

R&D

ANNUAL REPORT

Summary of Nextgreen's R&D Activities in 2022



2022

Second edition



NEXTGREEN'S VISION

To be the most innovative green technology company with sustainable zero waste industry model that ultimately lead us to a greener future



NEXTGREEN'S MISSION

To accelerate the world's transition to green and sustainable products



R&D DEPARTMENT'S AIM

To develop and deliver innovative products and processes, besides improving existing technology for company's future growth

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R&D ANNUAL REPORT Summary of Nextgreen's R&D Activities in 2022

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Li Shan CHIANG

#ZEROWASTECONCEPT
#CIRCULARECONOMY



On the cover:
Nextgreen's R&D Products Display

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Message from the MANAGING DIRECTOR

Industries must rapidly change or adapt their traditional business models to reflect sustainable practices, and to integrate sustainability criteria into their business policies aligned with the growth of global awareness about living in a greener and more sustainable future. Environmental, social and governance (ESG) framework of sustainable change management help to address climate change issues and challenges.

Integrating ESG into our business strategies, business processes and decision-making is our way forward, including our R&D Department, as we seek ways to add value while innovating products and services to adapt to the needs of commercial markets. Sustainability in pulp and paper manufacturing can contribute immensely to the realisation of a sustainable future.

Dato' Lim Thiam Huat
Managing Director
Nextgreen Global Berhad

“We look forward to strengthening our R&D and innovation capabilities in 2023”

To meet the rising market demand for sustainable food packaging, our R&D Department's key project with Universiti Putra Malaysia (UPM) in 2022, is funded by the Ministry of Science, Technology and Innovation (MOSTI), aimed to develop marketable oil palm biomass-based food packaging incorporating nanocellulose fibre.

Fostering industry-university collaborations produce new knowledge while bringing together professionals from different academic disciplines to share their latest research. Through ongoing research undertakings with universities, Nextgreen hopes to explore and tap the many potential opportunities of the circular economy, including the creation of employment opportunities through R&D training and development.

We are constantly finding ways to improve the efficiency of technical processes and resource utilisation, while seeking multiple applications for raw materials from oil palm biomass.

The mission of the R&D Department for 2023 is to focus on innovating and commercialising new ideas and products, while exploring and improving the competitiveness of existing products across the value chain with our valuable industry and institutional partners.

In December 2022, Nextgreen Global was awarded for attaining ***SDG Ambition Benchmark 6: 100% Sustainable Material Inputs that are Renewable, Recyclable, or Reusable*** during the UN Global Compact for Malaysia & Brunei (UNGCMYB) Sustainability Performance Awards. This will continue to drive our approach to sustainability as it signifies our commitment is recognised by external parties.

Our approach continues to focus on innovation emphasising on renewable energy and zero waste. This is an integral part to achieving sustainability goals, to mitigate environmental damage, and to engage local communities towards building a sustainable future.

EXECUTIVE MESSAGE from the DIRECTOR

R&D PROGRESS IN 2022

R&D is commonly associated with innovation to create value for the company, industry, and community as a whole. At Nextgreen, we believe that R&D allows a company to stay ahead of our competitors, so we are constantly developing new products and improving existing offerings, which is in line with our key objective to ensure strong returns to shareholders. We are maximising our R&D capabilities by centralising resources across the Group to realise the full potential of our synergies for sustainability and potential profitability.

We also believe that our success is rooted in our ability to continue improving existing products while innovating new technologies and products that meet the needs of customers. To accomplish this, we have been actively collaborating with other researchers from universities and research institutions throughout 2022.

ACCOMPLISHMENTS

Nextgreen has been focusing on the development of technologies and value-added products that align with national sustainability goals and government policies to promote green economy in the long run. The creative spark for innovations we have developed is through the use of the latest green technology, thus contributing to improving industry sustainability. Our commitment to advancing green technology in large-scale business operations and manufacturing practices has been recognised by the Malaysian government.

Nextgreen is listed as a key player in the National Advanced Technology Roadmap 2021–2030 by the Malaysian Ministry of Science, Technology & Innovation (MOSTI) in 2022. Our collaborative project with MOSTI and Universiti Putra Malaysia (UPM) on the sustainable production of empty fruit bunch-based food packaging worth RM4.4 million was completed in 2022. We managed to achieve Technology Readiness Level 7 (TRL7) and this innovative biomass green packaging product is ready to be commercialised.

R&D PLANS FOR 2023

As our business operations grow increasingly diverse, the R&D Department will strive to develop products that add value to the company and society in terms of function and quality, while enhancing cost efficiency. Nextgreen will continue to facilitate the conversion of wastes from GTP manufacturing facilities and oil palm industry.

As we march into 2023, investments in R&D will continue to be the fundamental backbone which supports the sustainability of our operations—technically, economically, socially and environmentally. It is our belief that the various initiatives undertaken in 2023 will create hundreds of job opportunities, fostering the development of a skilled local workforce, ensuring talent is never depleted, cultivating an inclusive management and work culture, and assisting in the development of rural communities.

Ms Lim Kah Yen
Executive Director
Nextgreen Global Berhad



NEXTGREEN'S R&D TOWARDS SUSTAINABLE DEVELOPMENT GOALS

In September 2015, world leaders adopted the 2030 Agenda for Sustainable Development which comprises 17 Sustainable Development Goals (SDGs) and 169 associated targets that address the world's most pressing economic, social and environmental challenges. Recognising that the private sector plays an important role in this global mobilisation, Nextgreen has identified four SDGs and several targets that are relevant to our business and R&D activities.

