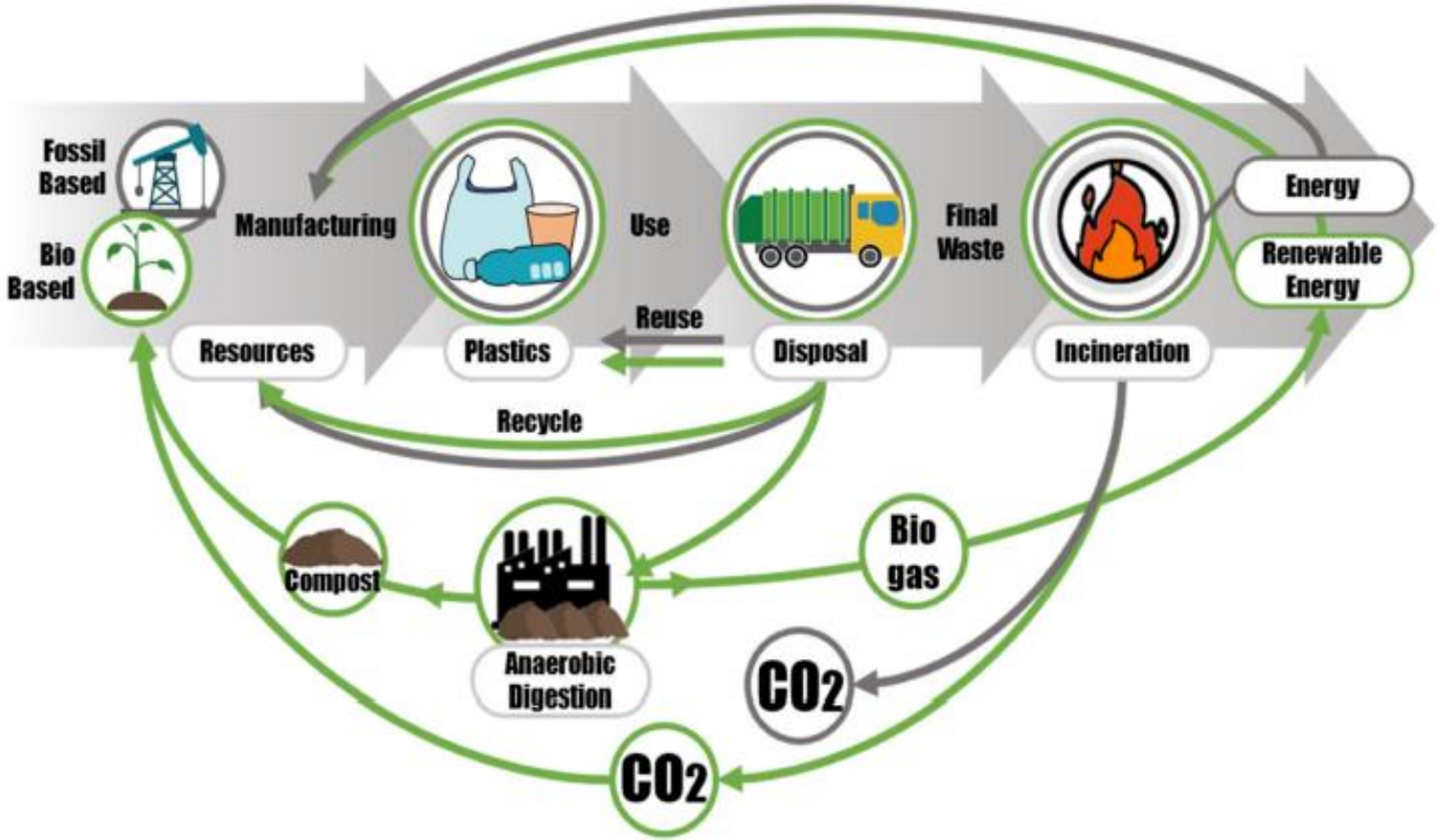




Source: https://www.european-bioplastics.org/bioplastics/ (Accessed 28March2023)

