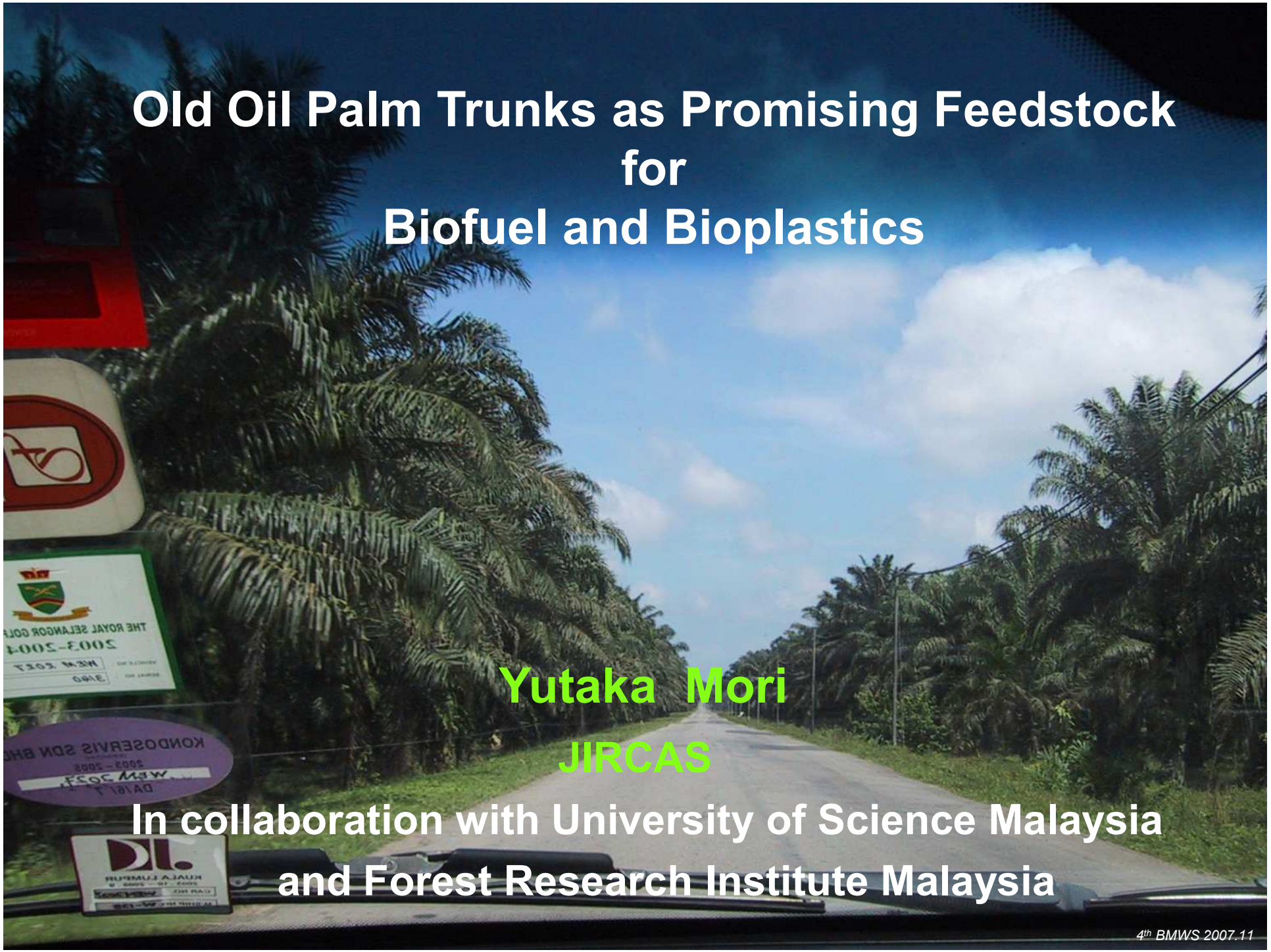

Old Oil Palm Trunks as Promising Feedstock for Biofuel and Bioplastics

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JIRCAS

In collaboration with University of Science Malaysia and Forest Research Institute Malaysia

