

# Revolution of Enzymatic Technologies in Palm Oil Industry

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# Presentation Outline

- 1 Introduction to Enzymes
- 2 Enzymes in Industrial Processes
- 3 Enzymatic Technologies in Palm Oil Industry
- 4 The Way Forward and Conclusion

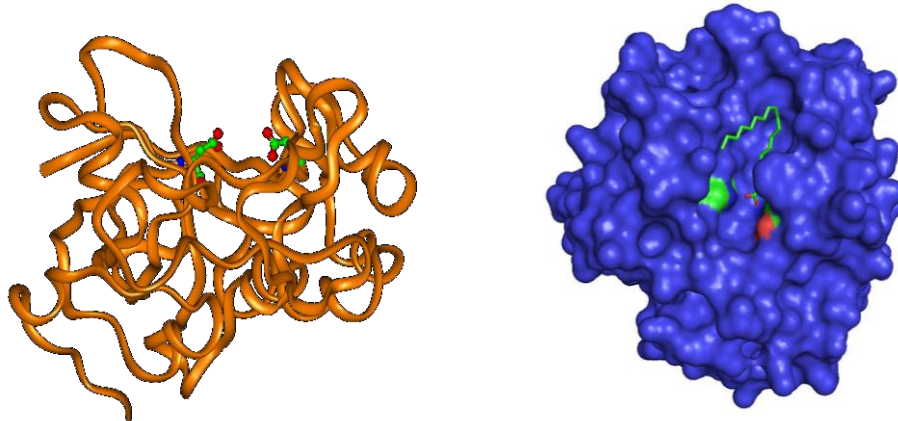
# What's Next

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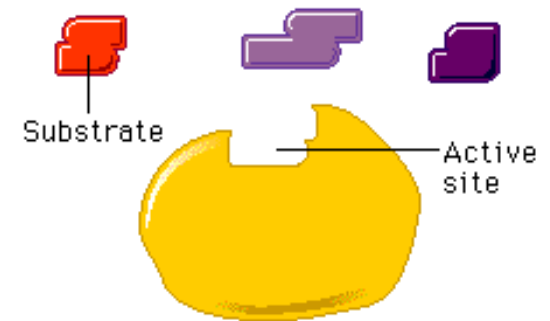
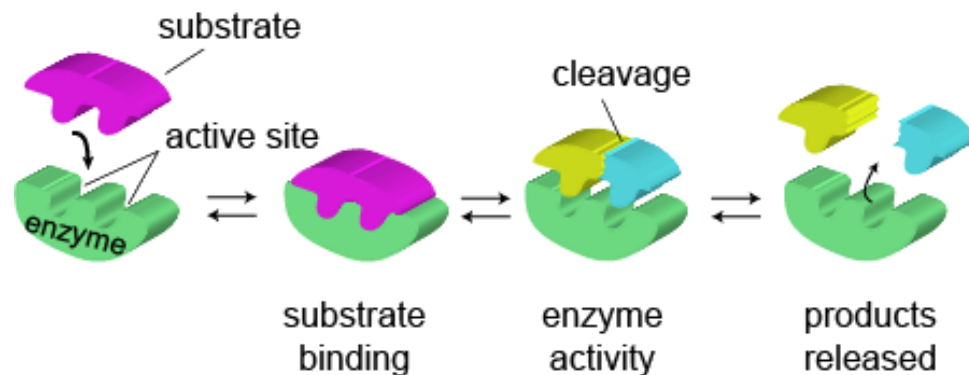
# What Are Enzymes?

- Enzymes are biological catalyst in the form of **proteins** that catalyze chemical reactions in the cells of living organisms.
- The first use of enzymes occurred more than 5,000 years ago, when people use enzymes turn milk into cheese.
- Enzymes are a renewable resource and **biodegradable**, and will keep on working until they are dissolved, usually by other enzymes or microorganisms found in nature.



# What Are Enzymes?

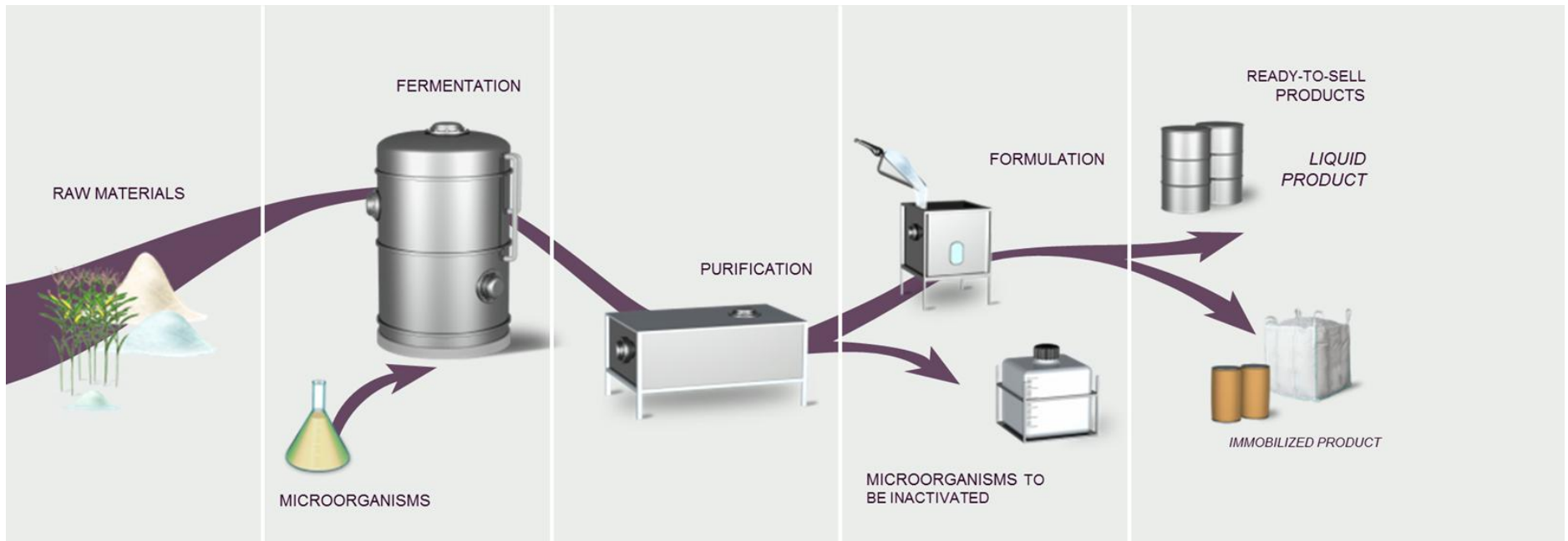
- Enzymes have one function only, and work like a key that fits in a lock.
- Only when the right enzyme finds the right material it can work upon, does a biochemical reaction occur.



