World Congress on Industrial Biotechnology, Montreal

Enzymes for Improving Oil Yield in Palm Oil Extraction

C. L. RATHI

Advanced Enzyme Technologies Ltd., India

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A bit about us

- Pioneered enzyme production in India in 1958
- Leading producer of enzymes in South Asia
- Exports to 45+ countries across 6 continents
- 60+ enzymes and 400+ products
- Safe, eco-friendly and biodegradable solutions for 25+ industries
- State-of-the-art manufacturing facilities that are ISO and WHO cGMP certified

Think of Life | **Think of Enzymes** | **Think of us!**

History & Milestones

- 1958: India's first enzyme manufacturing plant (for Papain) is pioneered by Mr. L.C. Rathi
- 1978: Rathi Papains Pvt. Ltd. was incorporated
- 1986: Specialty Enzymes & Biotechnologies, United States is set up
- 1989: Advanced Enzymes is incorporated (Originally under the name of Advanced Biochemicals Pvt. Ltd.)
- 1994: Commissioning of our 1st fermentation facility at Sinnar, Maharashtra
- 2008: Commissioning of 2nd fermentation facility at Pithampur, Madhya Pradesh
- 2016 : Listed in stock exchange (BSE)

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INTRODUCTION

Facts about Palm Oil

Palm Oil is beautifully defined by Ca'da Mosto, as - "It has the scent of violets, the taste of olive oil and a color which tinges food like saffron but is more attractive"

Current Scenario

- Oil & Fats Production (world 2016/17F) ≅ 213.5 million tons
- Palm Oil Production (2016) ≅ 58.9 million tons
  - Indonesia : 32.1 million tons
  - Malaysia : 17.3 million tons
- Projected demand by 2025 : 85 million tons
- Largest importers of palm oil : India, European Union & China