The Critical Role of Bioplastic in the Plastic Problem

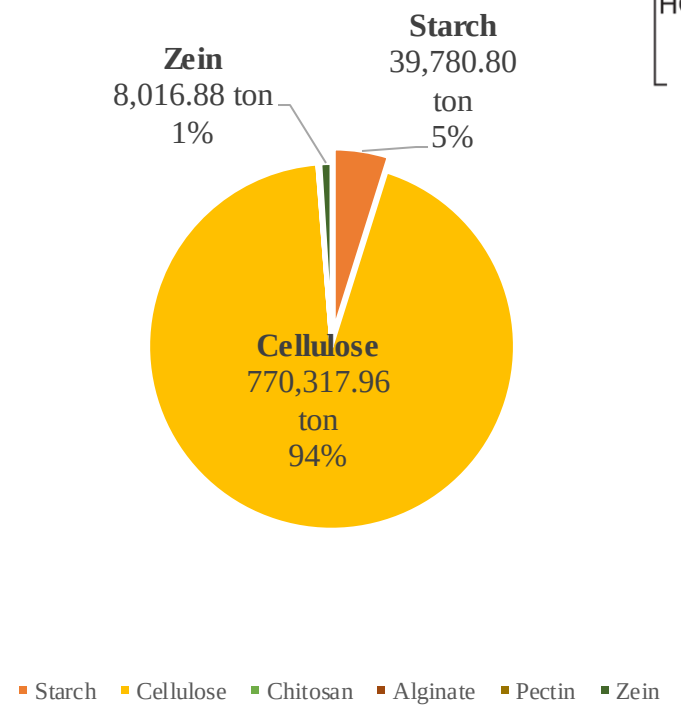
- Addresses circular economy of making plastics through valorization of wastes.



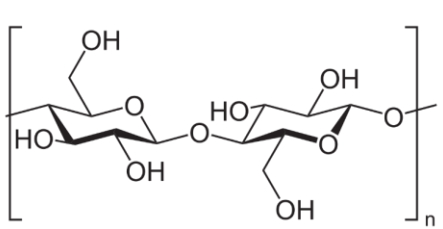
Source: Di Bartolo et al., A Review of Bioplastics and Their Adoption in the Circular Economy, *Polymers,* 2021, 13,1229.

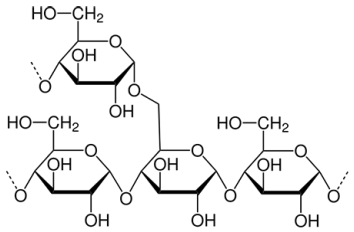
The Critical Role of Bioplastic in the Plastic Problem

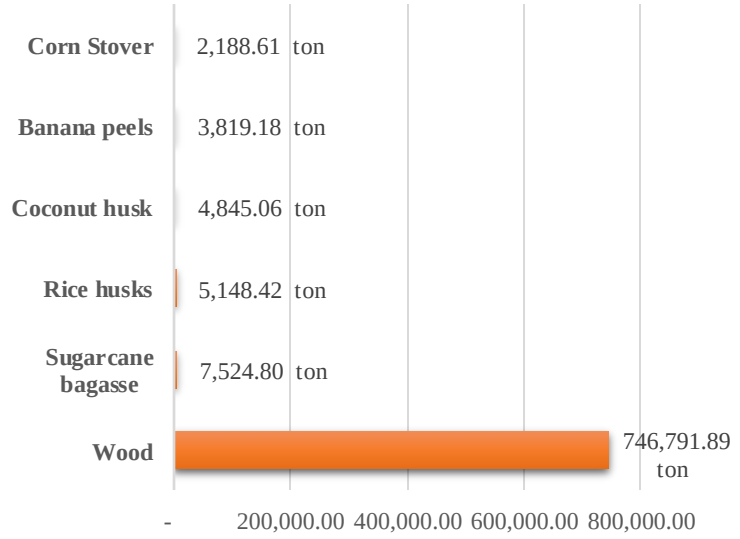
- Bioplastics serves at the forefront of packaging research. Biomass residue as a major potential source for bioplastics.