- The precise correlation means we never have to worry about side effects when enzymes are added to an industrial process.

# Industrial Enzyme Production

- Industrial enzymes are produced using a process called submerged fermentation.
- Selected microorganisms is grown in closed vessels containing nutrients and oxygen.
- As the microorganisms break down the nutrients, they produce the desired enzyme.



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# Why Use Enzymes in Industrial Processes?

- Many chemical transformation processes used in various industries have inherent drawbacks from a commercial and environmental point of view.
- These drawbacks can be eliminated by using enzymes. Why?
  - a) Enzyme reactions often carry out under **mild conditions**
  - b) Enzymes are highly **specific**
  - c) Enzymatic process involve **high reaction rates**
- ... small amounts of enzymes are needed in order to carry out chemical reactions, reduce environmental impacts by reducing the consumptions of chemicals, water and energy, and the subsequent generation of hazardous waste ...



# Enzyme Application in Industries



## Household Care

- Laundry
- Dish wash
- Cleaning solutions



## Food & Beverages

- Baking
- Brewing
- Distilling
- Health & Nutrition
- Oil & Fats
- Wine
- Juice



## Micro-Organisms

- BioAg
- Wastewater treatment



## Bioenergy

- Starch-based ethanol
- Cellulosic ethanol
- Biodiesel



## Technical Industries

- Animal nutrition
- Textiles
- Leather
- Pulp & Paper



## Biopharmaceuticals

- Cell culture ingredients
- Hyaluronic acid

# A Big Difference in Household Care Industry



## In The Past

- Water temperature near 100°C
- High alkalinity
- All clothes could be washed as long as it was white and made of linen

## With Bioinnovation

- Proteases, Amylases, Lipases
- Improve stain removal, garment care and wash performance
- Mild pH
- Temperature 20-60°C

# A Big Difference in OPO Fat



## In The Past

- Babies were fed cow's milk, which does not have the proper fat structure for infants

## With Bioinnovation

- The fat structure matches the structure of breast milk fat as closely as possible
- 1,3 specific lipase
- No harsh treatment is involved
- High quality products suited for infants can be made

# A Big Difference in Vegetable Oil Refining



## In The Past

- Degumming of vegetable oils was achieved using alkaline (NaOH) processes
- Require large amounts of water and energy

## With Bioinnovation

- Phospholipases
- Effective gums removal with no oil lost (via soap stock)
- Improve yield in physical refining of oils thereby increasing refining margins

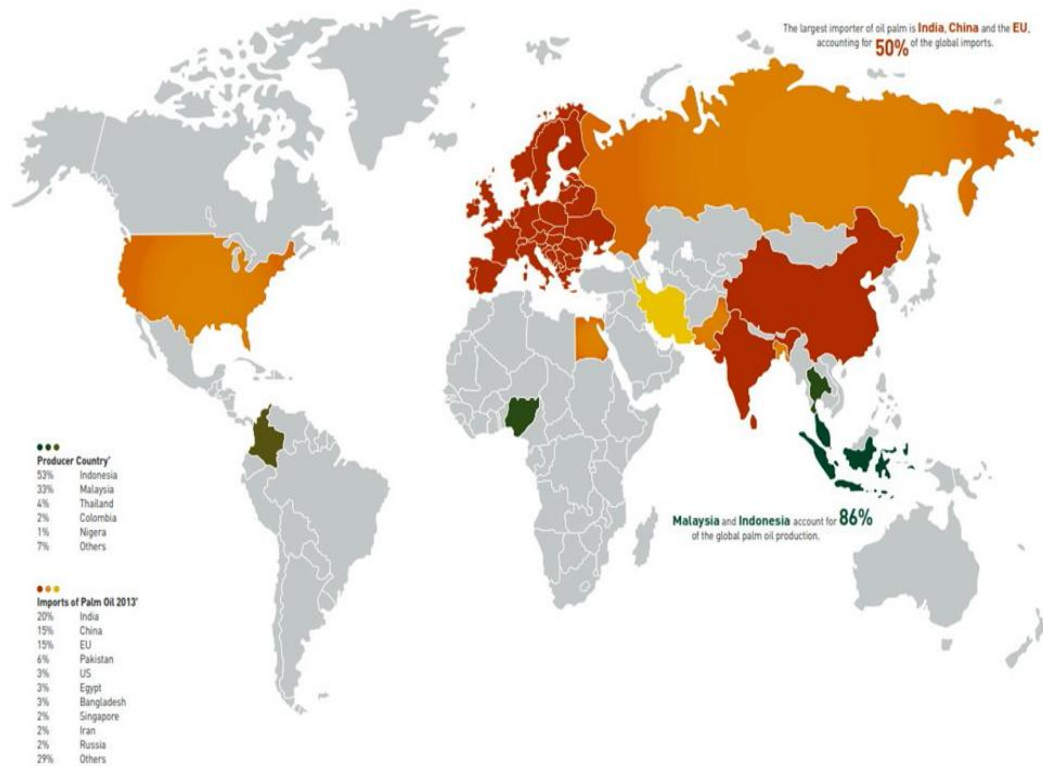
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# Palm Oil at a Glance