Source : Oil World

Palm Oil Plantation

Fresh Fruit Bunch

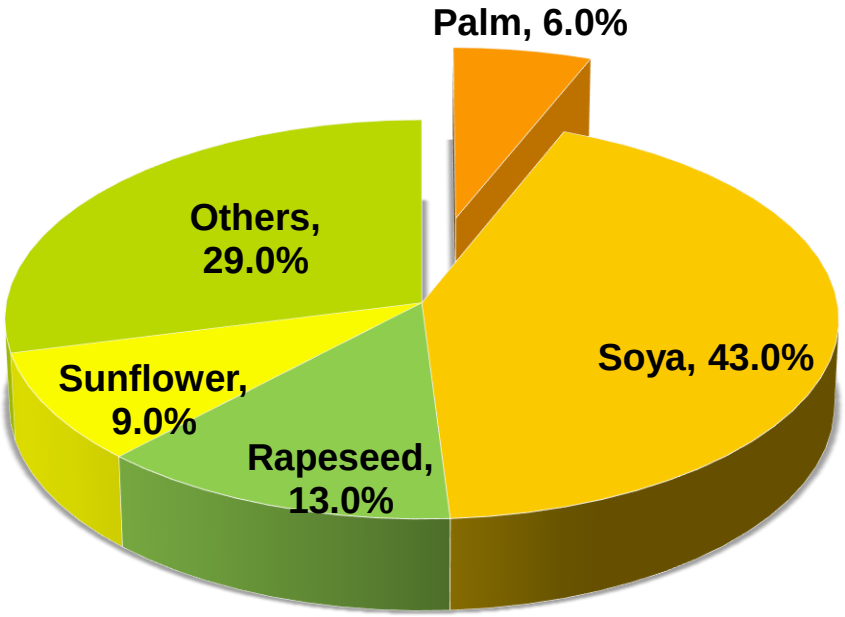
Palm Fruit

Palm Oil

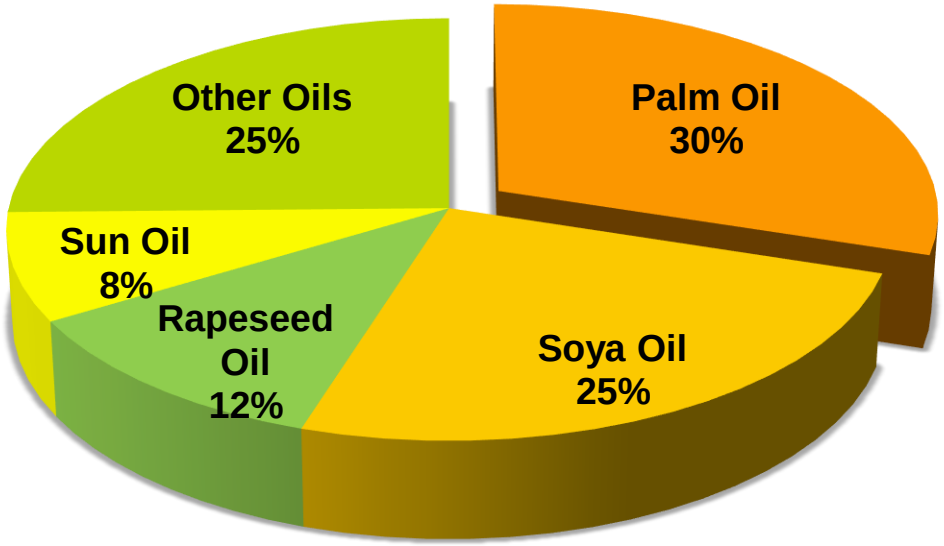
Oil Palm: Most Efficient Oilseed Crop 1/2

Palm fruit cultivation requires less harvested area to produce the major percentage of vegetable oil

Harvested Area of Major Oilseeds 275.98 million ha



Oil Production 213.7 million tons



Source : Presentation by Thomas Mielke (Oil World) in POC 2017

Palm Oil: Most efficient oilseed crop 2/2

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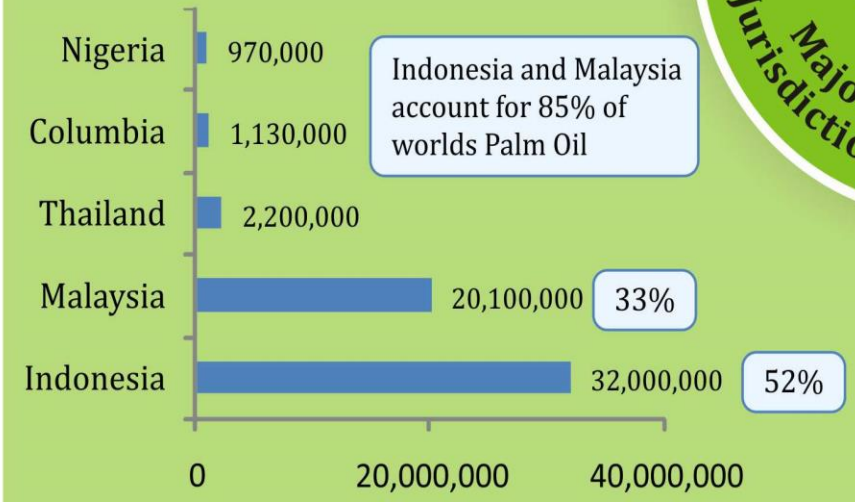
Drivers

1. Cost Benefit
2. Expanding Applications
   a. Edible (Specialty Fats)
   b. Non-edible sectors (Oleochemicals, Biodiesel, Cosmetics, etc.)
3. Increase in world population and income
4. Healthy: High carotene and vitamin E content, no risk of trans fatty acid

Challenges

1. Environmental concerns related to Palm Plantation
2. Limited land availability
3. Climatic uncertainties (El Nino, rainfall, etc.)
4. Oil losses that happen during processing