Problems occurred by introduction of bio-ethanol fuel

Feedstock: corn, wheat, cassava, sugar cane, molasses

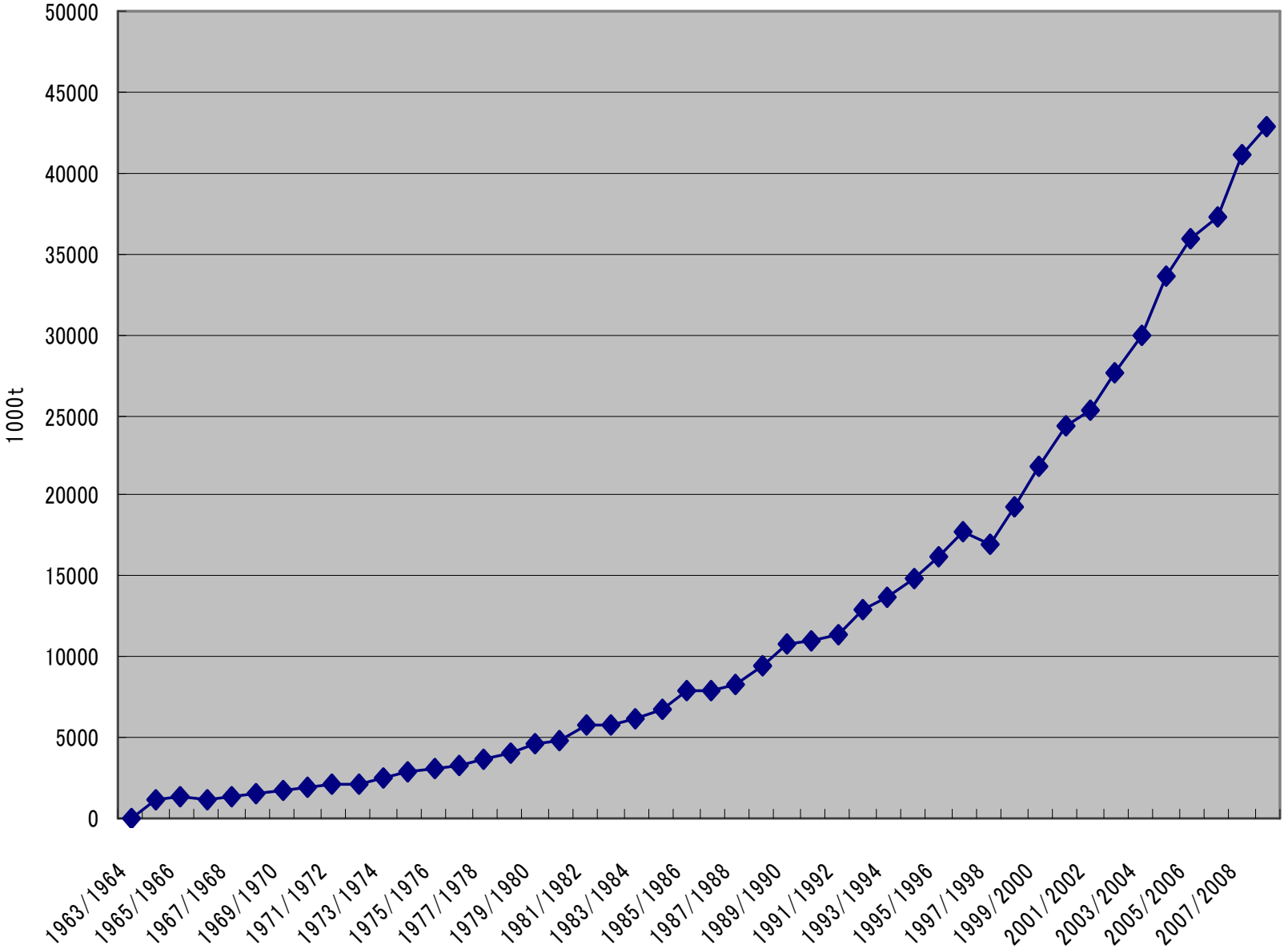
- Competition with food

→

- Shortage of feedstock
- Price hike in grain and feedstock