## PRODUCERS AND IMPORTERS OF OIL PALM



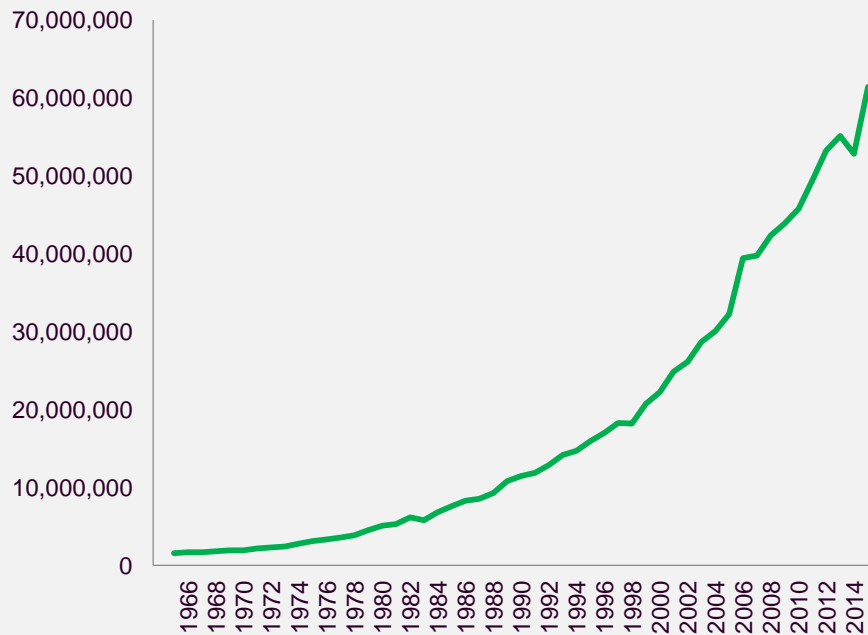
- Palm oil is a vegetable oil produced from the oil palm fruit.
- Malaysia and Indonesia are responsible for producing about 86% of the world's palm oil, while other producers include Thailand, Columbia, Nigeria, Papua New Guinea and Ecuador.



# Why Palm Oil?

- Palm oil is today the most produced vegetable oil in the world in terms of production – 60 million metric tons.

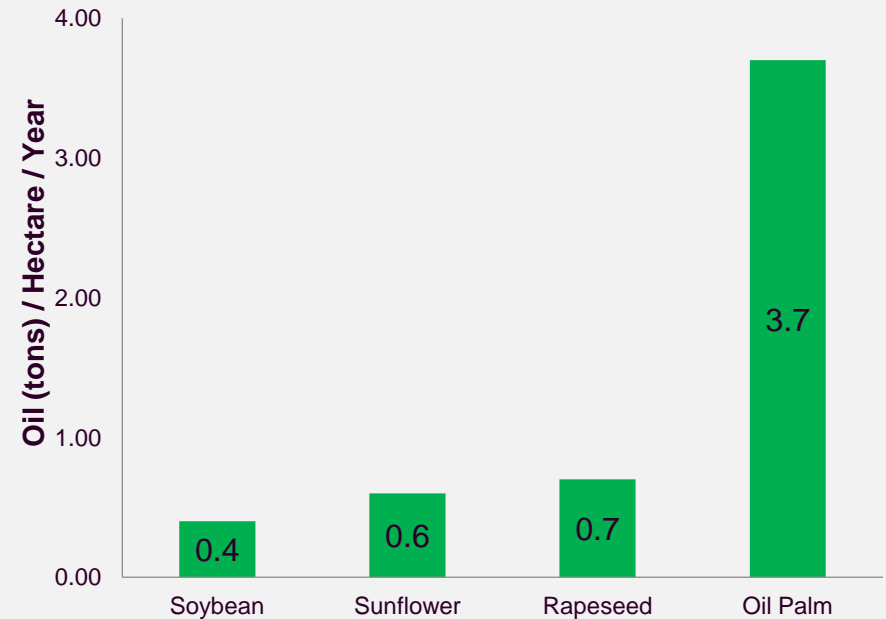
Global Palm Oil Production (1965 – 2015)



Source: FOASTAT 2016, Global Palm Oil Production 2016

- Oil palm is the most efficient oilseed crop in the world.