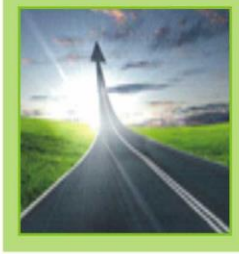
Major Jurisdictions



Indonesia and Malaysia account for 85% of worlds Palm Oil

Road Ahead

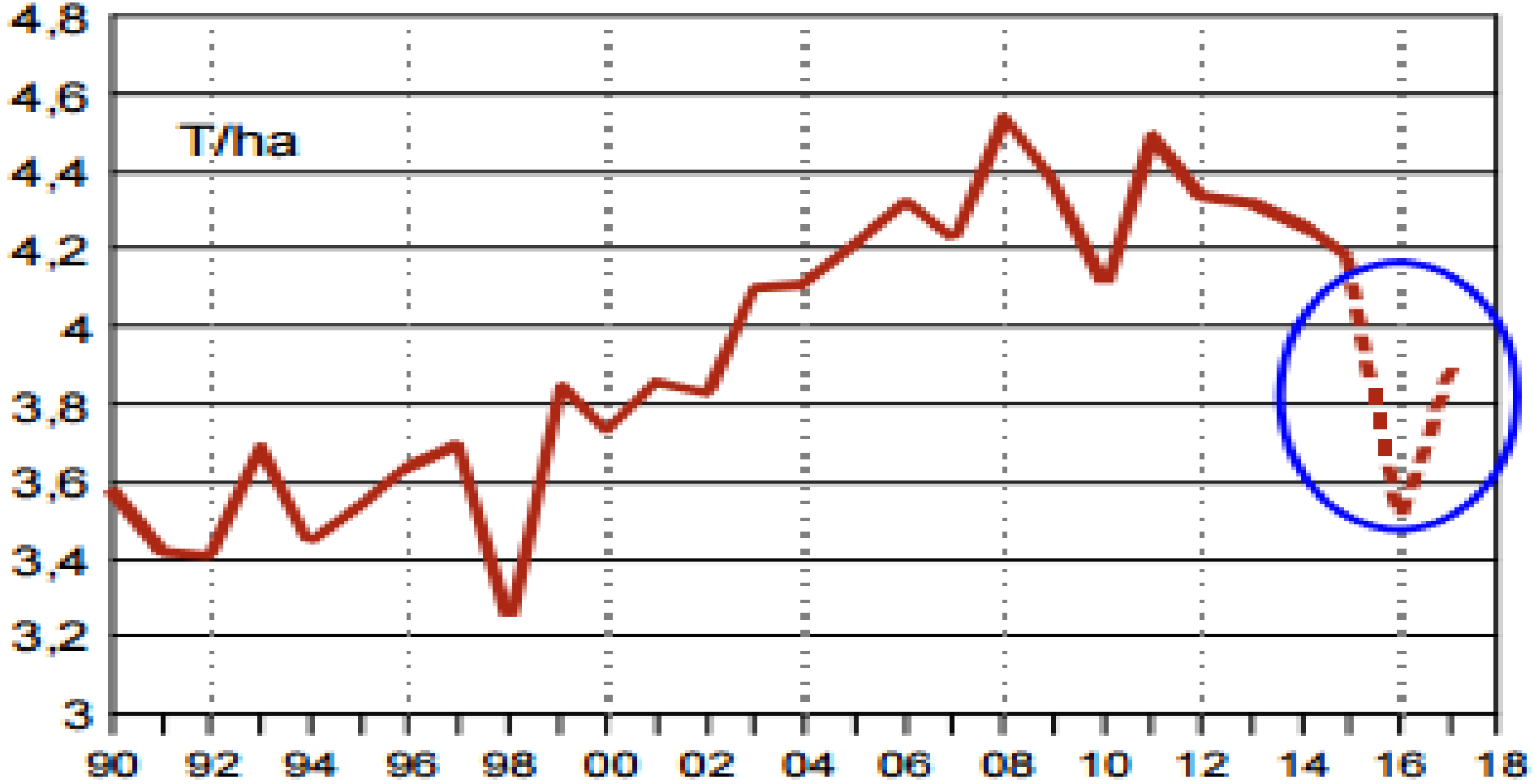
1. Increase the Oil Extraction Rate by optimising production process
2. Accelerate re-planting of palm fruits
3. Make best use out of all the waste that is generated during palm oil production
4. Commercialize second generation bio fuels



Malaysia : Decline in Oil Productivity in Recent Years

The following reasons are contributing to the fall in palm oil productivity in recent years:

1. Environmental Concerns / Sustainability / Water crisis
2. Old plantations are yielding lower fruits, leading to reduced production



