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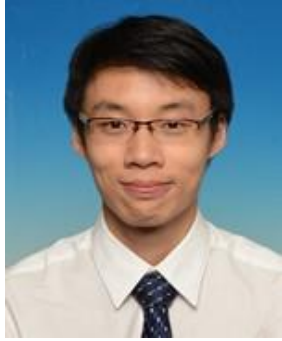

Current technological development and future prospects of palm oil industry in Malaysia

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Presentation Outline

- Introduction
- Current status
- Challenges
- Future prospects
- Conclusions

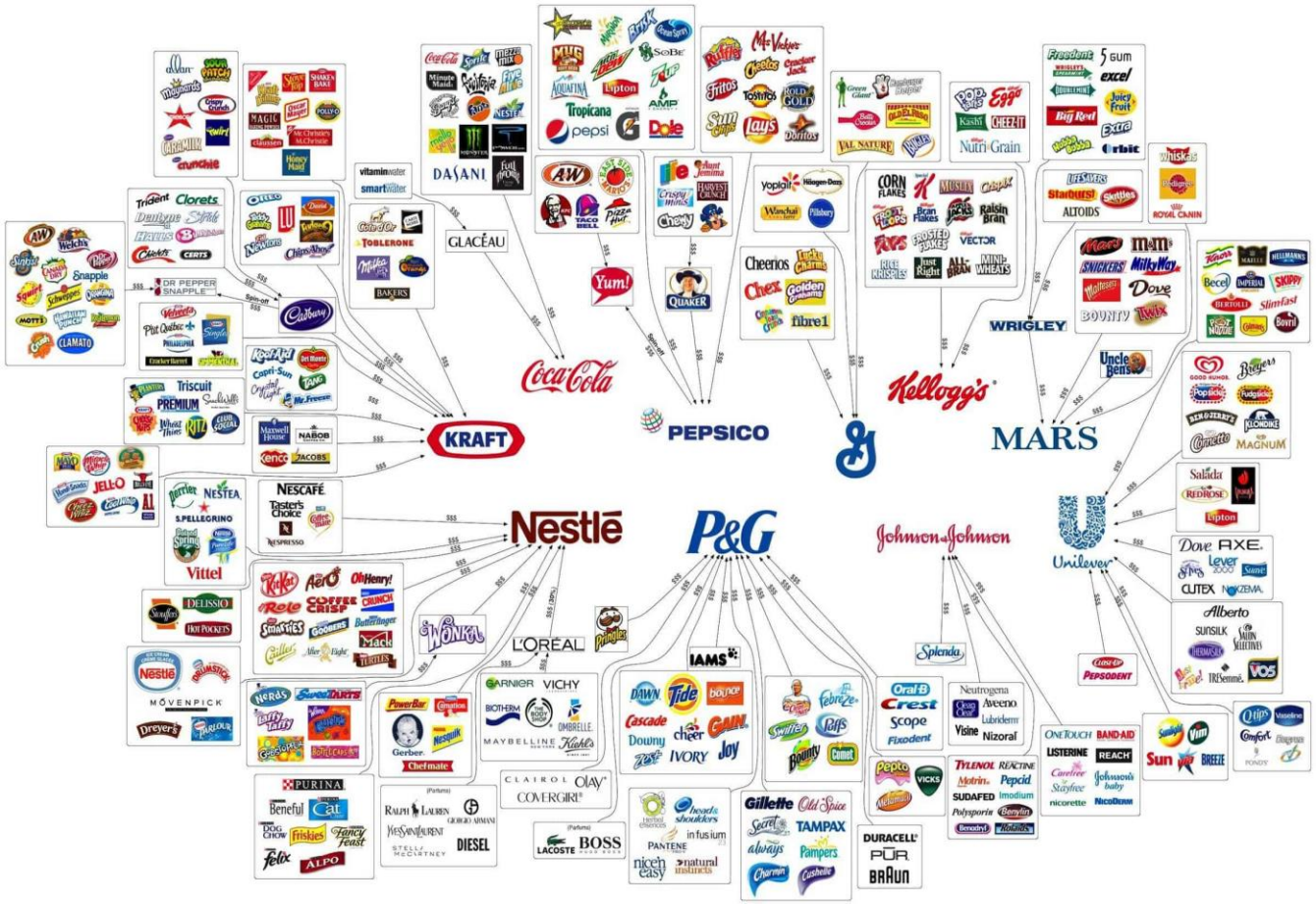
Why Palm Oil?

One of the highest productivity and most popular oils worldwide, accounting for one-third of global plant oil production

Oil palm crops globally produce an annual 81 Mt of oil from about 19 Mha. In contrast, the second and third largest vegetable oil crops, soybean and rapeseed, yield a combined 84 Mt oil but occupy over 163 Mha.

Ref: Murphy DJ, Goggin KA, Patterson R (2021) Oil palm crops in the 2020s and beyond: challenges and solutions

Palm Oil-based Products



More than half of the world's population in 150 countries use products containing palm oil.