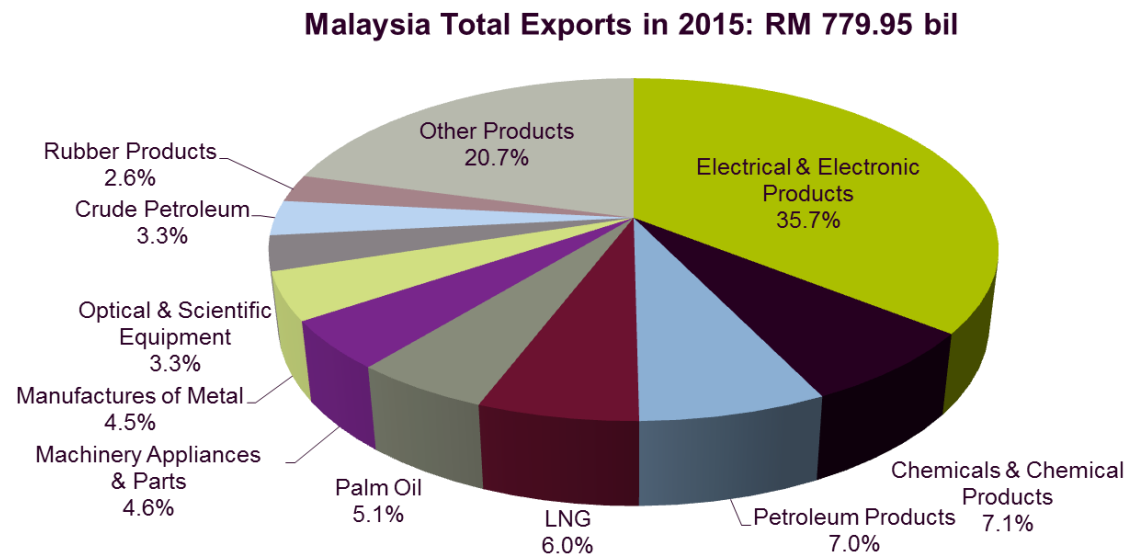
Average Oil Yield for Major Oilseed Crops



Source: Oil World, 2013

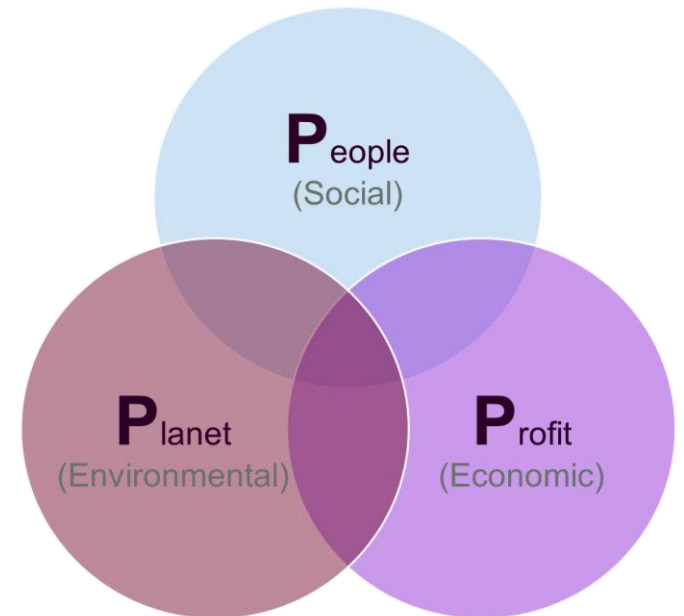
# Why Palm Oil?

- Malaysia is currently the second largest producer and exporter of palm oil worldwide.
- Malaysia supply a total of 32% in which is 19.96 million tons of total output for the global palm oil production in year 2015.
- In 2015, Malaysia palm oil export reached RM 40.14 billion and accounted for 5.1% of the total exports.



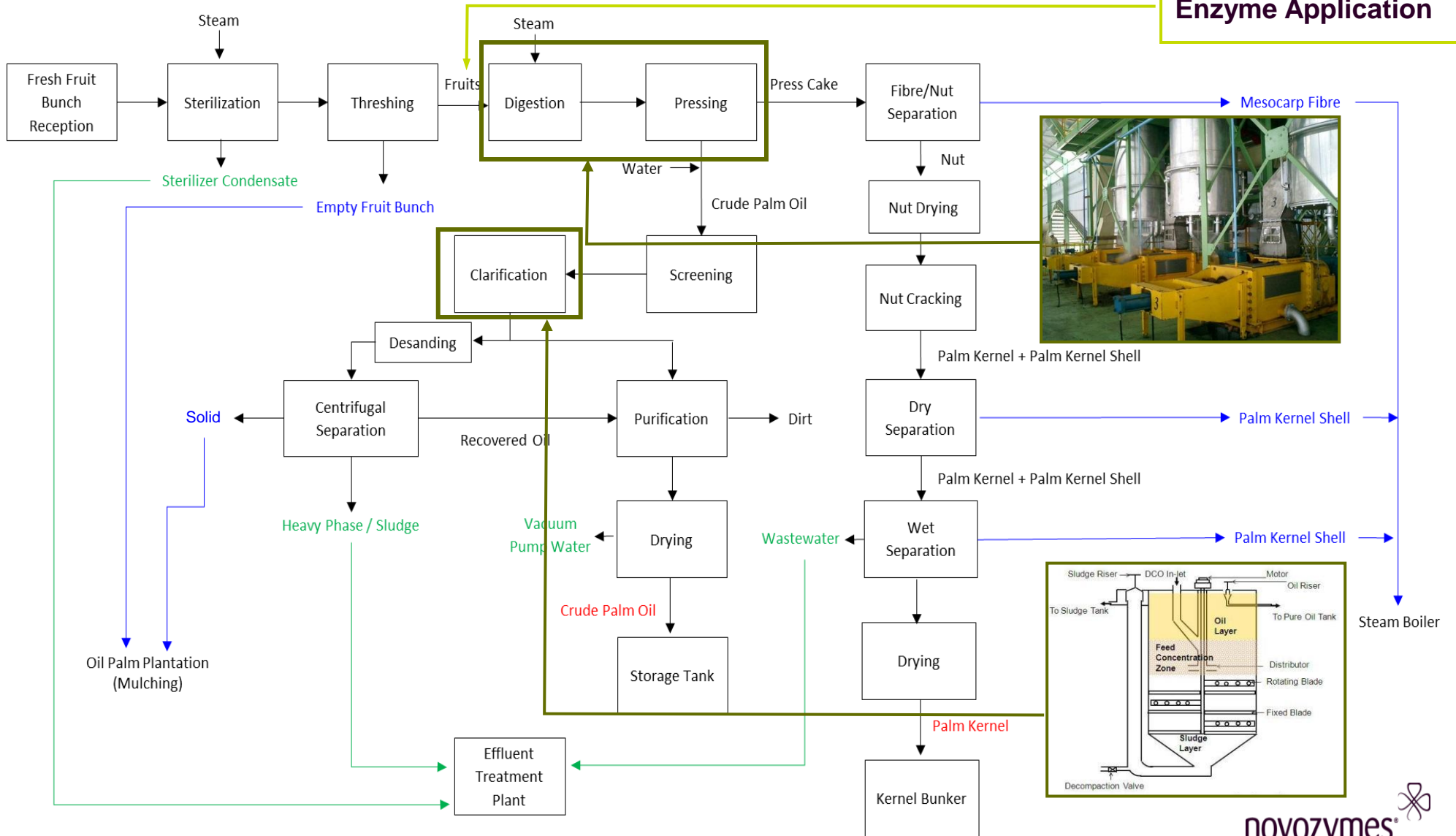
# Sustainability Impact of Increased Palm Oil Yield