Source : Presentation by Thomas Mielke (Oil World) in POC 2017

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PALM OIL EXTRACTION

Cell and cell wall components involved in palm oil extraction

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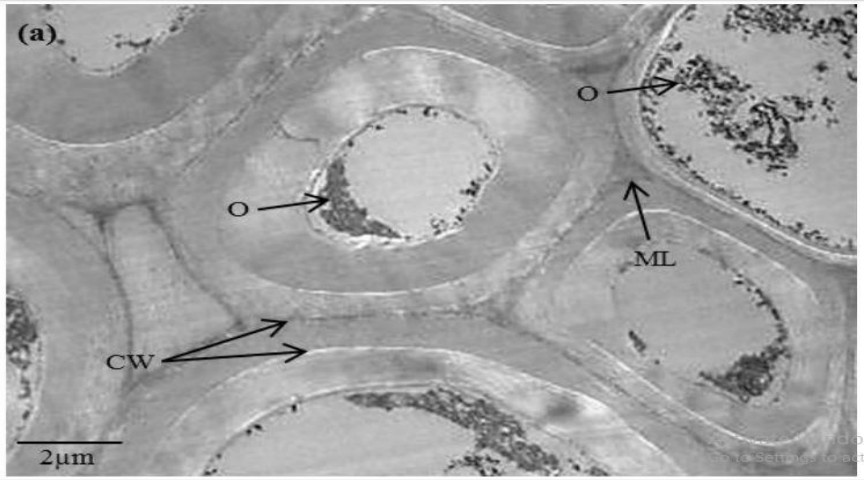
Composition of mass which enters the digester

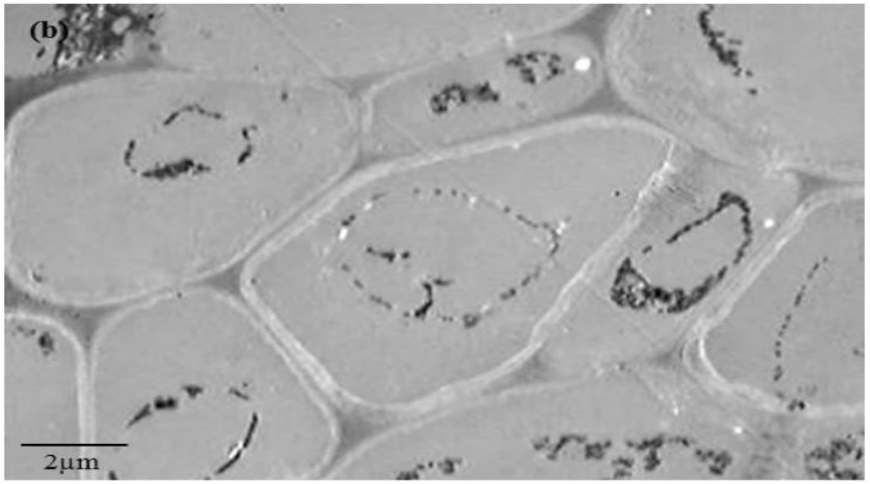
Structural Characteristics	%
Total lipid content	56.68
Soluble sugars	2.89
Total structural carbohydrate	13.76
Glucan	8.27
Xylan	4.52
Arabinan	0.97
Soluble lignin	3.58
Insoluble lignin	0.038
Water extractives	17.16
Ethanol extractives	17.98

Source : *Malaysian Journal of Analytical Sciences, Vol 19 No 1 (2015): 77 – 87 (*Hemavathi Silvamany and Jamaliah Md Jahim)



Fresh palm fruit

O=Oil, CW=Cell Wall, ML=Middle Lamella



Mass Passing to Digester

Enzymatic Oil Extraction : A boon

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Palm Oil Extraction Process

Mechanical Process

Sterilization, bunch stripping or threshing, digestion of fruits, pressing of pulp, followed by clarification and purification

Disadvantages:

Oil loss at every step which cannot be recovered

Time consuming process

Intense human labour required

Harsh treatment leads to loss of oil

Amount of water required is huge

High energy consumption

Enzymatic process

Stripped fruits are subjected to enzymatic treatment throughout the digester followed by pressing for maximum oil extraction