6
CLEAN WATER AND SANITATION

Utilisation of biomass-derived activated carbon and biochar for boiler's discharged water treatment –thus enabling reuse of treated water in the boiler wet-scrubber system (refer to page 13).

This research supports target 6.3 which is to improve water quality by reducing pollution, eliminating dumping and minimising release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally by 2030.

8
DECENT WORK AND ECONOMIC GROWTH

Production of sustainable value added products—nanocellulose from EFB cellulosic pulp (refer to page 9).

This collaborative research supports target 8.2 whereby higher levels of economic productivity through diversification, technological upgrading and innovation could be achieved. Additionally, research and development in nanocellulose aligned with target 8.3 which is to promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalisation and growth of micro-, small- and medium-sized enterprises, including through access to financial services

9
INDUSTRY, INNOVATION AND INFRASTRUCTURE

Research & development innovation and expenditure (refer to pages 9 - 13).

Nextgreen efforts and expenditure in R&D aligned with target 9.4 which is to upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities by 2030.

The R&D activities also support target 9.5 which is to enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending

12
RESPONSIBLE CONSUMPTION AND PRODUCTION

Utilises, recycles and reuse sustainable resources which includes but not limited to:

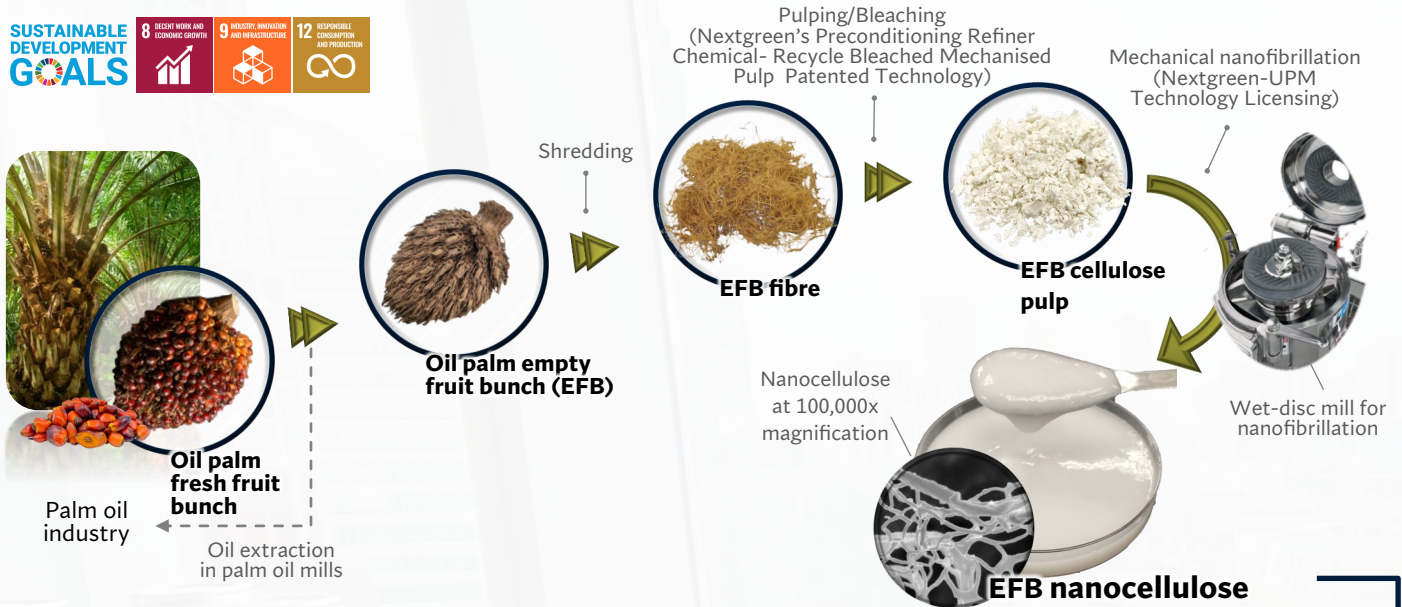
- **oil palm biomass for pulp and nanocellulose moulded food packaging** (refer to pages 10 & 11);
- **mill generated-wastes for value added application such as ash for soil conditioner** (refer to page 12) **and black liquor for adhesives** (refer to page 15);
- **Uses of biomass-derived activated carbon and biochar for wastewater treatment and recycling** (refer to page 13).

These efforts generally support target 12.2 which stated that by 2030, sustainable management and efficient use of natural resources could be achieved. The researches conducted also aligned with target 12.5 whereby waste generation could be reduced through prevention, reduction, recycling and reuse.