- What does **Sustainability** mean practically?
  - a) Increase output by increasing yield
  - b) Reduce environmental footprint
  - c) Optimize process to save energy and water
  - d) Increase the health benefits of products



# Typical Palm Oil Milling Process Flow

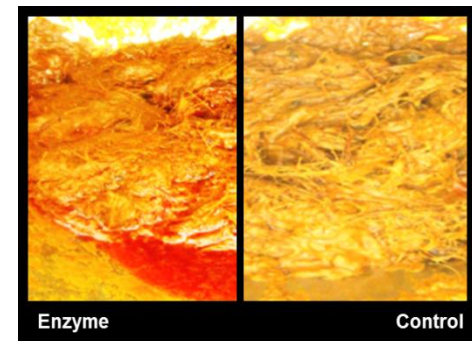
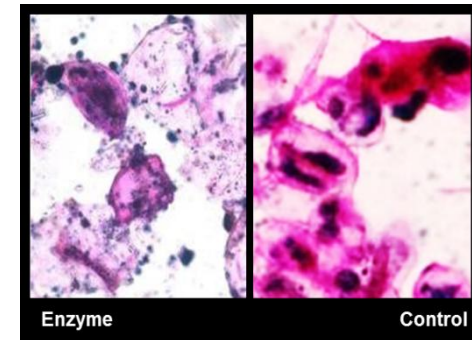
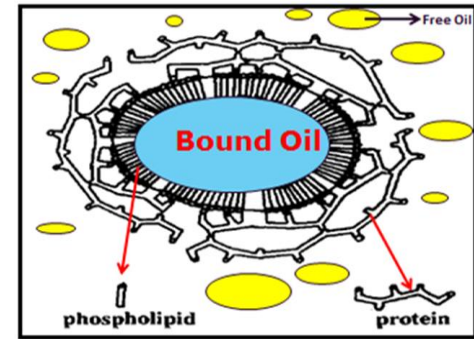
**Enzyme Application**





# Effects of Enzyme

- Cell wall loosening of oil bearing cells
  - a. Increased cell wall rupture during digestion
  - b. Softer cells are more easily burst in screw-pressing
  - c. Liberating oil bound inside cell
  - d. Less unbroken cell in sludge waste
- Reduction of crude palm oil P-content (phospholipid)
  - a. Reduction in viscosity
  - b. Lesser emulsification of oil
  - c. Faster clarification and oil separation



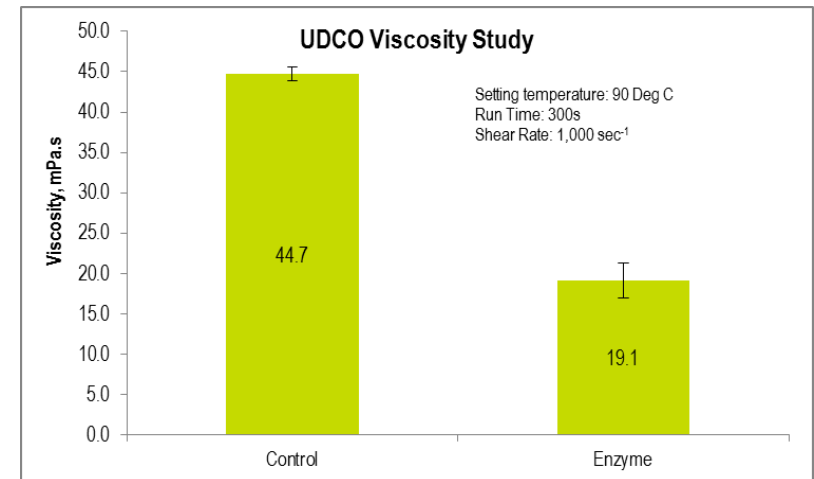
# Golden Rule for Gravity Separation

- Gravity separation in clarification process is governed by Stoke's Law.

$$v = \frac{(2gr^2)(d_1 - d_2)}{9\mu}$$

$v$  = particles rising / settling velocity, m/s  
 $g$  = acceleration of gravity constant, m/s<sup>2</sup>  
 $r$  = radius of particle, m  
 $d_1$  = specific gravity of fluid, kg/m<sup>3</sup>  
 $d_2$  = specific gravity of particle, kg/m<sup>3</sup>  
 $\mu$  = dynamic viscosity of fluids, Ns/m<sup>2</sup>

- With all operating conditions being equal, less viscous fluids will promote better separation and enable early oil harvesting!