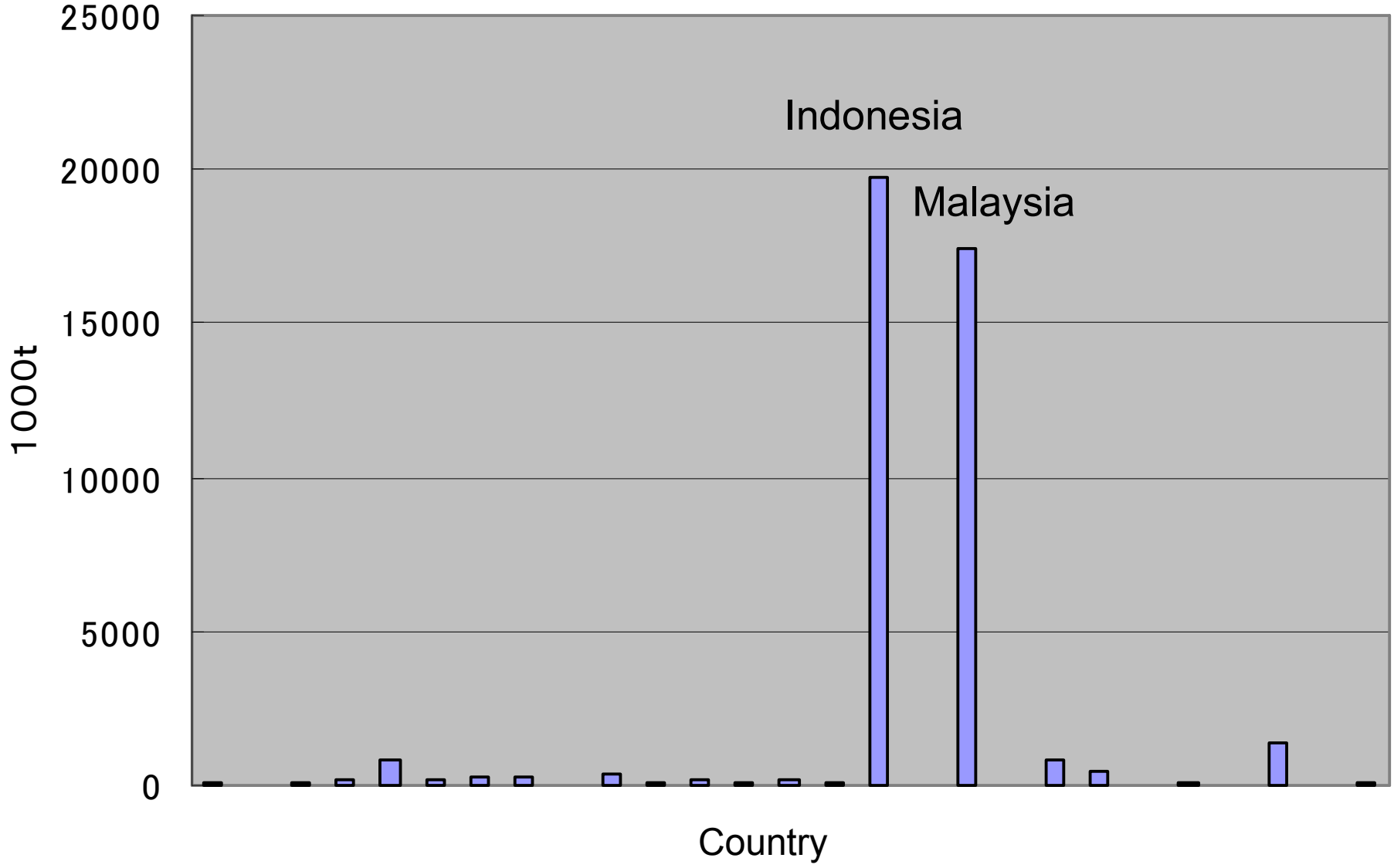
Second-generation ethanol that does not compete with food

Worldwide Palm Oil Production



Source：USDA PSD Online 2008

Palm Oil Production in Each Country (2007)