NANOCELLULOSE

A Sustainable Advanced Material from Cellulosic Pulp

Tengku Arisyah Tengku YASIM-ANUAR^a, Nur Sharmila SHARIP^a, Farhana AZIZ UJANG^a, Hazwani HUSIN^a & Li Shan CHIANG^b
^a Research & Development Department, Nextgreen Pulp & Paper Sdn. Bhd.; ^b Research & Development Department, Nextgreen Fertilizer Sdn. Bhd



Nextgreen is listed among the industrial players of Advanced Materials Ecosystem in Malaysia¹

Also called cellulose nanofibre (CNF)
 Fibre in micrometer-long with diameter **less than 100 nm** (equivalent to 1/1000 of hair size)
 Possesses about **8 times the strength of steel** and is claimed to be **stiffer than Kevlar²**
 Biodegradable, sustainable, biocompatible, non-toxic, excellent mechanical & barrier properties

GLOBAL INDUSTRIAL OVERVIEW

| | |
|-----------------------------------|--|
| Market size in 2022 | USD 340 million ² |
| Forecast period | 2023 to 2032 ² |
| CAGR | 23.9% ² |
| 2032 Value Projection | USD 3.4 billion ² |
| Price per kg | USD 100 to USD 5000 ² |
| Growth drivers | <ul style="list-style-type: none"> • Strong product demand across the packaging industry² • Rising demand for technologically advanced sustainable products across various end-user industries² • Rising food & beverage industry across the globe² • Rising personal care industry in Asia Pacific² • Increased in customer consciousness on environment friendly and sustainable products³ |
| *Pitfalls & Challenges | <ul style="list-style-type: none"> • High product prices² • Lack of consumer awareness² |

*Exploration of new manufacturing processes and the demand for sustainable packaging solutions could support market statistics.

MALAYSIA ADVANCED TECHNOLOGY ROADMAP FOR NANOCELLULOSE¹

Target by 2030

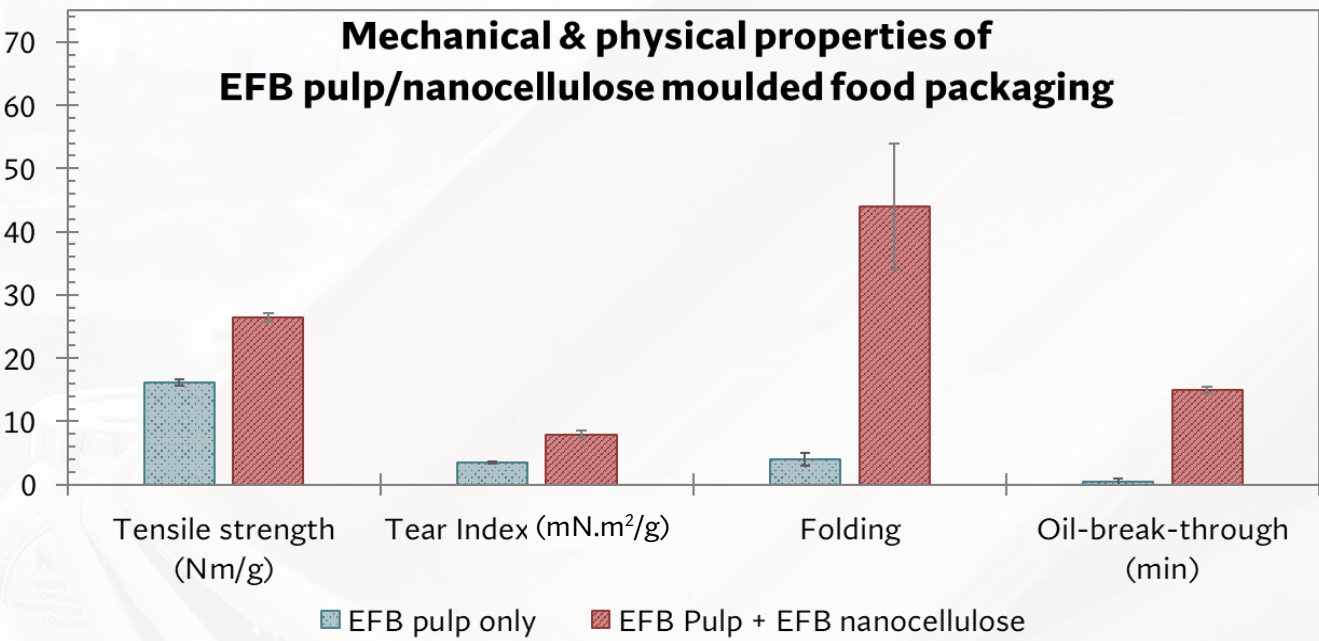
Investment
RM75
Million

Jobs created
500

Revenue **RM45** Million/annum

Source:
 1) Ministry of Science, Technology & Innovation (MOSTI), 2022. National Advanced Technology Roadmap 2021-2030. Putrajaya, Malaysia
 2) Global Market Insight (2022). *Nanocellulose Market Size & Share Forecasts, 2023 – 2032*. Delaware, USA.
 3) *Accenture Chemicals Global Consumer Sustainability Survey (2019)*. Accenture Newsroom. 4 June.