Palm Oil-based Products

Identification

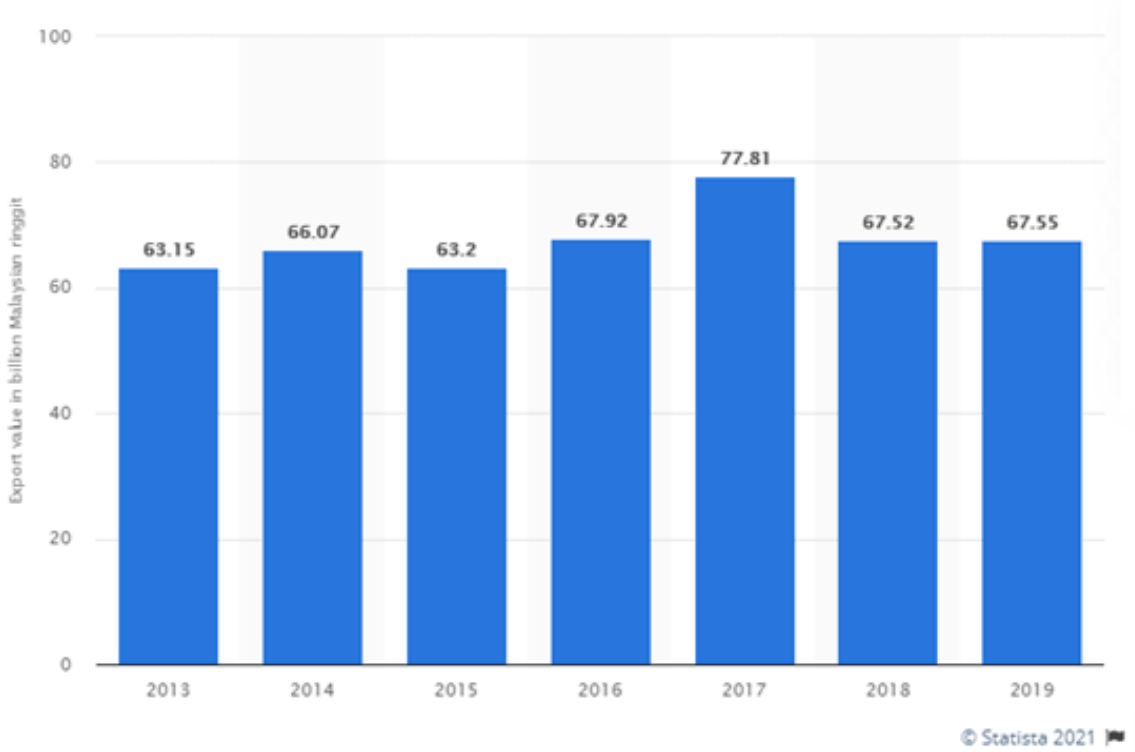
Palm Oil Industry in Malaysia

Palm oil contribution to key economic indicators in 2013.

	Malaysia	Indonesia
Total production, KPO (million tons)	2.3	5.5
Total production, CPO (million tons)	19.2	27.8
Total exports, CPO (million USD)	2.99	4.98
Total exports, palm oil fractions (million USD)	10.08	13.56
No. of jobs in the palm oil sector (millions)	0.44	3.72
No. of smallholders in the palm oil sector (millions)	0.68	1.46
Total GDP (million USD)	310,616	793,728
Agricultural GDP (million USD)	28,278	106,254
Palm oil sector GDP (million USD)	11,756	14,279
Agricultural GDP / Total GDP (in %)	9.1	13.4
Palm oil sector GDP (million USD) (in %)	3.8	1.8

Sources: Malaysia: Department of Statistics Malaysia (2015), ITC (2016). Indonesia: Central Statistical Agency (2015), Ministry of Agriculture (2015), and ITC (2016). The year 2013 was selected since it is the last year for which official statistics in both Malaysia and Indonesia are considered final. Assumed exchange rate is MYR 3.28 per USD for Malaysia and IDR 12,000 per USD for Indonesia.

Export value of palm oil and palm-based products from Malaysia from 2013 to 2019 (in billion Malaysian ringgit)