Source : USDA PSD Online 2008

Palm Oil Industry in Malaysia

- 1911: Introduced from Africa
- 1917: Commercial Production started
- Exports: 2007

  36,292M RM＝13 billion US dollars
- Employment： more than 500,000
- Cultivation area： 430M ha (2007： 13% of total land)

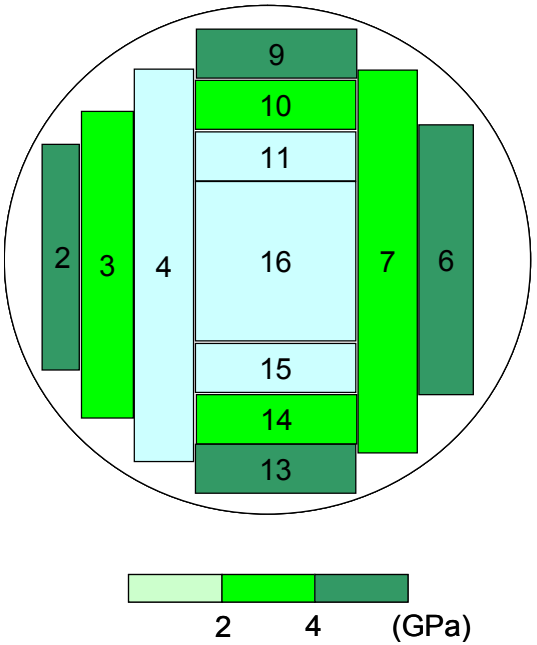
  peninsula(236Mha), Saba(128Mha), Sarawak(66Mha)
- Palm oil production (2007): 17.7M ton
- Kernel oil production (2007): 2M ton
- Productivity: 3.4-4.9 ton/ha (palm oil)

  0.7-1.2 ton/ha (kernel oil)