Sustainable Food Packaging Materials from EFB PULP & EFB NANOCELLULOSE

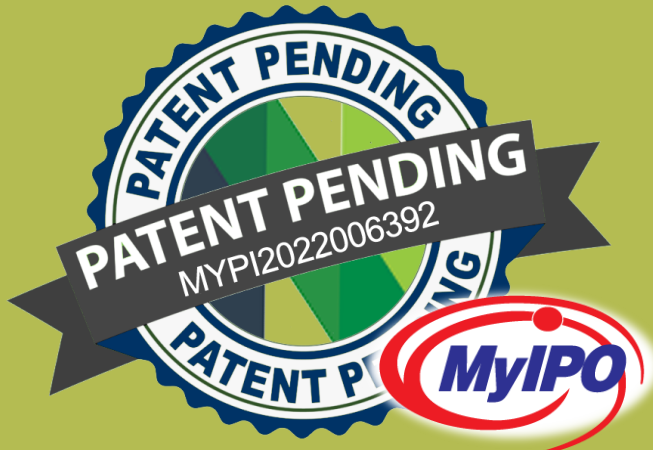


Funded by:  NEXTGREEN PULP & PAPER

In collaboration with:  UPM UNIVERSITI PUTRA MALAYSIA

NANOCELLULOSE IN EFB PULP

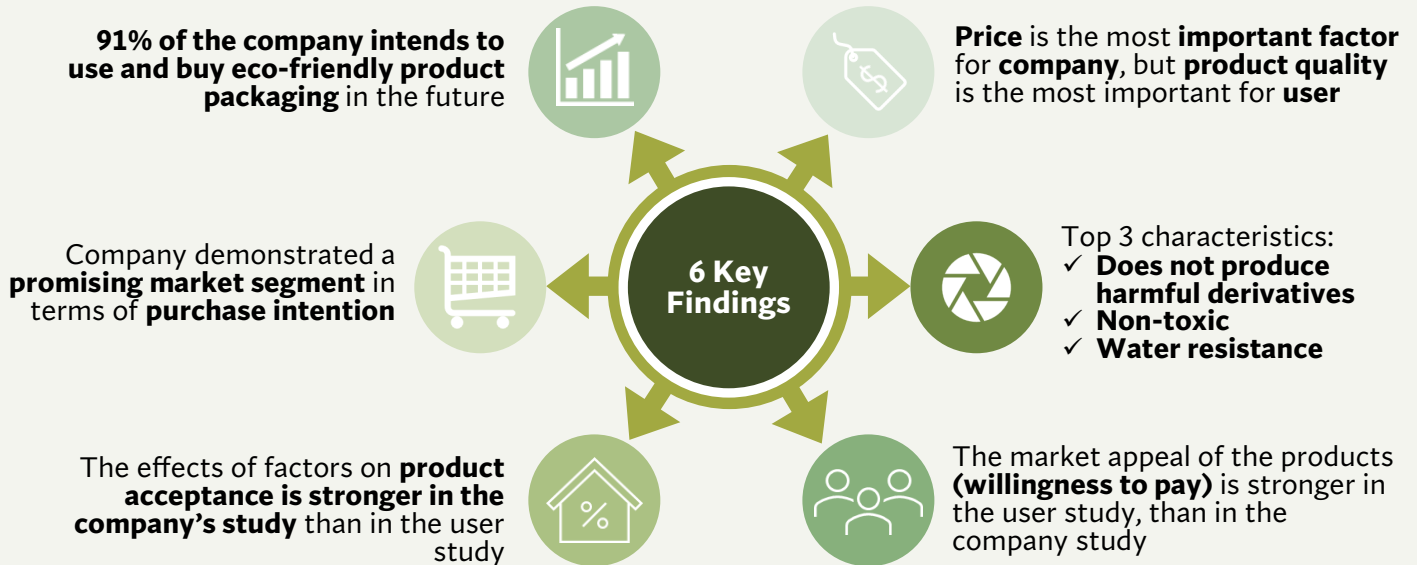
- 2x** higher tensile strength
- 2x** higher tear index
- 11x** higher folding capacity
- 30x** higher oil resistance



#zerowasteconcept #nanocellulose

PRODUCT ACCEPTANCE STUDY

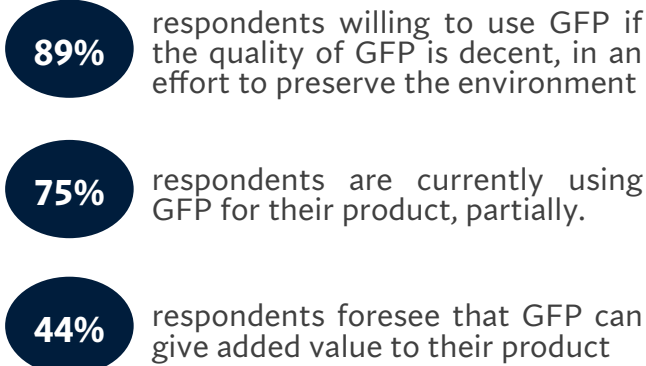
Objective: To investigate business operators' and consumers' perceptions on EFB pulp/nanocellulose food packaging



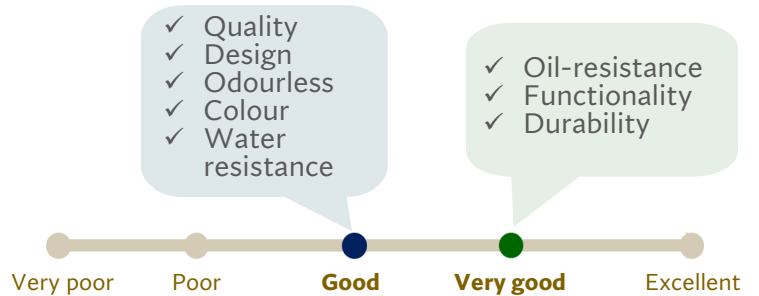
Note: Sample size: 100 companies & 30 users