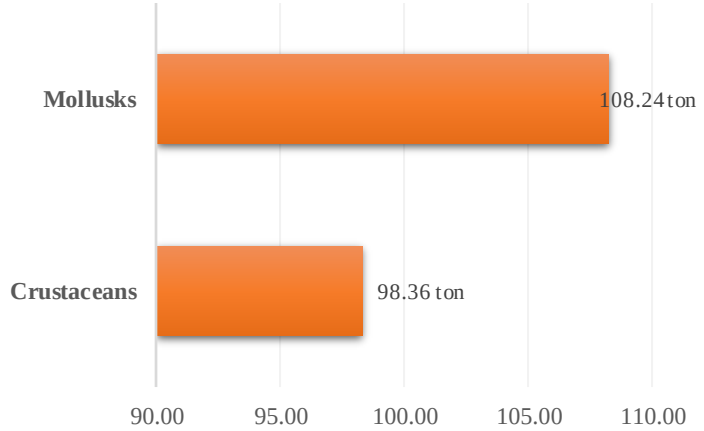
Biopolymers and their potential amounts in the Philippines



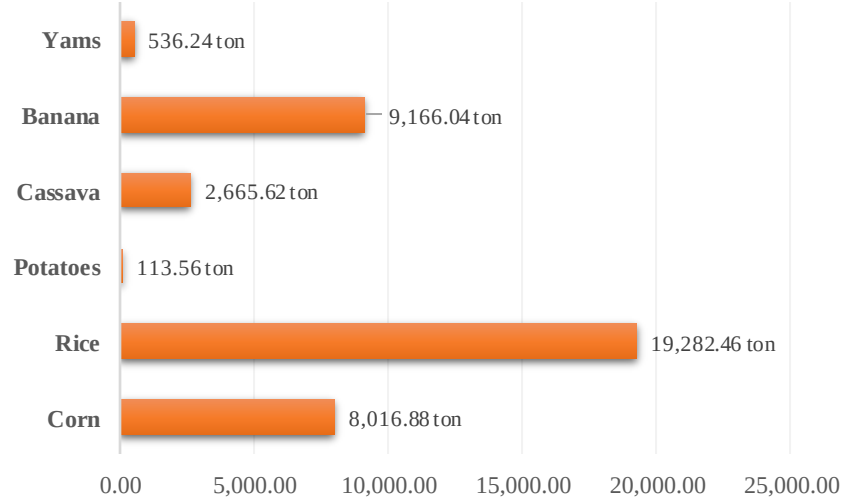




Cellulose sources and their potential amounts



Chitosan sources and their potential amounts

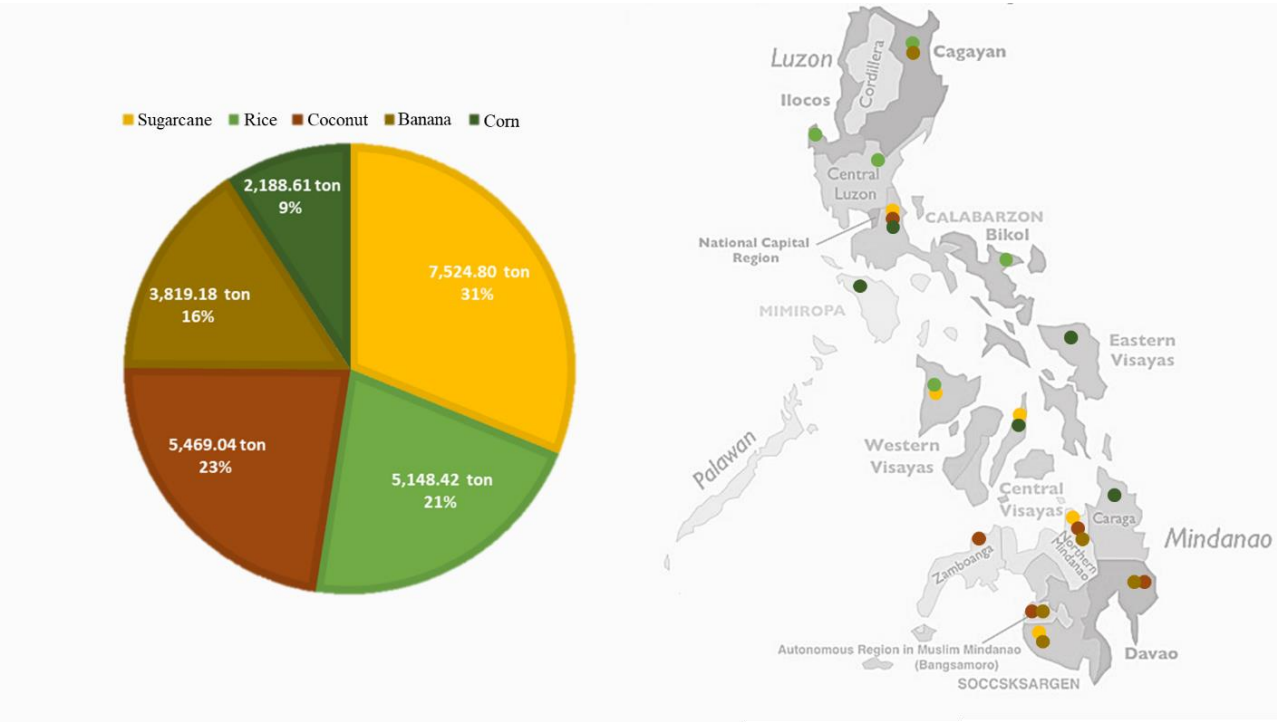


Starch sources and their potential amounts

Abundance of Renewable Resources for Bioplastics and its Challenges

❑ Biomass residue abundance in the Philippines.

Major Crops[1]	Production Volume (ton)	Residues	%RPR[2]	Potential Amount of Residues (ton)
Sugarcane	25,082.66	bagasse	30%	7,524.80
Rice	19,282.46	husk	26.70%	5,148.42
Coconut	14,549.72	husk	33.30%	4,845.06
Banana	9,166.04	peels	42%	3,819.18
Corn	8,016.88	Stover	27.30%	2,188.61



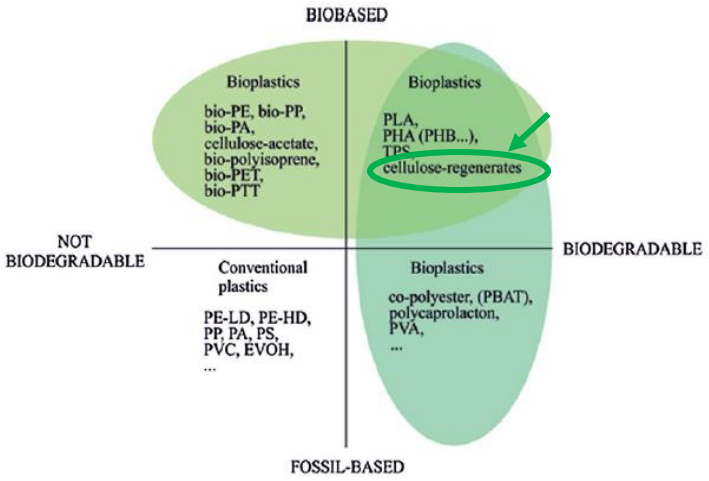