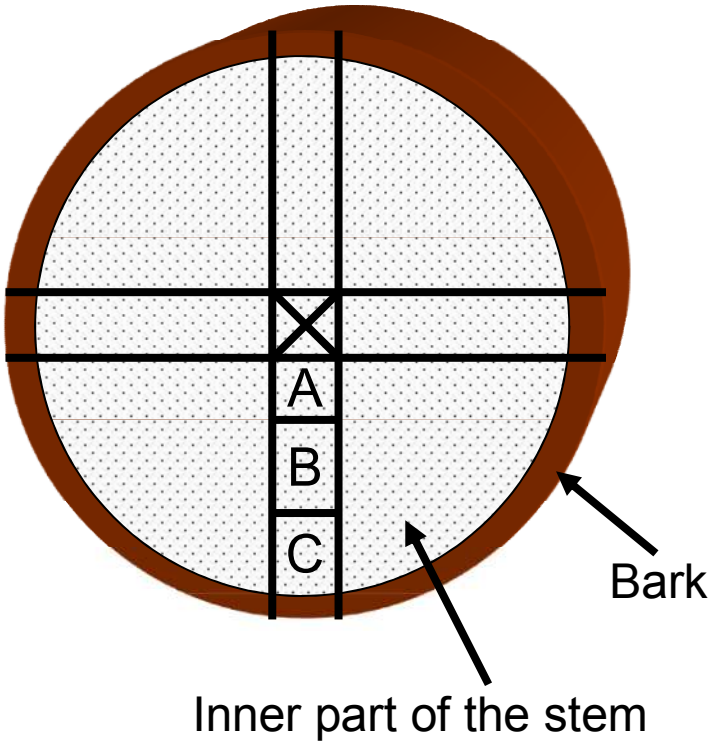
Re-plantation of Old Oil Palm

Plywood Production from Old Palm Trunk

Young's Modulus