MARKET TESTING STUDY

Objective: To identify customer's opinions on green food packaging (GFP)

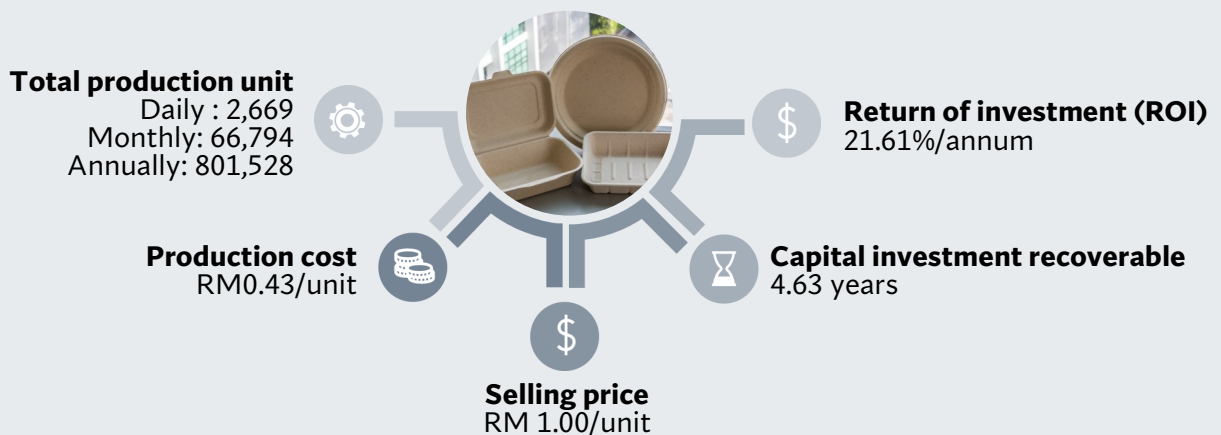


Respondent's feedback on the Nextgreen's EFB pulp/nanocellulose food packaging



PRODUCT FEASIBILITY STUDY

Objective: To identify the capital expenses (CAPEX), operating expenses (OPEX), and return on investment (ROI) of EFB pulp/nanocellulose food packaging



from **FACTORY** to **FIELD**

EFB Boiler Ash as Soil Conditioner for Bok Choy & Marigold Planting

Nur Sharmila SHARIP & Farhana AZIZ UJANG
 Research & Development Department, Nextgreen Pulp & Paper Sdn. Bhd.



Boiler ash
(from EFB)



Soil conditioner

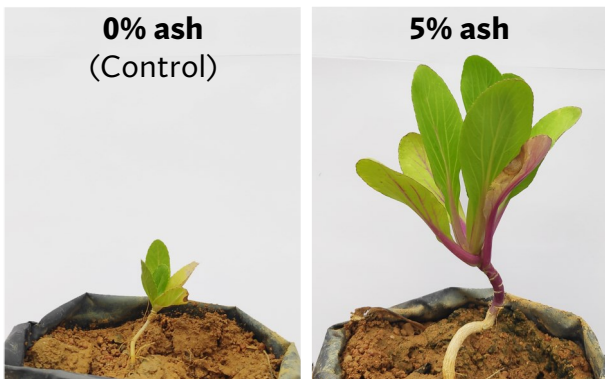
- Most mills dispose boiler ash at a landfill ¹
- Boiler ash contains **high alkalinity** and various **nutrient contents** that can be good for soil improvement and improving crop growth^{2,3,4}

- To **enhance the nutrient in soil** ^{5,6}
 - increase soil fertility
 - stabilise the soil by reducing acidity



Planting trials on vegetable and ornamental plants Incorporation of boiler ash in planting media (top soil)

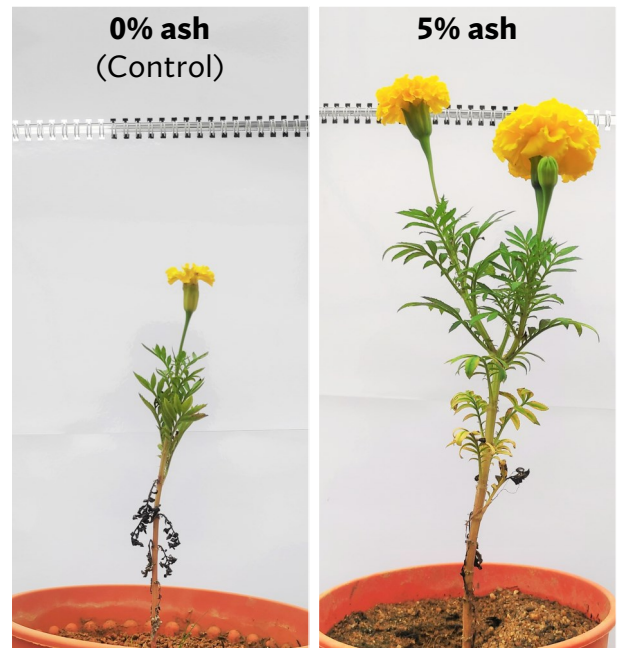
Bok Choy — *Brassica rapa* var. *chinensis*