❑ **Properties of bioplastics are not at par with conventional plastics in terms of mechanical properties, stability, barrier properties.**

❑ **Cost limits scalability.**

Development of Nano-modified bioplastics

To develop a nano-enabled green alternative material for industrial flexible non-food packaging.

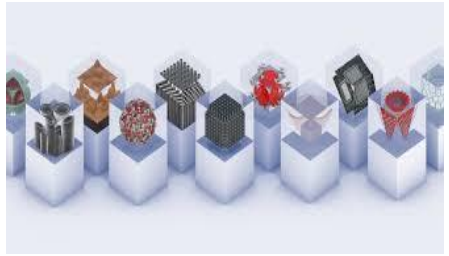
Use of regenerated cellulose as natural alternative source of (bio) plastic



Maguey, Rice Hay

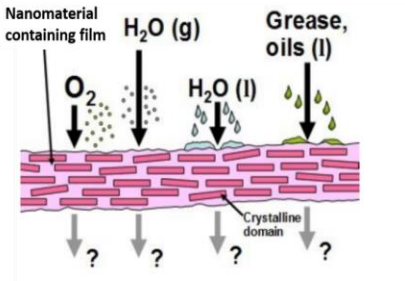
Source: TomLindstrom and Folke Osterberg, Nordic Pulp and Paper Reseaarch Journal 2020; 35(4): 491-515

Tailor Design with Nanomaterials for Packaging solution



To improve mechanical and barrier properties, and plasticity of the bioplastic.