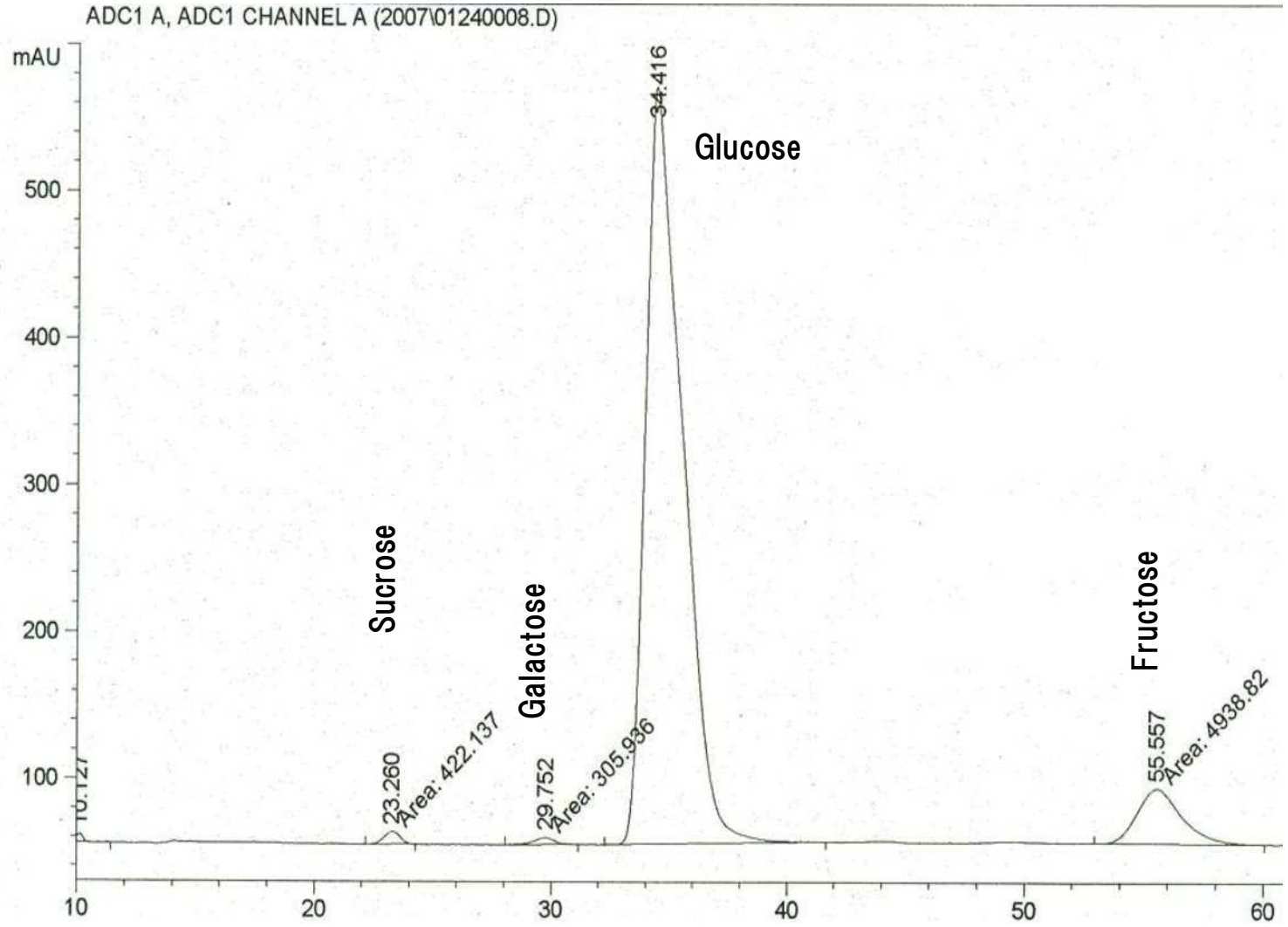


Moisture Content of Oil Palm Trunk



	Moisture
A (core)	83%
B (middle)	75%
C (outer)	68%

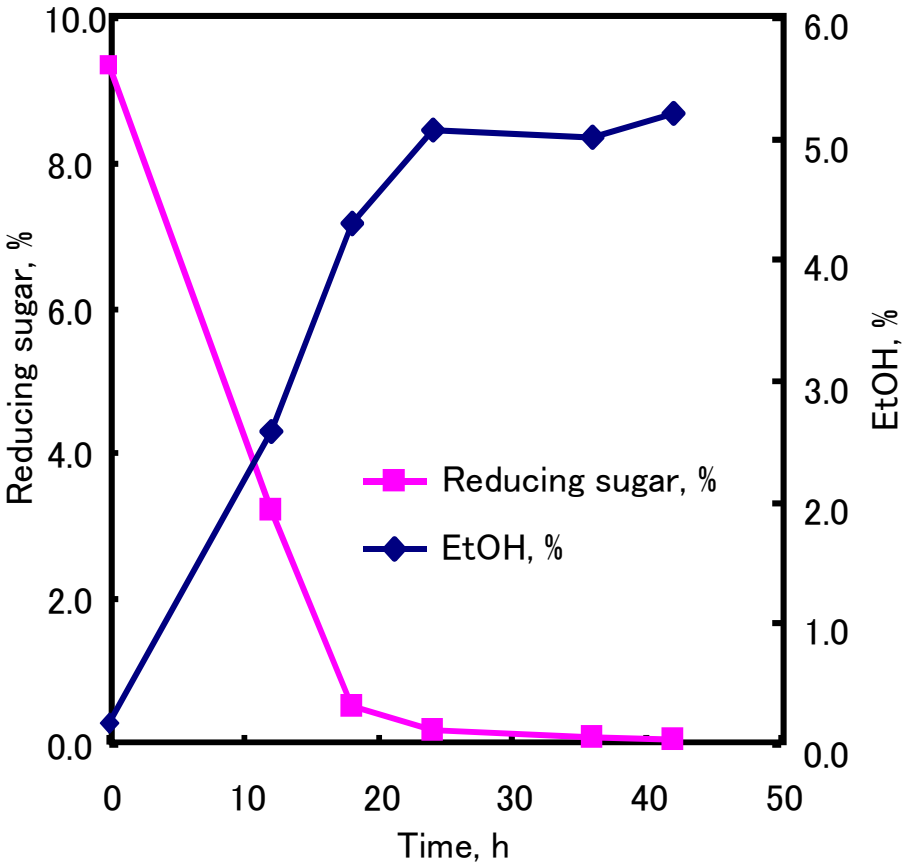