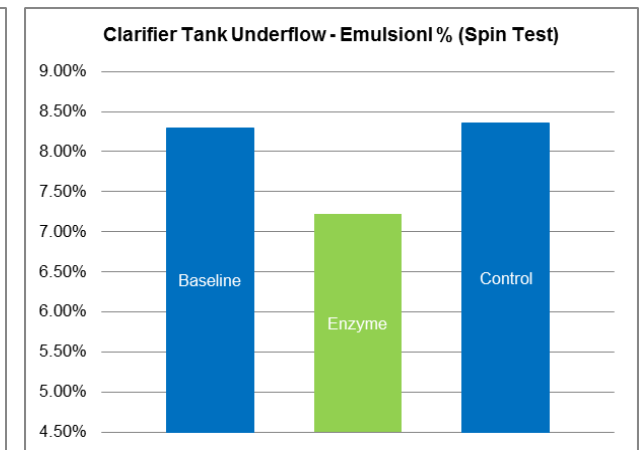
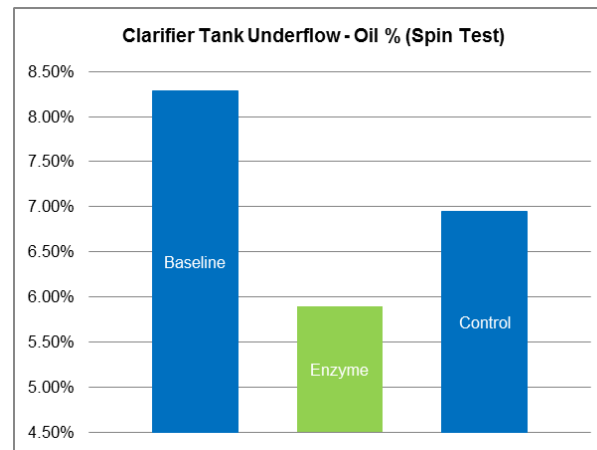
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# Enzymatic Palm Oil Extraction: A Boon

## Conventional – Mechanical Process

Sterilization, threshing, digestion of fruits pressing of pulp, followed by oil extraction and clarification and purification.

### Limitations

- Unable to recover bound oil loss at waste streams
- Require huge amount of hot water for dilution
- Require high consumption of energy/steam for heating

## Bioinnovation - Enzymatic Technology

Threshed fruits are subjected to enzymatic treatment throughout the digester followed by pressing, clarification and purification for maximum oil recovery.

### Advantages

- Loosen cell wall for bound oil liberation
- Improve mass viscosity
- Reduce hot water consumption, and hence reduce effluent generation
- Reduce energy/steam consumption

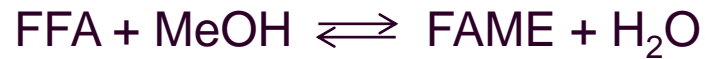
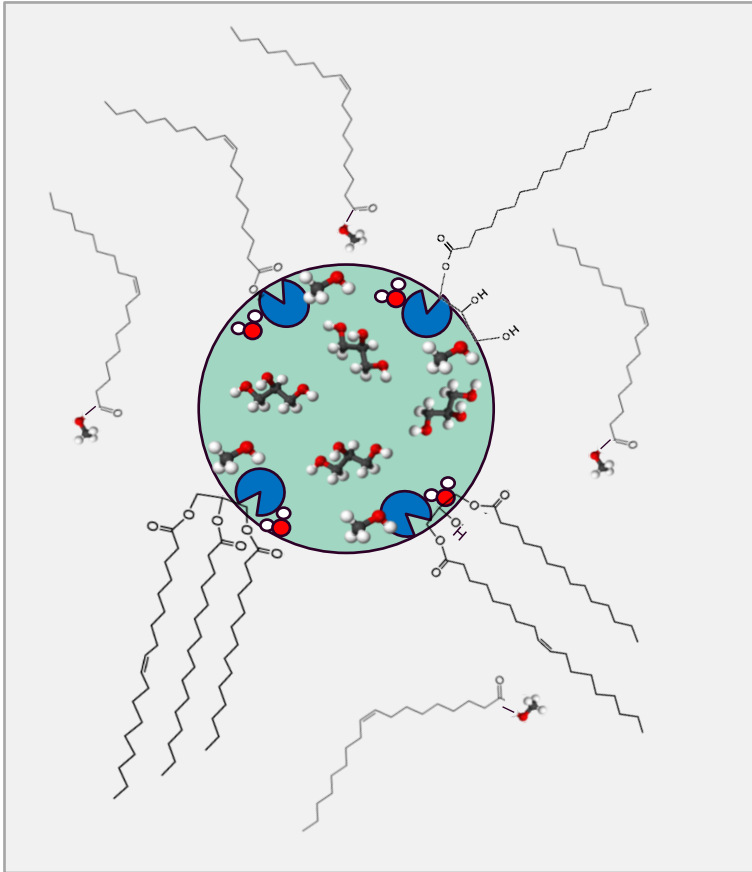
# Revolution of the Biodiesel Production

- Food vs Fuel debate.
- New technology can provide feedstock flexibility.
- Enzymatic process can use all types of feedstocks, either low or high in free fatty acids, for biodiesel production.
- Enzymatic process eliminates the need for sodium methoxide, one of the most hazardous chemicals in traditional biodiesel plants.