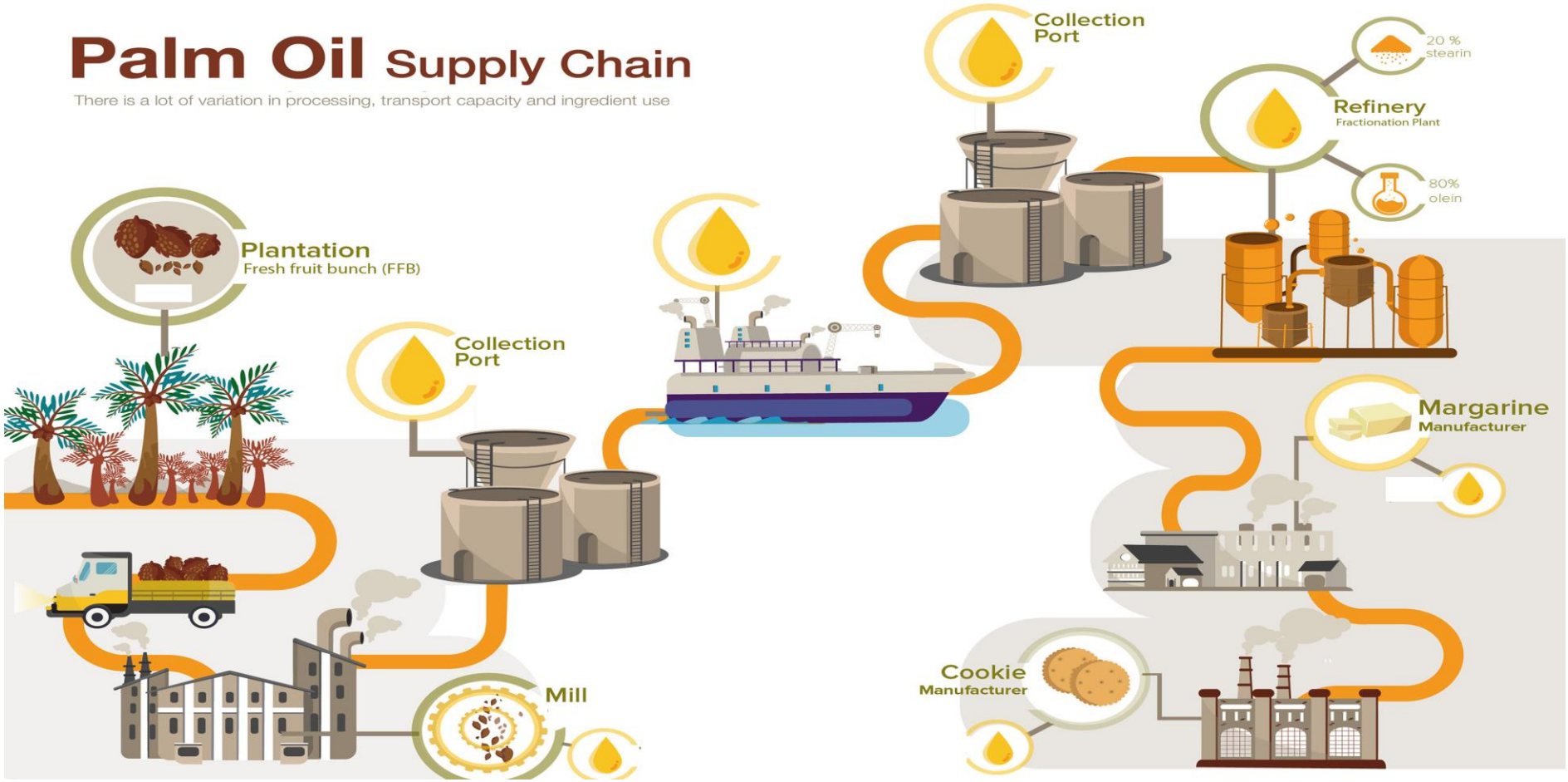


Palm oil accounts for around 13.7% of Malaysia's gross national income in 2019. (The Guardian, 2020)

In Indonesia and Malaysia, more than 4.5 million people earn their living from palm oil production.

Current Status

Ensuring sustainable processing and fair practice at every stage of the supply chain

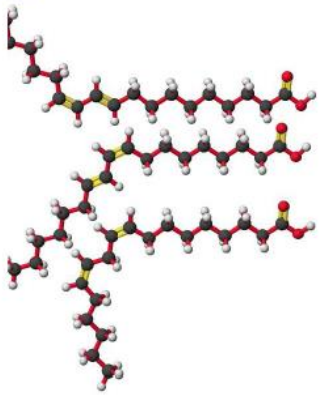


Current Status

Product diversification plays an important role

VEG. OILS → **BASIC OLEOCHEMICAL** → **DOWNSTREAM OLEOCHEMICALS**

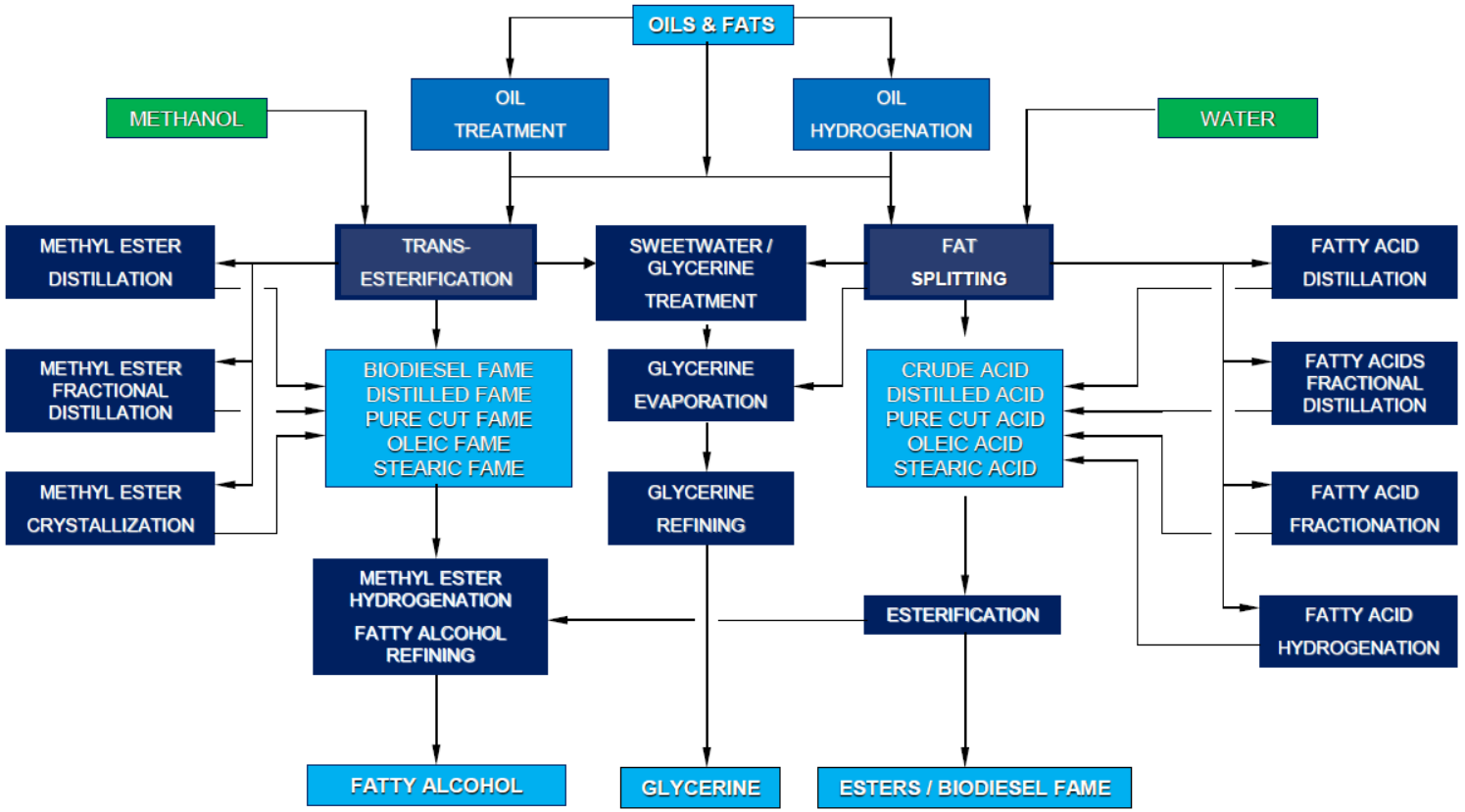
- Fatty Acids
- Fatty Alcohols
- Glycerine
- Esters



- Detergents
- Cosmetics
- Textile
- Plastics
- Pharmaceuticals
- Lubricants
- Food/feed
- Paint
- Rubber
- Propylene glycol
- Epychlorohydrin
- Green Methanol
- Etc…