- Nanocellulose
- Nanoclay



Produce Eco-friendly design packaging

Bio-based and biodegradable

Composition:
~95% Bioplastic
~5% Nanomaterials

Mono-material; easy recyclability

Replacing industry – product specific packaging

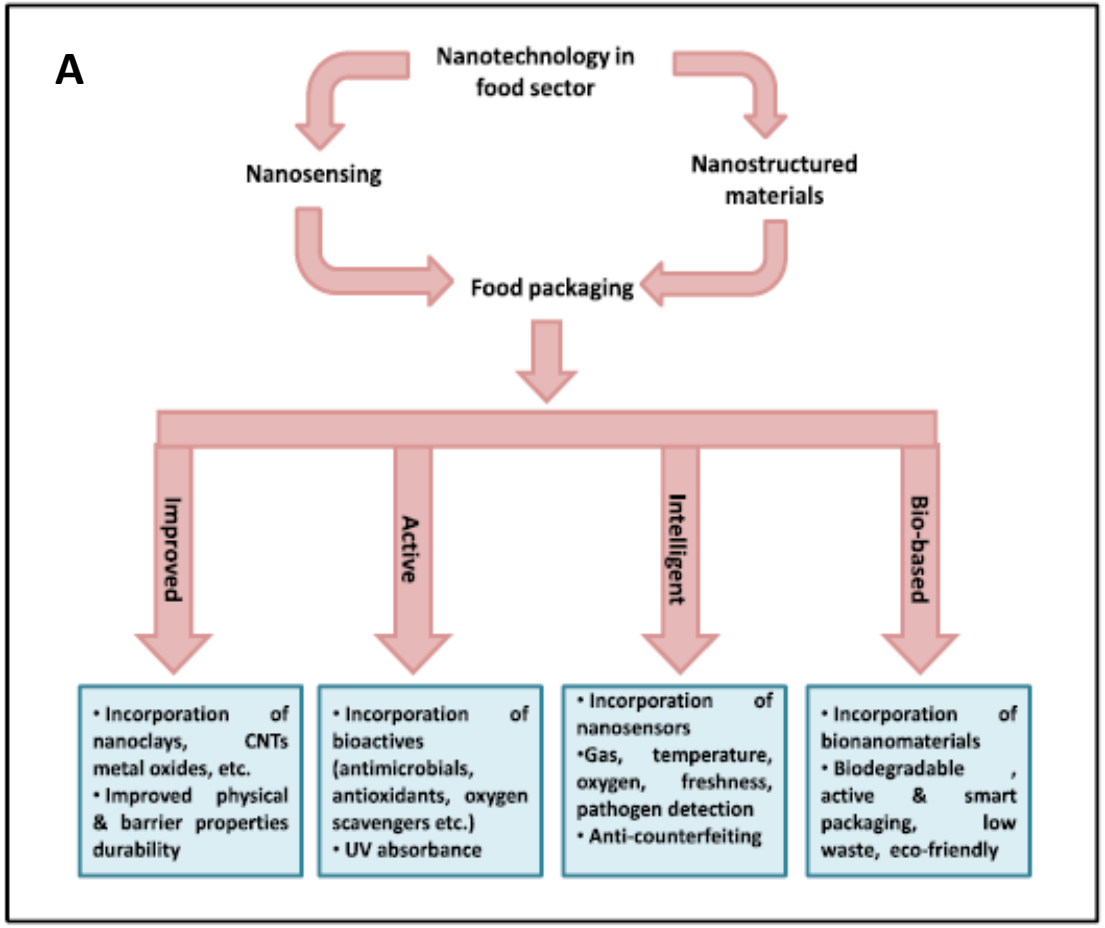
Non-biodegradable