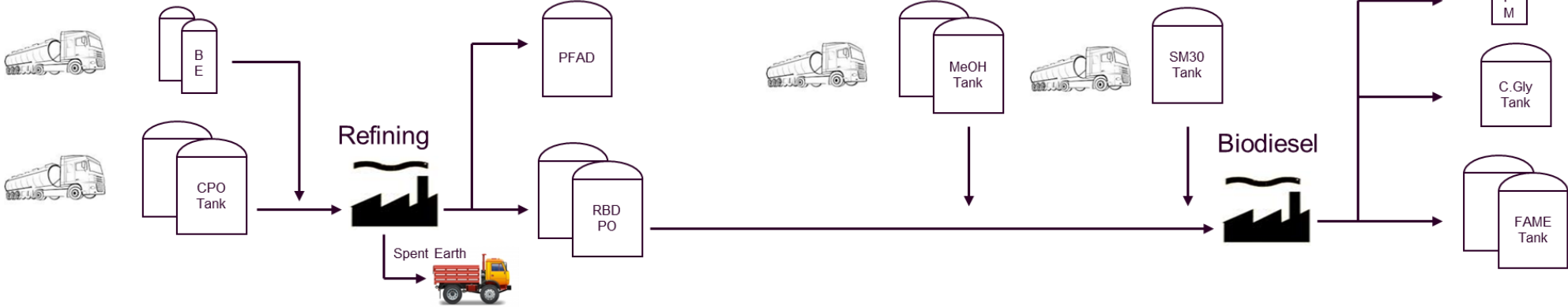
# Enzymatic Process



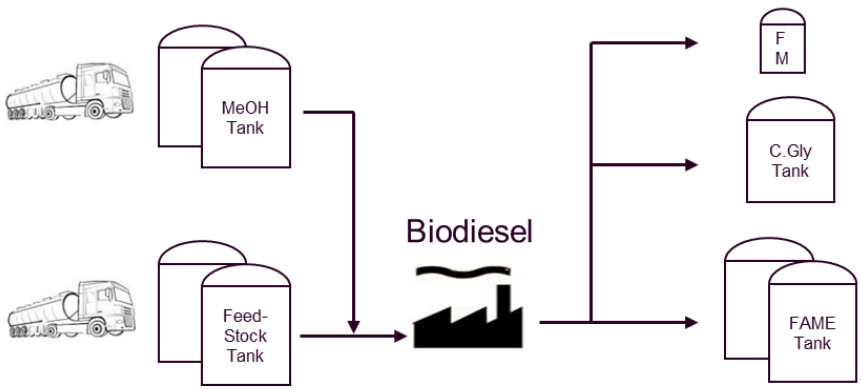
Driving process by increasing mixing, methanol and/or decreasing glycerol and water