Current Status

MAIN PROCESSING ROUTES FOR BASIC OLEOCHEMICALS



Challenges

- **Land availability and sustainable land use change**
- **Shortage and expensive labour**
- **Climate change**
- **Cost**
- **Product safety**
- **Customer demand and sentiment**

Challenges

Land availability and sustainable land use change

Challenges

Shortage and expensive labour with unfair practise

Challenges

Climate change and plant disease

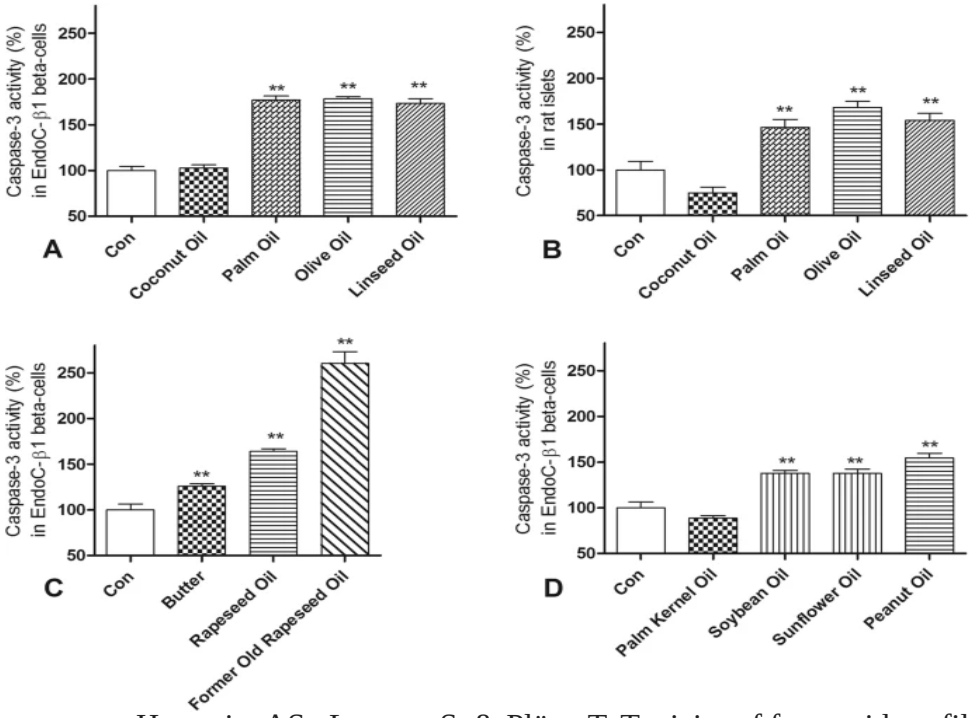
Challenges

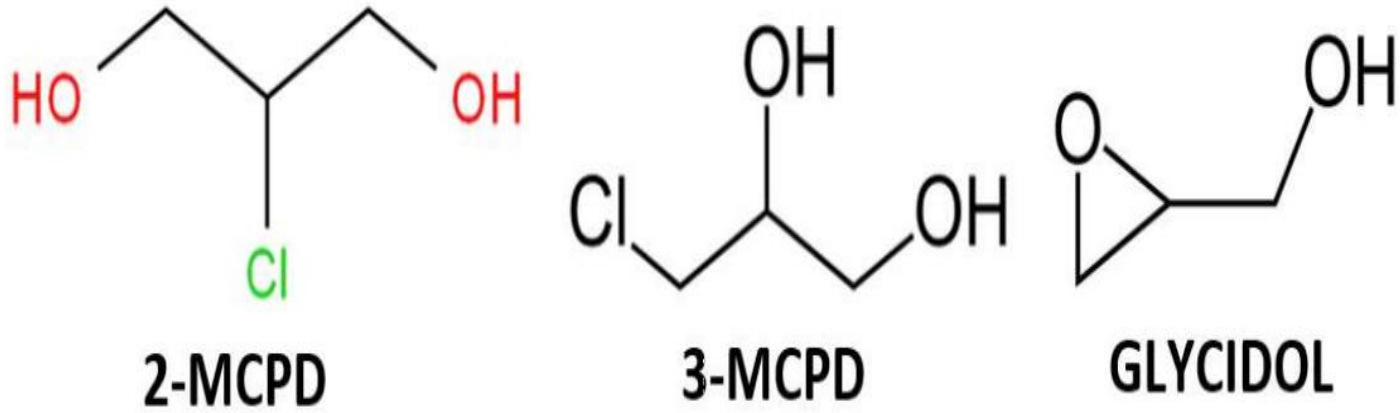
Certification on Sustainable Palm Oil (CSPO) and rising cost

Challenges

Product safety

Toxicity of different FFA compositions mimicking popular edible plant oils and butter as well as selected mixtures of them in human EndoC-βH1 beta-cells and rat islets.





Glycidyl fatty acid esters (GE), 3-monochloropropanediol (3-MCPD), and 2-monochloropropanediol (2-MCPD)

Source: von Hanstein, AS., Lenzen, S. & Plötz, T. Toxicity of fatty acid profiles of popular edible oils in human EndoC-βH1 beta-cells. *Nutr. Diabetes* **10,** 5 (2020). https://doi.org/10.1038/s41387-020-0108-7