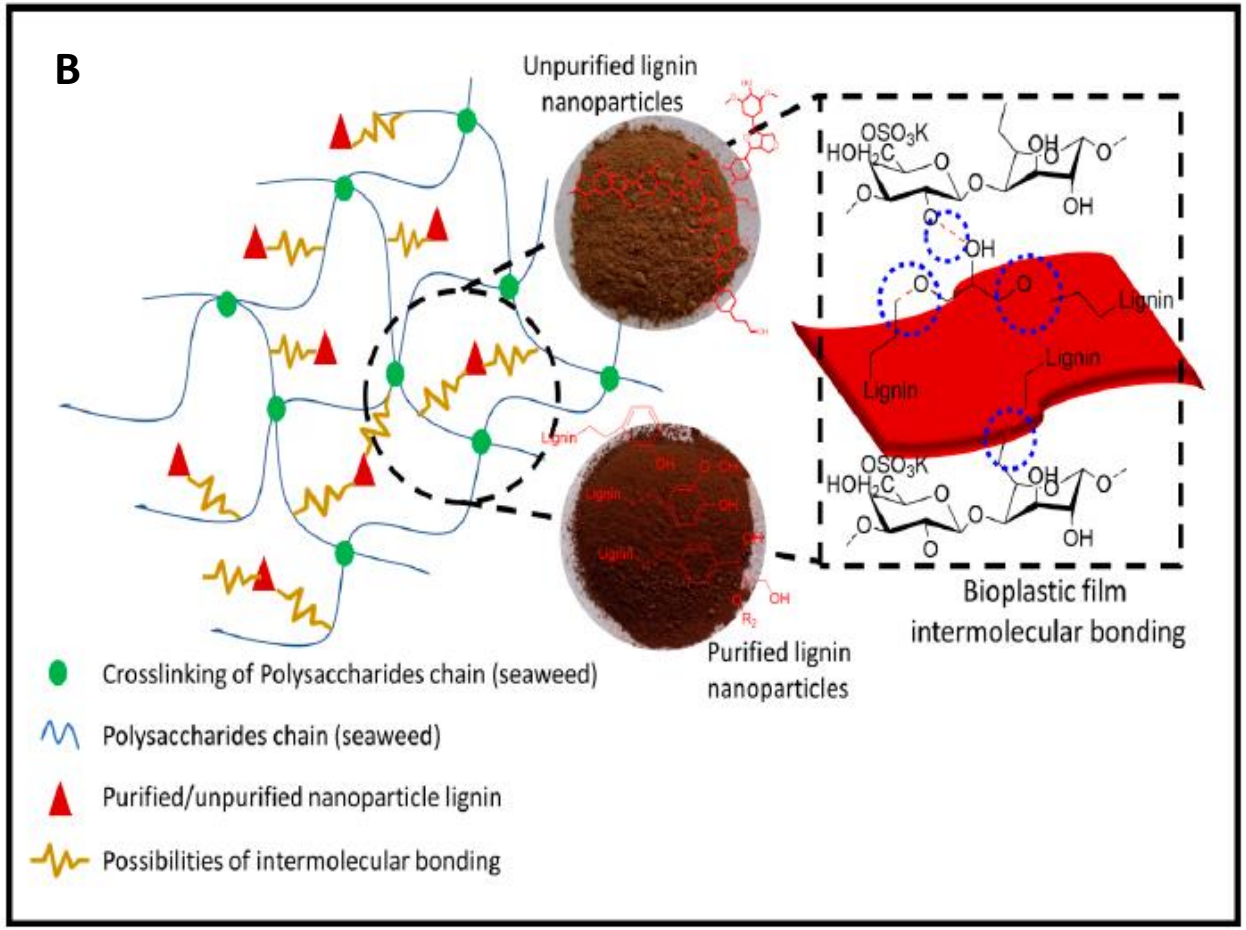
Not easy to Recyclable

Composition:
~99% Synthetic polymer
~1% Ink & Adhesive

Printed

Development of Nano-modified Bioplastics





Source: A) Chausali, et al., Journal of Agriculture and Food Research, 2022, 7, 100257. B) Rizalm S. et al., Polymers, 2022, 14, 5126.