Advantages:

Almost complete oil recovery

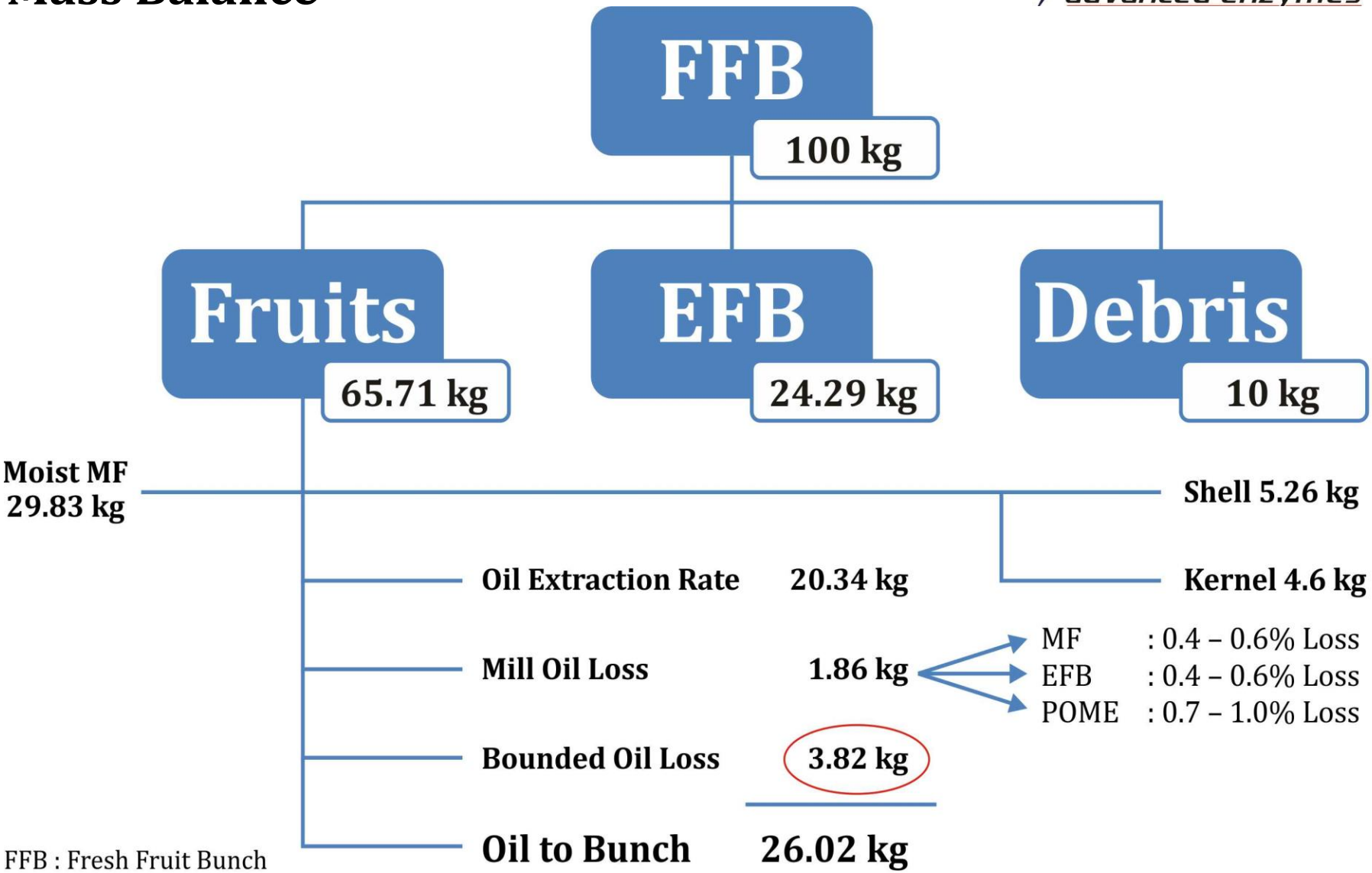
Overall nutritional quality is maintained