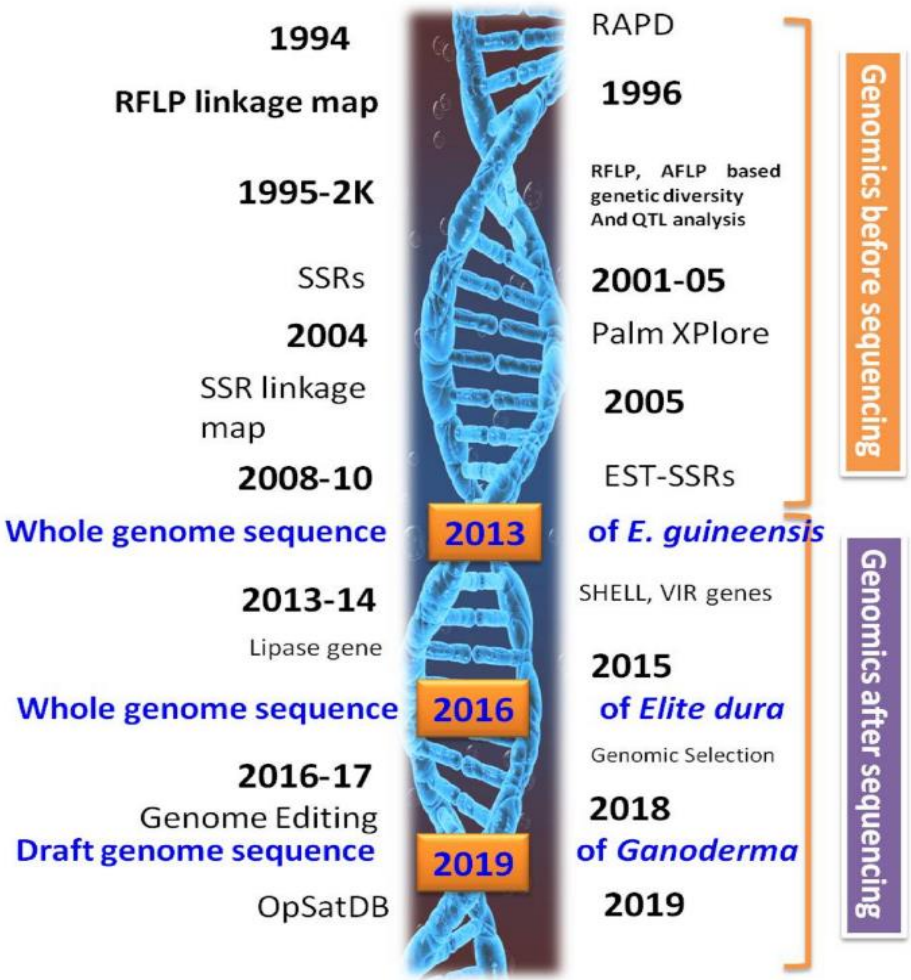
Challenges

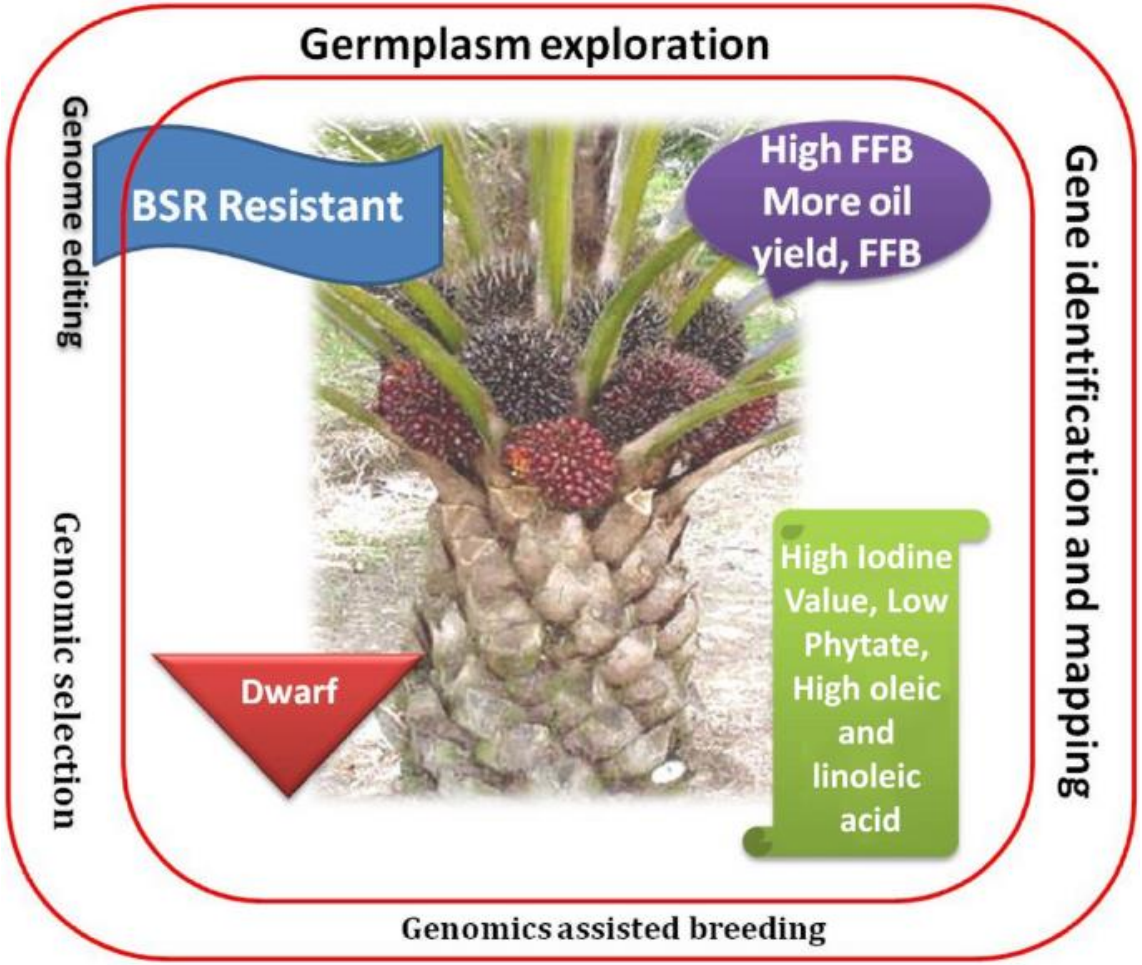
Customer demand and sentiment

Future Prospects

- **Genetic Engineering**
- **Robotics and Mechanization**
- **IOT and Digitalization**
- **Optimization in Processing and Refining**
- **Marketing and Social Media**