Chemical composition of the planted bok choy **meet the requirements** of Food & Agriculture Organization (FAO) and World Health Organization (WHO)

No detection of **cadmium, lead, nickel, copper and zinc**. Iron contents are less than 425.5 mg/kg

African marigold — *Tagetes erecta*



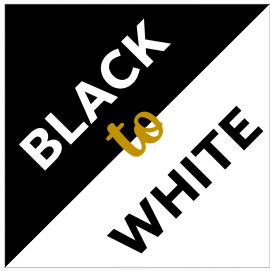
POTENTIAL OF EFB BOILER ASH AS A SOIL CONDITIONER FOR PLANT GROWTH



1.6x taller
2.1x leaves number
1.6x bigger canopy

Sources:

1. Lamers et al. (2018). *IEA Bioenergy*, 1–61.
2. Abdullah & Sulaiman (2013). *Journal of Physical Science*, 24(2), 117–137.
3. Anyaoha et al. (2018). *Resources, Conservation and Recycling*, 136, 399–409.
4. Zhang et al. (2018). *Journal of Cleaner Production*, 170, 379–387.
5. Cherian & Siddiqua (2019). *Sustainability*, 11(16), 4394.
6. Mahmood & Kamal (2022). *Waste Management*, 141, 282–289.



by the BLACK FILTER

Biochar & Activated Carbon for the Treatment of Boiler's Discharged Water

Tengku Arisyah Tengku YASIM-ANUAR & Hazwani HUSIN
Research & Development Department, Nextgreen Pulp & Paper Sdn. Bhd.



Boiler wet scrubber system

Issue:
Discharged water from the boiler system

Bad odour & dark colour due to concentrated impurities and/or contaminants



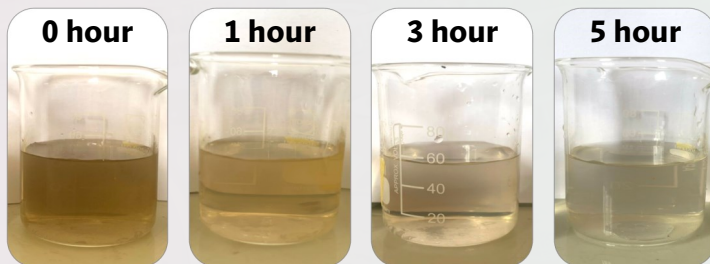
Solution:
Biochar & activated carbon as bioadsorbent

- Carbon-rich derived from biomass¹
- High surface area—effective in 'capturing' (adsorb) contaminants in water²



Biochar

Boiler water treatment by using activated carbon

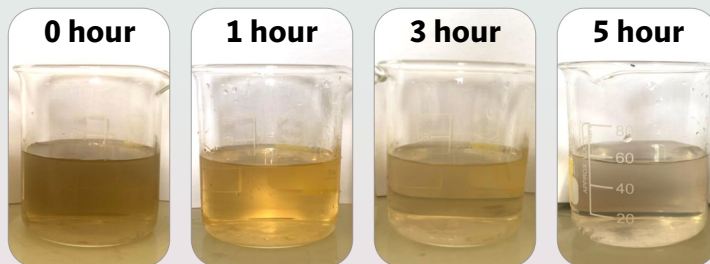


Dark brown colour

Light yellow (almost colourless)

51% to *82%
Particulates removal
(reduced in turbidity)

Boiler water treatment by using biochar



Dark brown colour

Light yellow (almost colourless)

33% to *58%
Particulates removal
(reduced in turbidity)

*24 hours treatment



Sources:

1. Tan et al. (2016). *Bioresource Technology*, 212, 318-333.
2. Ahmad & Azam (2019). *Bottled and Packaged Water* (Vol. 4), 83-120.

Research

PROJECTS & PARTNERS



MINISTRY OF SCIENCE, TECHNOLOGY & INNOVATION (MOSTI)

Nextgreen received RM3.3 million matching grant from 2019 until 2022 in liaison with government effort to enhance and expedite the commercialisation of research and development findings. This also acknowledge Nextgreen as the entity with capacity and expertise to further improve the new technology for development of sustainable food packaging from oil palm empty fruit bunch (EFB) cellulosic fibre extracted using Nextgreen's patented technology.



UNIVERSITI PUTRA MALAYSIA (UPM)

Nextgreen collaborates with UPM to utilise the EFB treated by Nextgreen's hybrid technology called Preconditioning Refiner Chemical-Recycle Bleached Mechanised Pulp (PRC-RBMP) as a main raw material for the development of sustainable food packaging. This collaboration also aims to maximise the potential of nanocellulose as an advanced nanomaterials, which also made from EFB to enhance the mechanical and water barrier properties of EFB-based food packaging.

Nextgreen also participates UPM CEO@PTJ Programme that brings together CEOs (Chief Executive Officers) and local/international industry leaders to share their knowledge and experience with students and the university community.

In Nextgreen's effort to create and support local talents as industry-relevant leaders and experts, the company offers industrial training opportunities and Awards of Excellence for bright and high-achieving UPM students in the Department of Bioprocess Technology, Faculty of Biotechnology and Biomolecular of Sciences, UPM.