Higher anti-oxidant concentrations in extracted oil

Improved mash viscosity, oil bleachability

Reduced FFA content in the final oil

Mass Balance



FFB : Fresh Fruit Bunch
MF : Mesocarp Fiber
EFB : Empty Fruit Bunch
POME : Palm Oil Mill Effluent

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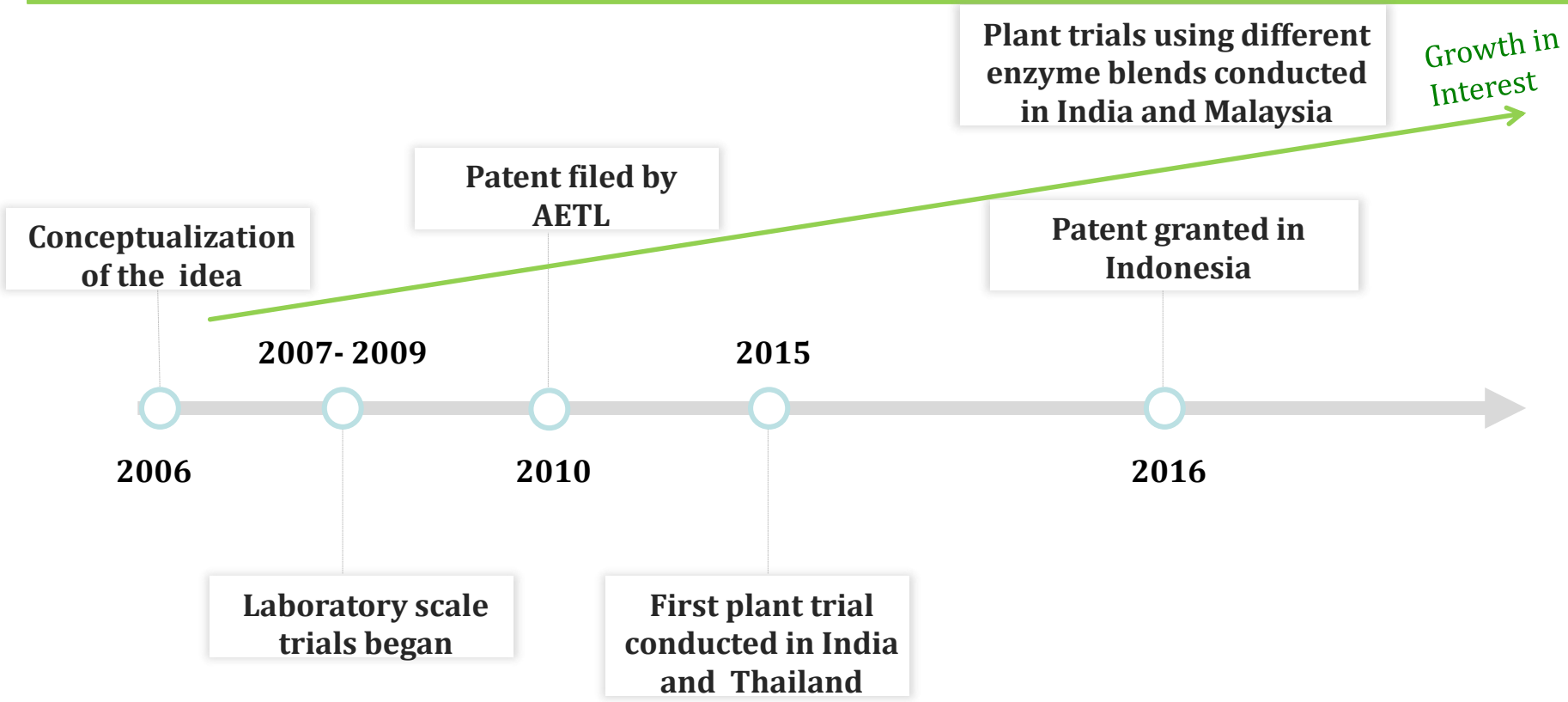
ROLE OF AETL IN PALM OIL EXTRACTION