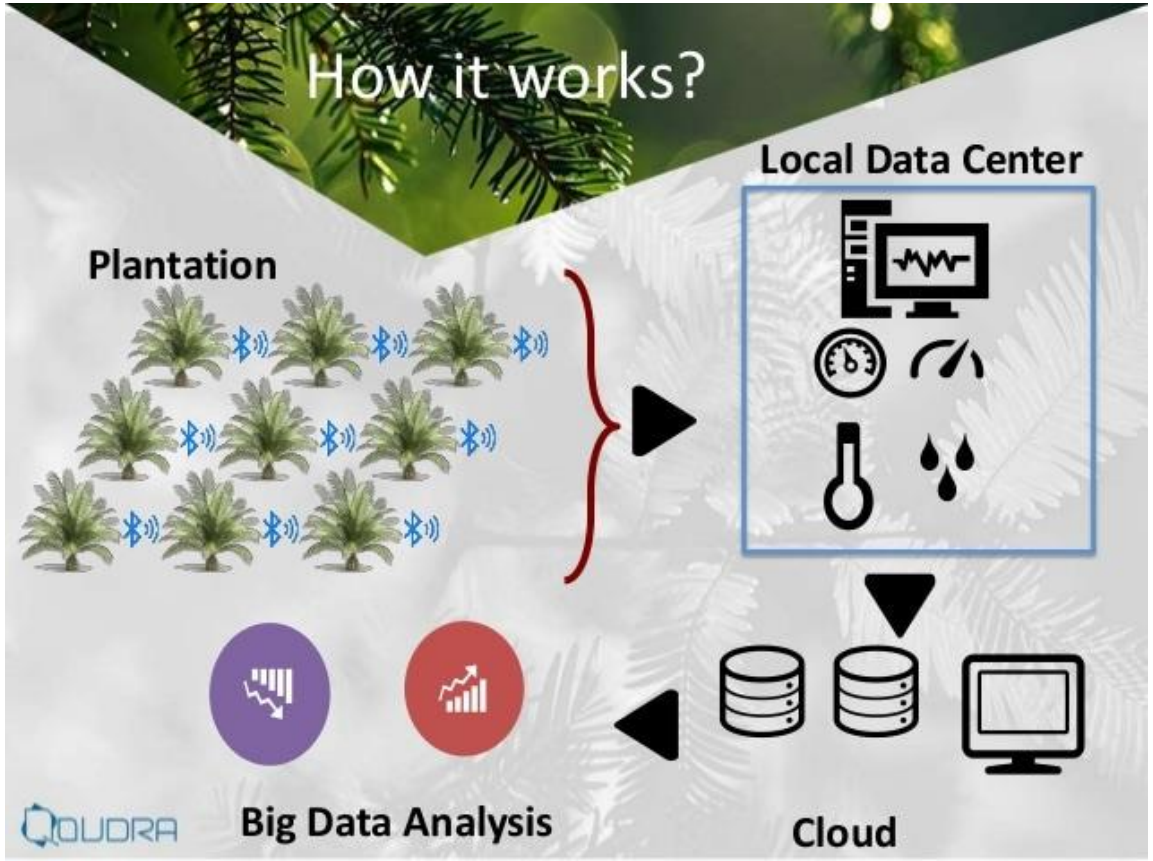
Genetic Engineering



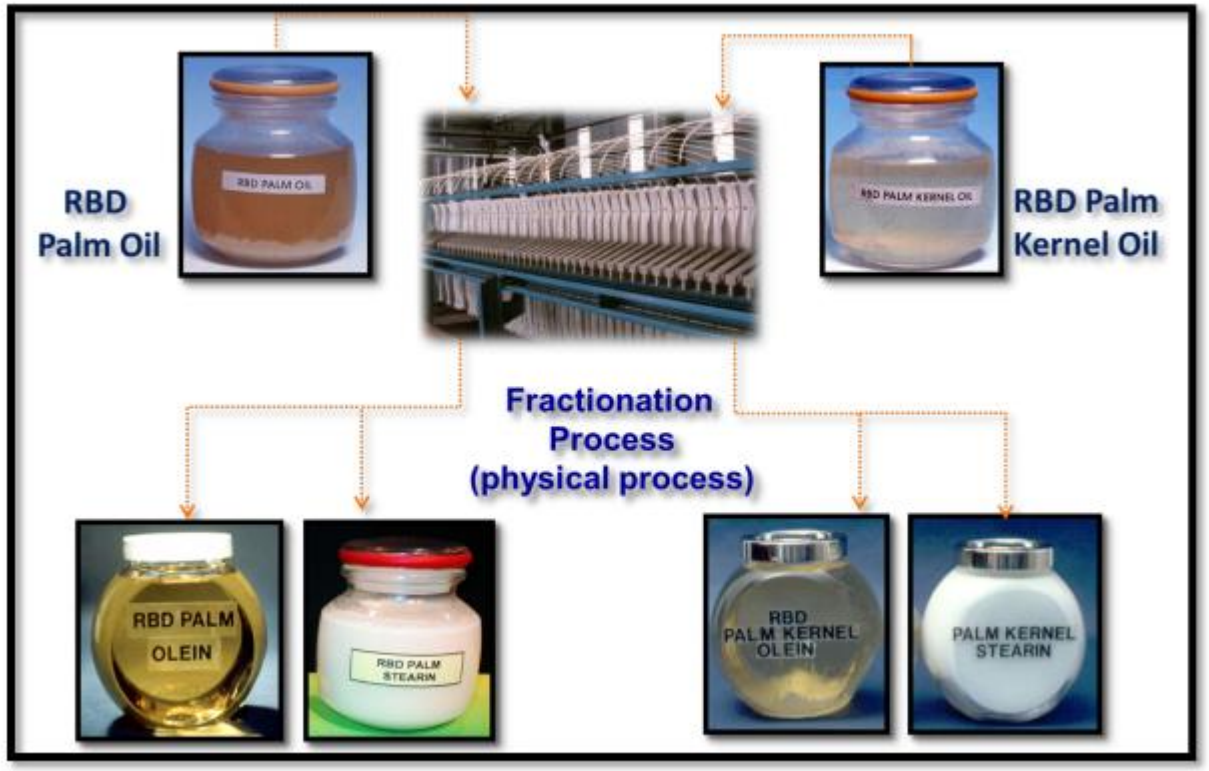


Robotics and Mechanization

IOT and Digitalization



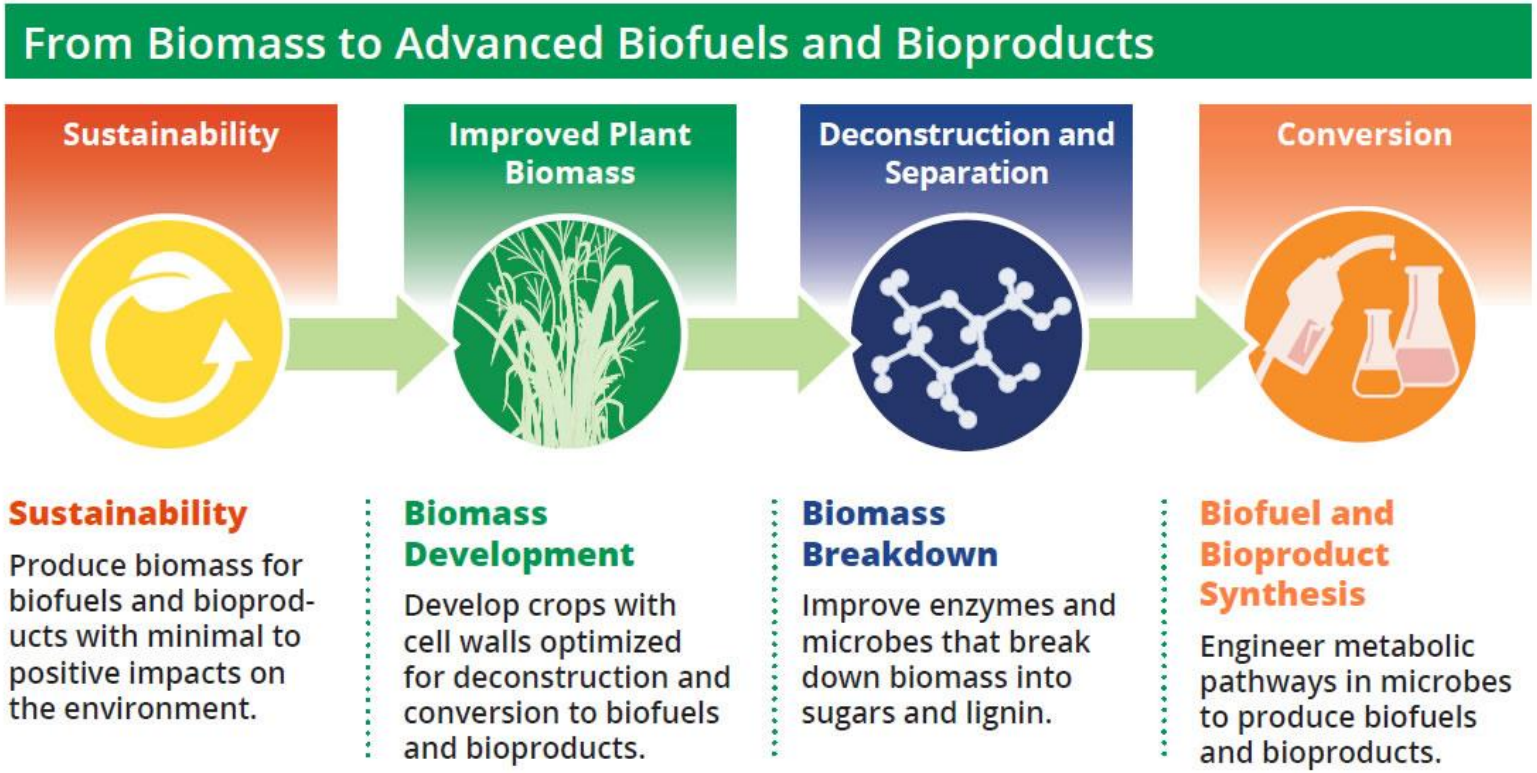
Optimization in Processing and Refining



Palm oil fractionation process

Marketing and Social Media

My Research

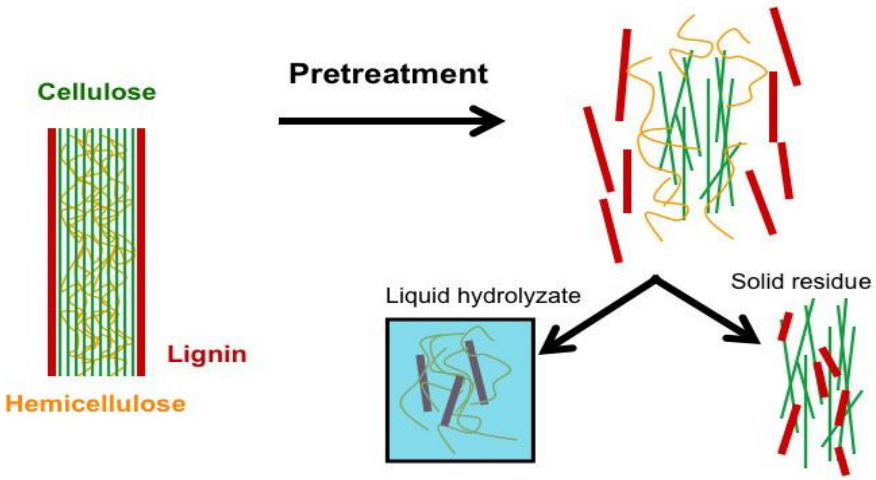

From Biomass to Advanced Biofuels and Bioproducts
Sustainability
Improved Plant Biomass
Deconstruction and Separation
Conversion
Sustainability
Produce biomass for biofuels and bioproducts with minimal to positive impacts on the environment.
Biomass Development
Develop crops with cell walls optimized for deconstruction and conversion to biofuels and bioproducts.
Biomass Breakdown
Improve enzymes and microbes that break down biomass into sugars and lignin.
Biofuel and Bioproduct Synthesis
Engineer metabolic pathways in microbes to produce biofuels and bioproducts.