HPLC Profile of Sugar Analysis on Sap



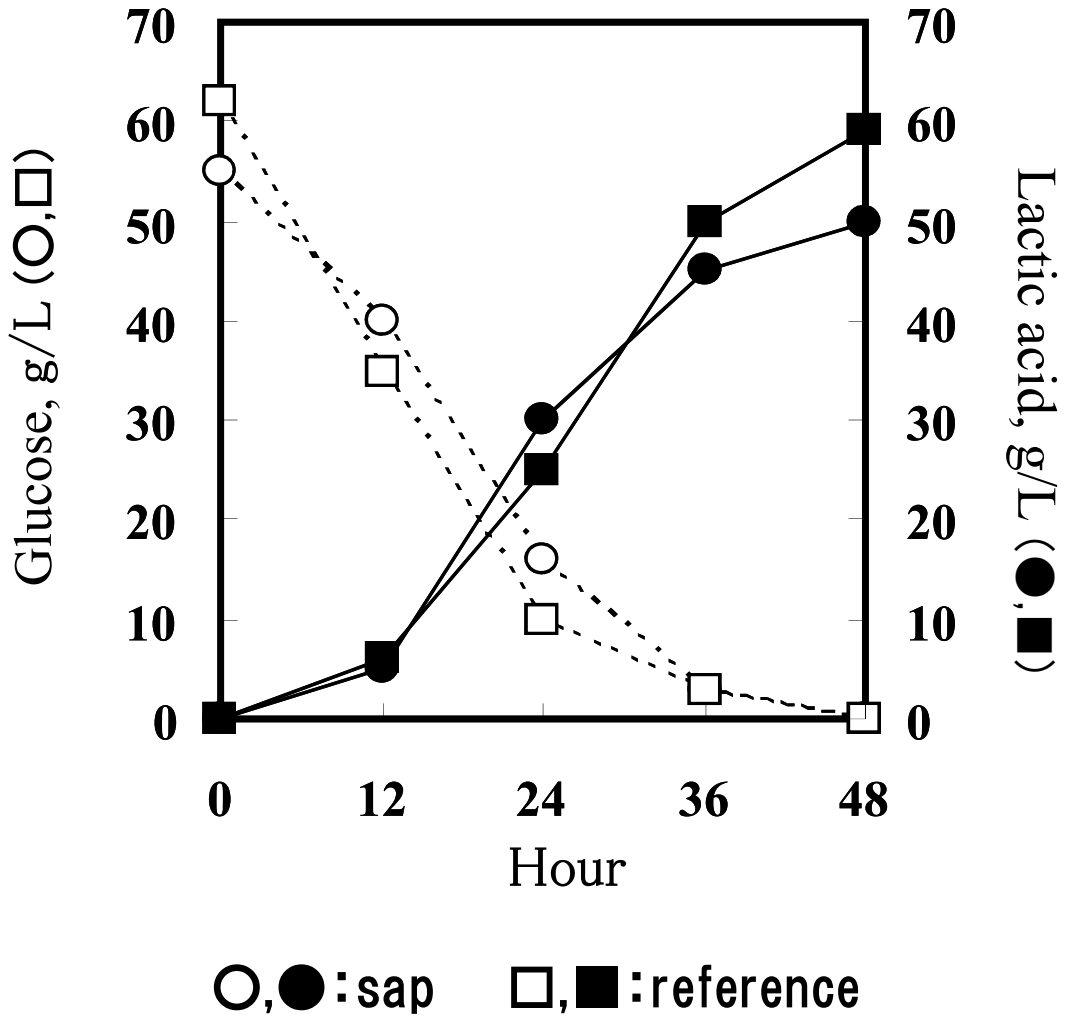
Sugars contained in oil palm sap (g / L)