AETL's journey – Exciting and Challenging

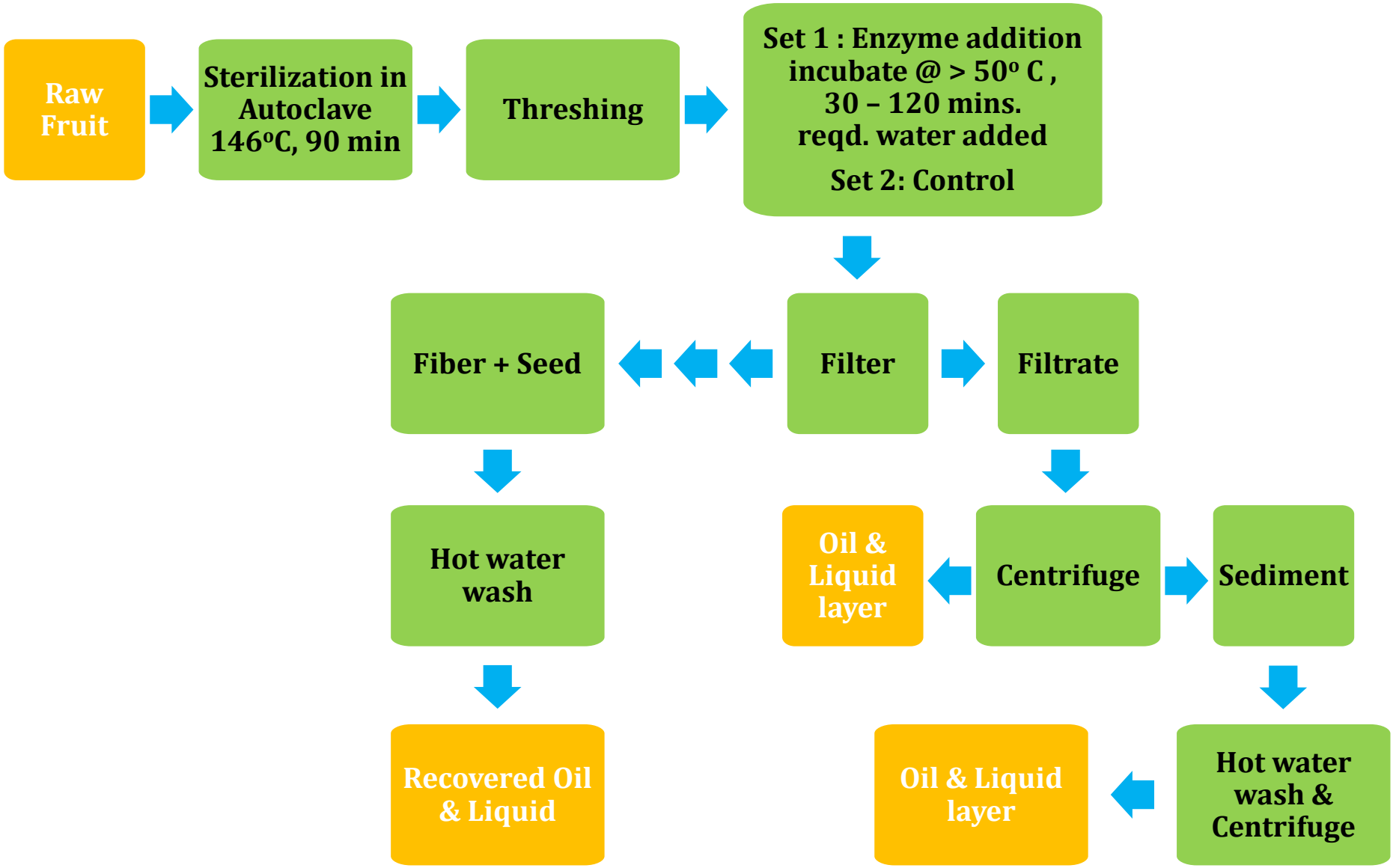
With the focus of enzyme application getting diversified in various industries, AETLs initiative to start palm oil extraction using enzymes has rendered good results

Success and positive results at every step, it has been a morale booster for AETL to further expand its work in the area of palm oil extraction

AETL is working in close association with palm oil producers in India, Malaysia, Indonesia and Thailand



Laboratory Process



Observations 1/2

	CONTROL	ENZYME TREATED
Viscosity	Highly viscous	Free flowing
Filtrate	Lower quantity	High quantity