Synthesis of Solid Catalyst from Biomass for Biodiesel Production

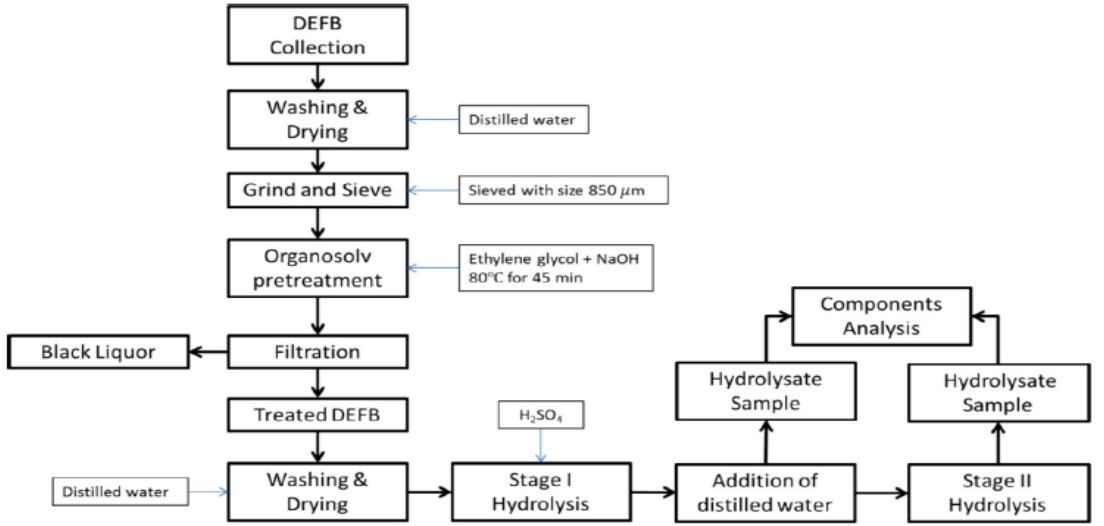
- Synthesizing of various biomass catalysts
- Easily separable, green, renewable and biodegradable
- Corncob, empty fruit bunch, palm oil fronds, wood sawdust, papaya seed, sugarcane bagasse, Monk fruit, banana peel, rubber seed etc.
- Different benign and facile **sulphonation methods** including sulphonation by reduction and arylation (4-benzenediazonium sulfonate), ferric sulfate aqueous and thermal decomposition of ammonium sulfate
- Applied for **transesterification, esterification and interesterification**

Organosolv Pretreatment

- Pretreatment with organic solvent and water with or without catalyst (acid/base)
- **Biothermochemical pathway** to isolate lignocellulosic components
- Solvents : ethanol, methanol, 1-pentanol, glycerol, ethylene glycol and acetic acid
- Advantages
  - High purity of products
  - Recoverable solvent
  - Lower operating cost



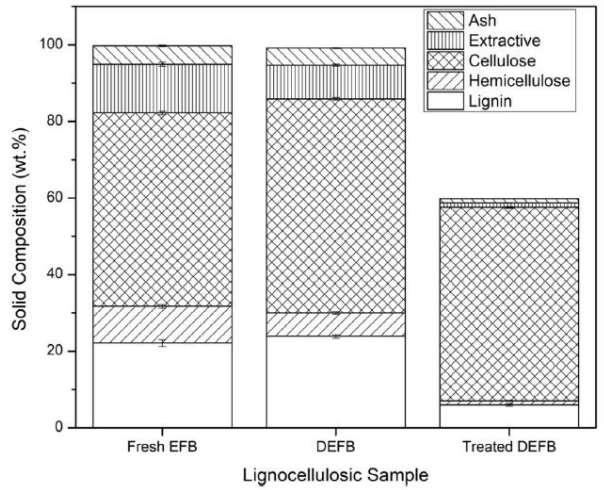
Extraction of Cellulose



Experimental flow diagram of two-staged acid hydrolysis

Pennisetum Purpureum (Napier Grass)

Empty Fruit Bunch (EFB)



Lignocellulosic composition

List of Publications

- Wong, W.Y., Lim, S., Pang, Y.L., Shuit, S.H., Chen, W.H., Lee, K.T. Synthesis of renewable heterogeneous acid catalyst from oil palm empty fruit bunch for glycerol-free biodiesel production. Science of The Total Environment, (2020), 727, 138534.
- Chin, D.W.K., Lim, S., Pang, Y.L., Lim, C.H., Lee, K.M. Dataset of alkaline ethylene glycol pretreatment and two-staged acid hydrolysis using oil palm empty fruit bunch. Data in brief, (2020), 30, 105431.
- Lim, S., Yap, C.Y., Pang, Y.L., Wong, K.H. Biodiesel synthesis from oil palm empty fruit bunch biochar derived heterogeneous solid catalyst using 4-benzenediazonium sulfonate. Journal of Hazardous Materials, (2020), 390,121532.
- Lim, S., Pang, Y.L., Shuit, S.H., Wong, K.H., Leong, C.K. Synthesis and characterization of monk fruit seed (Siraitia grosvenorii)-based heterogeneous acid catalyst for biodiesel production through esterification process. International Journal of Energy Research, (2020)
- Chin, D.W.K., Lim, S., Pang, Y.L., Lim, C.H. and Lee, K.M. Two-staged acid hydrolysis on ethylene glycol pretreated degraded oil palm empty fruit bunch for sugar based substrate recovery. Bioresource Technology, 292 (2019), 121967.

Conclusions

- Palm oil industry still has an important role to play in this century
- It needs to implement the correct strategy, improvements and traceability
- Requires the coordination and cooperation from all the relevant stakeholders
- Counter the allegations with facts and proven scientific findings

Thank you! Q&A?

For further enquiry and research collaborations:
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