The Hub for Sustainable Smart Nanomaterials in CANMEET

an Institution Development Program (IDP) – grant from DOST-PCIEERD

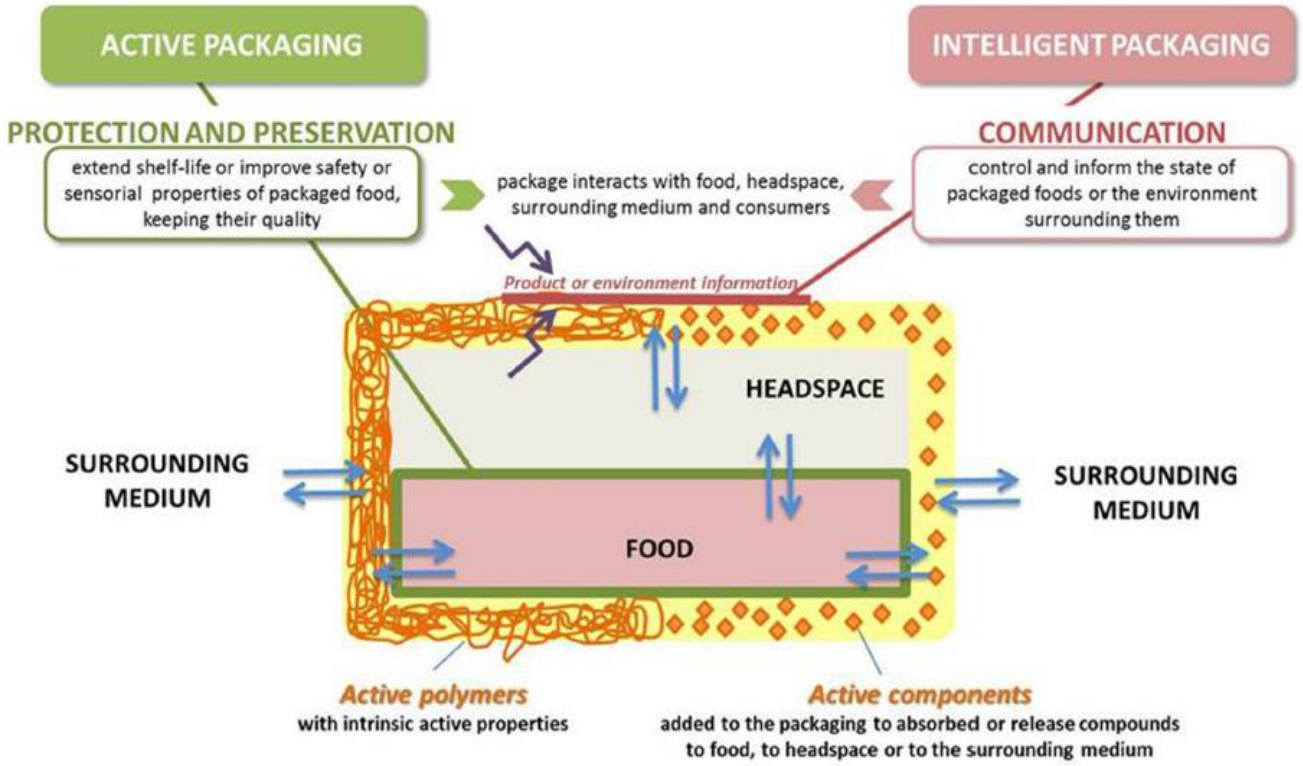
Nano-enabling of locally-sourced bioplastics and its development for Smart Packaging

OBJECTIVES

To acquire state-of-the-art instruments that will enable the establishment of a Smart Packaging Laboratory

To develop and train science, technology, and innovation (STI) talents

To generate proof-of-concept data for succeeding research grant proposals on smart packaging.

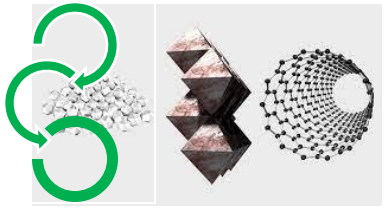


Salgado et al., Front. Sustain. Food Syst. 5:630393.

The Future of the Hub for Sustainable Smart Nanomaterials in CANMEET

Increase STI Talents and experts in Smart Packaging

Collaborative projects with other institutions and stronger ties with Food and Packaging Industries



Innovative production of safe and Smart Nanomaterials

Prototypes of functional bioplastic to be tested on food packaging

THANK YOU!

NOEL PETER B. TAN, Ph. D.
Director, Center for Advanced New Materials, Engineering, and Emerging Technologies (CANMEET)
University of San Agustin, General Luna St., Iloilo City
DOST-PCIEERD Balik-Scientist
Email: dtan@usa.edu.ph