Observations 2/2

	CONTROL	ENZYME TREATED
Fiber and Seed component	Dark color and gummy	Dry and non-gummy
Oil Extracted	High sediments and dark color	Clear and light color

Sample Data from Laboratory Set Up

Parameters	Enzyme Treated Palm Fruit	Control Palm Fruit
Viscosity of mash (cP)	< 50	> 1500
Oil recovered (ml)	54 – 71	27 – 40
Oil recovery as % of fruit	38.6% – 50.7%	19.3 – 28.6%
Estimated oil recovery as % of FFB	28.9% – 38.0%	14.5% - 21.4%

Note : The variations are observed due to origin, ripeness and size of fruit

Plant Process

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Enzyme blend

FFB → Steriliser → Stripper / Thresher → Digestor → Screw Press

Screw Press → Oil / Nuts / Fibre

Nuts → Palm Kernel → Palm Kernel Oil

Fibre → Boiler

Oil → Vibro Screen → Clarifier → Purifier → Vacuum Dryer → Crude Palm Oil (CPO)

Summary of Plant Trial Results

Qualitative Parameters :

Parameters	Conventional Process	Process using Enzyme Blend
Fibre (screw press output)	Still having gums attached Dark colour & glossy (indicating oil residue)	Light colour and no gums visible (indicating lesser oil residue)

Summary of Plant Trial Results

Qualitative Parameters :

Parameters	Conventional Process	Process using Enzyme Blend
CPO Quality	Partially hazy / suspended particles observed	Less hazy / less suspended particles

Calculations – Increased OER

- Increase in Oil Yield by 8%
  - Oil increase 8% x 20.34 kg = 1.63 kg
  - In terms of OER = 20.34 + 1.63 = 21.97%
- Process throughput : 40 ton FFB / hour
- Assuming 1.5% increase in OER
- Additional Oil : 40 T/h x 1.5% x 20 h/day
  = 12 tons per day
  Or **3,600 Tons per year** (300 days) !
  i.e. ~ 2.2 million USD per year!!

AETL's enzyme blends – Asset to palm oil producers

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PROVEN

- Increases the oil yield by 5-15% i.e. about 10 – 30 kg of oil per ton of FFB.
- Lesser Effluent, easier biomass treatment
- Enzymes are lipophobic, no traces remain in oil
- Destabilization of oil-water emulsion
  → easier separation in decanters
  → Improved filterability

FURTHER RESEARCH FOCUS

- Higher recovery of Oleoceuticals (tocotrienols & carotenoids)
- Reduces/eliminates the need for organic solvents
- Possibility to eliminate degumming step
- Potential to deliver fermentable sugar solution which can be readily utilized for ethanol production
- Increase in overall processing capacity

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CONCLUSION

Possible revolution in palm oil industry!

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Major Issues faced by Palm Oil Industry	Possible Solution	How to achieve the solution
Rise in Oil Demand Low Productivity Limited land Availability Loss of Oil at every step of Processing	Make the best output in terms of oil extracted	USE ENZYMES

Solutions from Advanced Enzymes :

Apart from Palm Oil Extraction, Advanced Enzymes also offers solutions for:

- Yield improvement in PKO production along with High value PK Meal using Enzymes
- Free Fatty Acid Reduction in CPO & other oils by Enzymatic Remediation
- Enzymatic Hydrolysis of CPO and other oils to produce fatty acids
- Enzymatic Esterification for Production of Mono & Di Esters from various fatty acids
- Production of Enzymatic Biodiesel
- Enzymatic Interesterification for production of trans-free fats

Solutions from Advanced Enzymes :

…continued

- Holding global patent on use of Enzymes as Plant Growth Promoter
- Production of Structured Lipids like Human Milk Fat Substitutes (HMFS) and Cocoa Butter Equivalents (CBE)
- Fish Oil Applications : Production of Ethyl Esters and Omega 3 concentrates
- Biomass
- Production of Mono- & Di Glycerides
- Oil Degumming

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- AETL's lab trial data
- AETL's plant trial data
- AETL PCT application

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THANK YOU!