# Enzymatic Biodiesel Process Flow

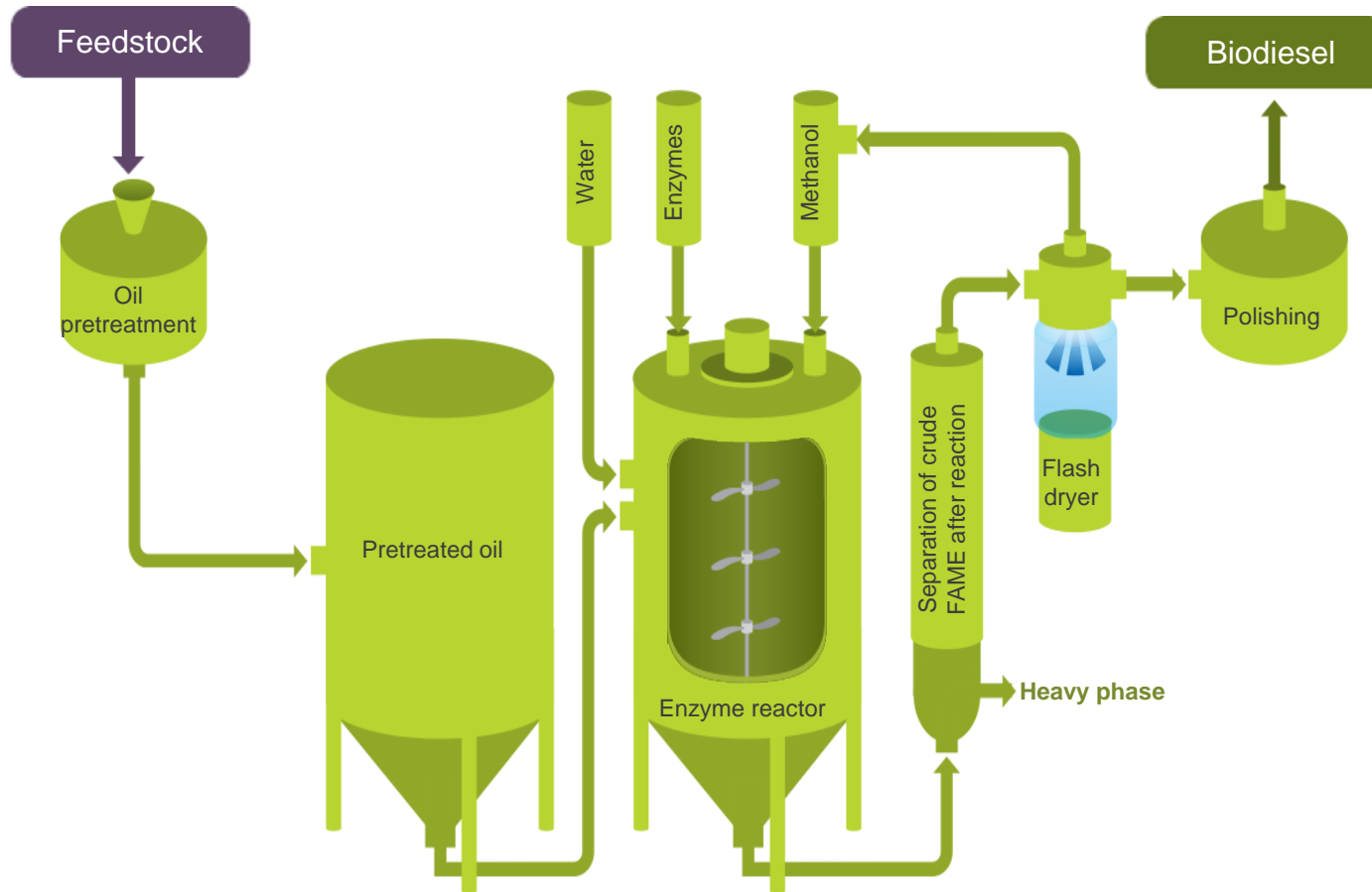
## Typical Operation



## Enzymatic Technology



# Enzymatic Biodiesel Process Flow



# Enzymatic Biodiesel Production: A Boon

## Feedstock flexibility

- Enable use of low cost raw materials
- The enzyme process oils independent of the FFA content

## Energy consumption

- Significantly lower methanol rectification costs
- No need to dry the oil feedstock

## Glycerin is pure

- Technical grade glycerin (>97% of pure glycerol) can be sold at high value

# What's Next

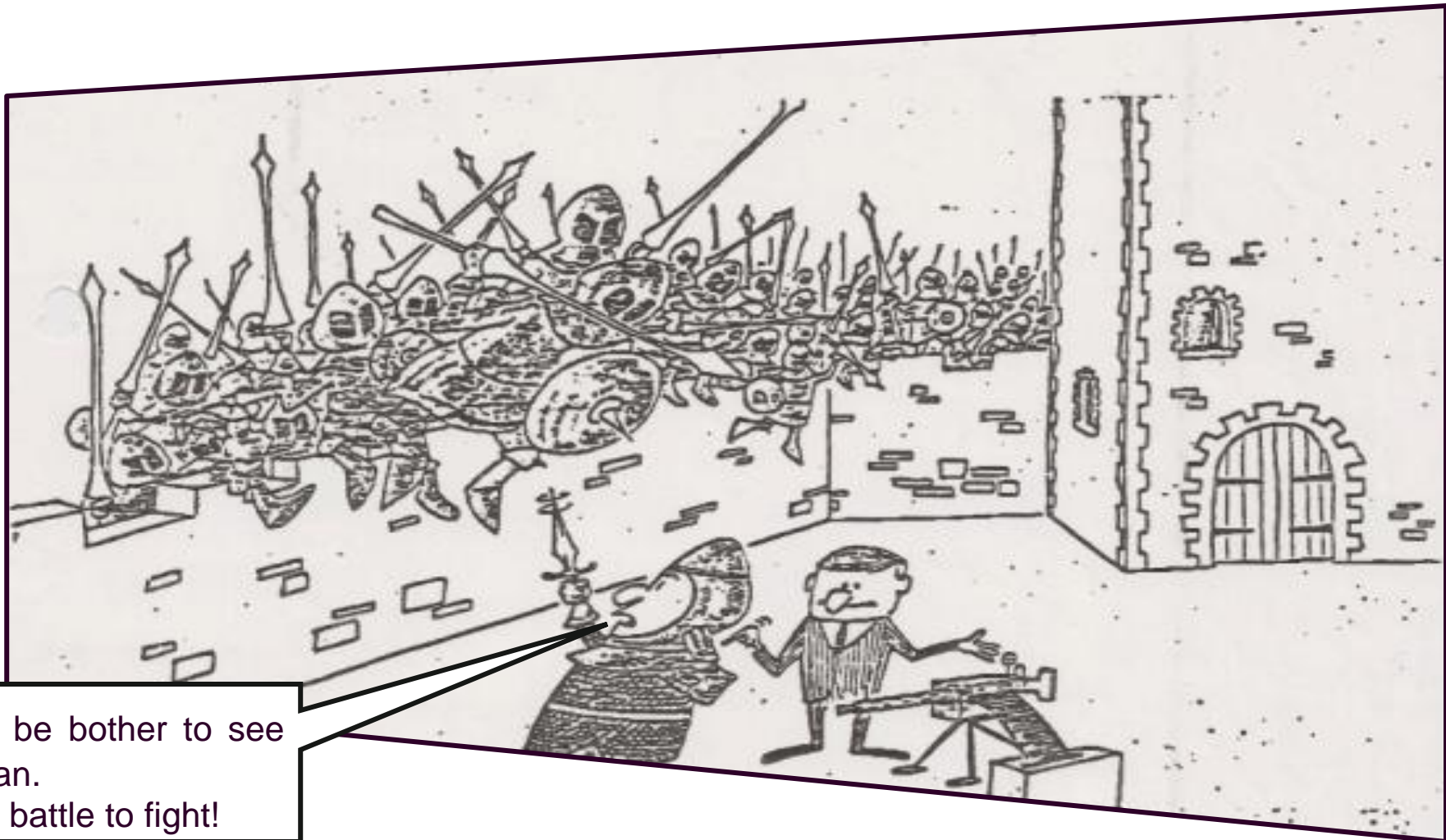
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# The Way Forward and Conclusion

- Industrial biotechnology has an important role to play in the palm oil industry.
- Enzymatic technologies are likely to bring benefits in many areas: greater efficiency, saving in natural resource, lower energy consumption, and lower production cost.
- Compared with traditional approaches, the more specific and cleaner enzymatic will promote the continued trend towards sustainable processes in palm oil industry.
- What is the next bioinnovation?



# Rethink Tomorrow?



**N**o! I can't be bother to see any salesman. We've got a battle to fight!

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Rethink Tomorrow