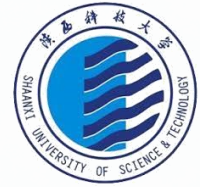


UNIVERSITI TEKNOLOGI MARA (UiTM)

Nextgreen in collaboration with UiTM has identified the potential of kenaf bast and kenaf core as filler for the pulp and paper. The goal of this project is to produce EFB/kenaf-based papers using green technology.

SHAANXI UNIVERSITY OF SCIENCE & TECHNOLOGY CHINA (SUST)

Nextgreen is working with a group of SUST researchers to develop an environmentally and industrially-friendly process to extract lignin from black liquor, which will then be used to produce bio-adhesives.



UNIVERSITI MALAYSIA PAHANG (UMP)

Nextgreen and UMP committed to collaborate in areas such as industrial training, matching funds, tree replanting projects, and industry talks. Additionally, Nextgreen offers scholarships to qualified UMP students for their study.



FOREST RESEARCH INSTITUTE MALAYSIA (FRIM)

Nextgreen is collaborating with FRIM to develop a Certification Module for Sustainable Green Paper From Oil Palm Empty Fruit Bunches (EFB).



INSTITUT KEMAHIRAN BELIA NEGARA (IKBN)

As a technical institution, IKBN has trained numbers of skilled and competent personnel in liaison with the Technical and Vocational Educational Training (TVET) Programme by the Ministry of Education Malaysia. In this context, Nextgreen has developed partnership with IKBN, Pekan, Pahang to create a future-ready workforce that will be skilled in plant operation, maintenance and manufacturing.



PAHANG SKILLS DEVELOPMENT CENTRE (PSDC)

Nextgreen is committed towards developing employees competencies and training provision through collaboration with PSDC.



Total R&D *Expenditure*

RM4.5 million

Research

EVENTS & AFFAIRS

January

12th January 2022
Biodegradable
moulded food packaging
Social Return of
Investment (SROI)
survey



February

10th February 2022
NGPP visit to Universiti
Teknologi MARA (UiTM)
Pahang for NGPP-UiTM
collaboration project



16th – 17th February &
8th – 9th March 2022
Pulp moulding
machinery training for
NGPP-MOSTI-UPM
collaboration project



March

3rd March 2022
Universiti Malaysia Sabah
(UMS) and SIRIM visit to
GTP





21st March – 12th June &
28th March – 1st July 2022
UPM & UiTM
industrial training

21st March 2022
Memorandum of
Agreement (MoA)
exchange ceremony
between NGPP and UiTM
for EFB/Kenaf
collaboration project



April



1st April 2022
Moulded packaging
production training for
NGPP-MOSTI-UPM
collaboration project

29th April 2022 –
31st January 2023
R&D internal project—
EFB boiler ash as
soil conditioner for
bok choy & marigold
planting



29th April 2022 –
31st January 2023
R&D internal project –
Water treatment using
activated carbon &
biochar

May

9th – 11th May 2022
R&D internal workshop—
Scientific writing and
file management



17th May 2022
Pahang Skills
Development Centre
(PSDC) visit to GTP



27th May 2022
NGPP visit to
Pahang Skills
Development Centre
(PSDC)



June

30th June 2022
NGPP-UiTM Transfer of
Technology Workshop



July

25th – 28th July 2022
NGPP-UPM Transfer of
Technology Workshop



August



4th August 2022
Social Return of
Investment (SROI)
Workshop by UPM

5th August 2022
Biodegradable
moulded food packaging
market testing at
MAHA 2022



September

5th & 15th Sept 2022
MOSTI interim audit for
NGPP-MOSTI-UPM
collaboration project



6th September 2022
FRIM visit to GTP

October

12th – 14th October 2022
Biodegradable
moulded food packaging
market testing at
IGEM 2022



November

17th November 2022
Commercial document
exchange between
Nextgreen and FRIM for
EFB Green -Paper
Certificate Module



December

27th December 2022
Faculty of Biotechnology
UPM academic
visit to GTP



Throughout the year




Biodegradable
moulded food
packaging
production


United Nations (UN) International Days

Nextgreen's R&D department shows support in the UN International Days through LinkedIn posts to spread awareness and educate the general public on relevant issues of concern, to address global problems, and to celebrate and reinforce achievements of humanity.


April 26, 2022

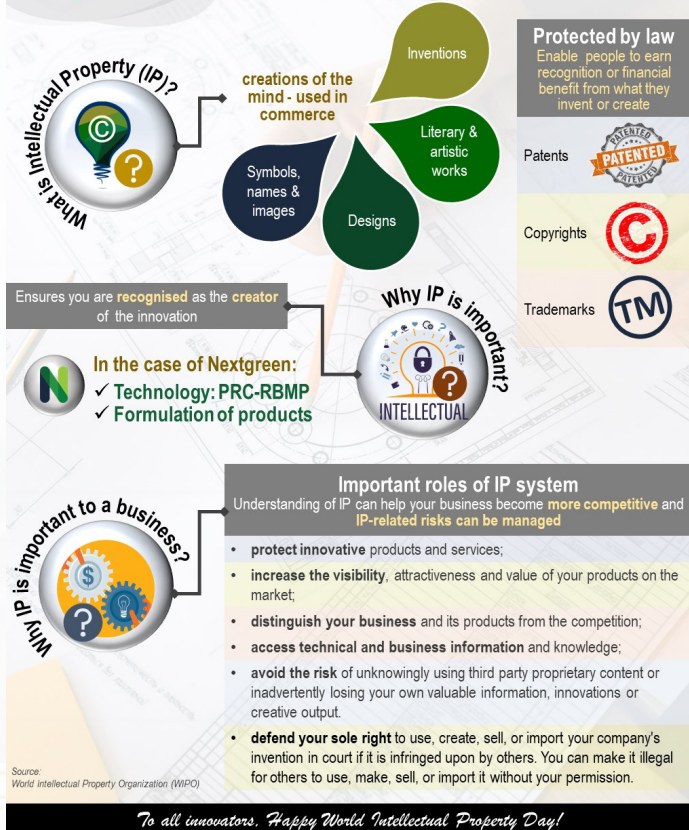


World Intellectual Property Day



Nextgreen Pulp & Paper
901 followers
6mo • 🌐





What is Intellectual Property (IP)?
creations of the mind - used in commerce
Inventions, Literary & artistic works, Designs, Symbols, names & images

Protected by law
Enable people to earn recognition or financial benefit from what they invent or create
Patents, Copyrights, Trademarks

Why IP is important?
Ensures you are recognised as the creator of the innovation
In the case of Nextgreen:
✓ Technology: PRC-RBMP
✓ Formulation of products

Why IP is important to a business?
Important roles of IP system
Understanding of IP can help your business become more competitive and IP-related risks can be managed

- protect innovative products and services;
- increase the visibility, attractiveness and value of your products on the market;
- distinguish your business and its products from the competition;
- access technical and business information and knowledge;
- avoid the risk of unknowingly using third party proprietary content or inadvertently losing your own valuable information, innovations or creative output.
- defend your sole right to use, create, sell, or import your company's invention in court if it is infringed upon by others. You can make it illegal for others to use, make, sell, or import it without your permission.

Source: World Intellectual Property Organization (WIPO)

To all innovators, Happy World Intellectual Property Day!

Inspiring Change on World Intellectual Property Day

For businesses, the protection of tangible assets can add great value to their creative endeavours as well as R&D efforts.

As a research-focused green tech corporation, Nextgreen strongly subscribes to the belief that intellectual property (IP) plays a significant role in stimulating innovation and creativity.

Our exclusive patent, the Pre-Conditioning Refiner Chemical Recycled Bleached Mechanised Pulp (PRC-RBMP), for instance, was the result of 20 years of extensive R&D to become the basis of Nextgreen's oil palm biomass-based paper and packaging manufacturing. The technology also ensures the quality of raw materials for renewable energy production.

Awareness of IP rights is not only crucial for inventors, designers and creators, it helps entrepreneurs achieve their goals to generate income, support the creation of jobs, and to solve local and global environmental challenges.

Nextgreen takes this opportunity to wish all innovators a happy and inspired World IP Day.

[#Nextgreen](#) [#WorldIPDay](#) [#intellectualproperty](#) [#innovation](#) [#creativity](#)

May 22, 2022



International Day for Biological Diversity
"Building a shared future for all life"



Nextgreen Pulp & Paper
901 followers
5mo • 🌐





Biodiversity remains the solution to a number of long-term development issues. From nature-based solutions to climate, health, food and water security, and sustainable livelihoods, biodiversity is the foundation on which we can rebuild better.

Our planet's life fabric is biodiversity. It is essential to human well-being now and in the future, and its rapid depletion endangers both nature and people.

At Nextgreen Global Berhad, we are committed in preserving biodiversity by implementing green technology and zero waste concept throughout our operations, aiming to lead the world towards a higher level of environmental awareness and sustainability.

"Biodiversity is the foundation upon which we can build a shared future for all life and achieved sustainable development."
-Elizabeth M. Mrema, Executive Secretary of Convention on Biological Diversity-

May 22, 2022
International Day for Biological Diversity

A Strong Fabric of Life

Earth suffers continued assault by human development activities, which result in a rapid decrease in biological diversity. This only brings more harm to our climate, health, wellbeing, and endangers our sources of food, water and livelihoods. Biodiversity is a key solution.

Nextgreen Global Berhad is committed to preserving biodiversity by exploring nature-based solutions and planning long term environmental strategies through implementing green technology and zero waste concepts in all our operations.

Let's celebrate the important role of biodiversity in sustaining socioeconomic progress, and do our utmost to ensure all forms of life on earth are part of the strong and precious fabric we weave for the future.

Happy International Day for Biological Diversity.

[#ForNature](#) [#biodiversity](#) [#Nextgreen](#) [#naturebasedsolutions](#) [#greentechnology](#) [#zerowaste](#)

Meet the Team

RESEARCH & DEVELOPMENT (R&D) DEPARTMENT



R&D Senior Executive
B. (Hons.) Bioindustrial Science
Ph.D. (Materials Science)

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R&D Executive
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M. Sc. Environmental Biotechnology
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M. Sc. Environmental Biotechnology

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R&D PLANNING FOR 2023



Pre-commercialisation of the biodegradable oil palm empty fruit bunch (EFB)-nanocellulose moulded food packaging

Biodiversity ecosystem study in Green Technology Park, Pekan, Pahang.



R&D products exhibition and presentation in local or international conference and/or competition.

Intellectual properties application and R&D products carbon footprint evaluation





R&D ANNUAL REPORT 2022

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