	A	B	C
Sucrose	20.6	23.6	22.1
Glucose	68.4	60.8	54.7
Fructose	23.3	27.0	30.9
Total sugars	113	112	108

Ethanol production from oil palm sap

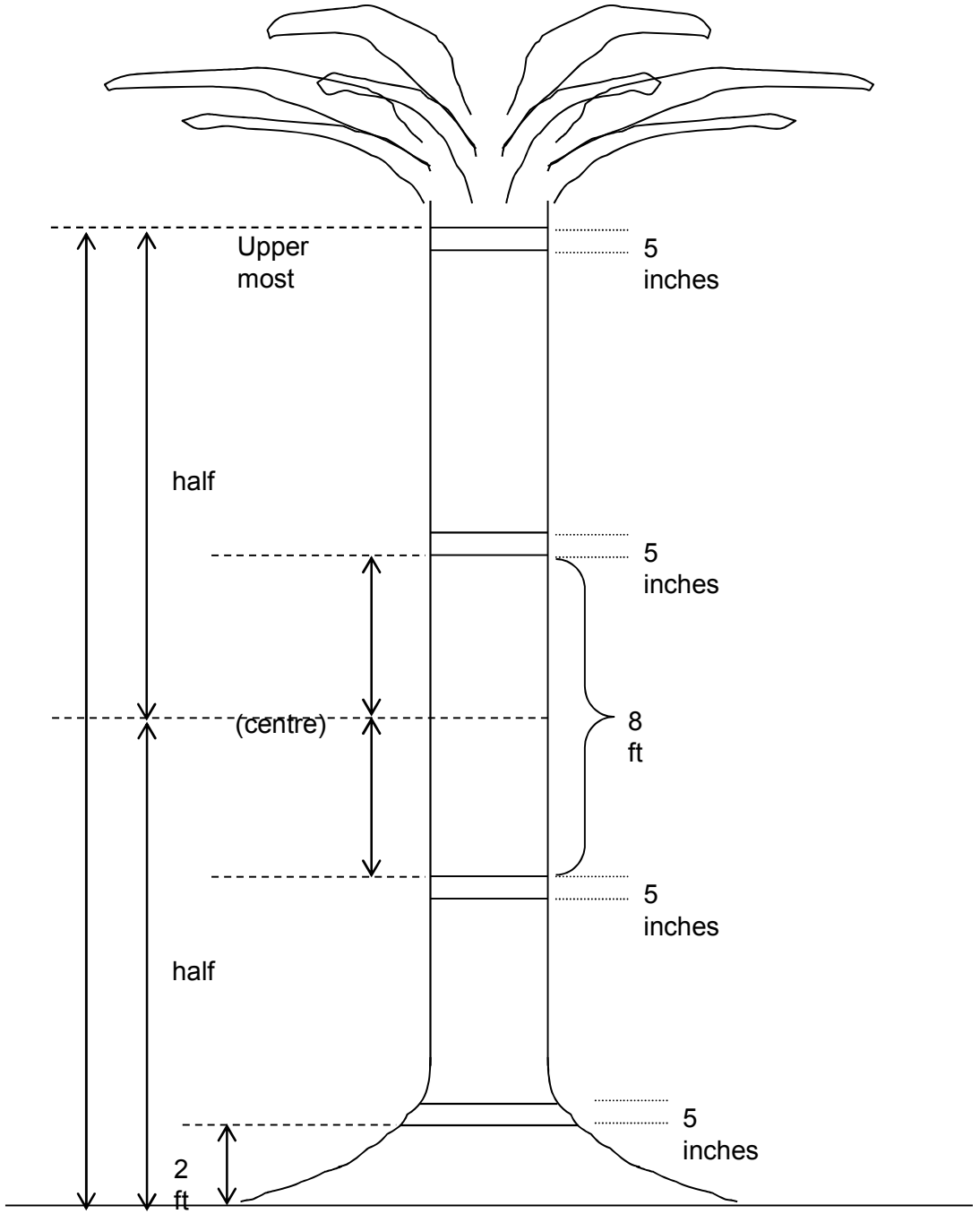


Lactic Acid Production from Oil Palm Sap

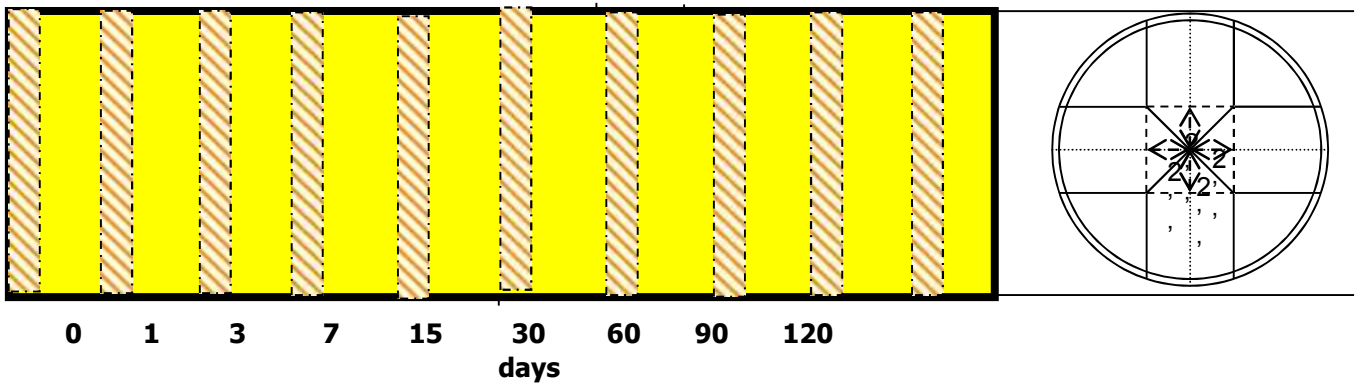


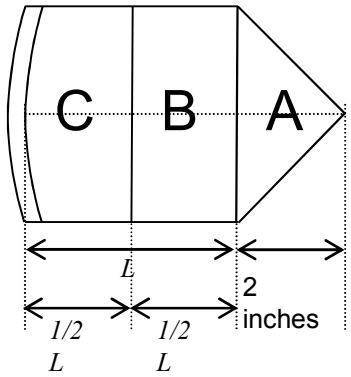
Sugar content and composition at different height

- Same amount and composition throughout the height except uppermost part
- Approximately 20% less at uppermost part



Accumulation of sugars during storage of OPT





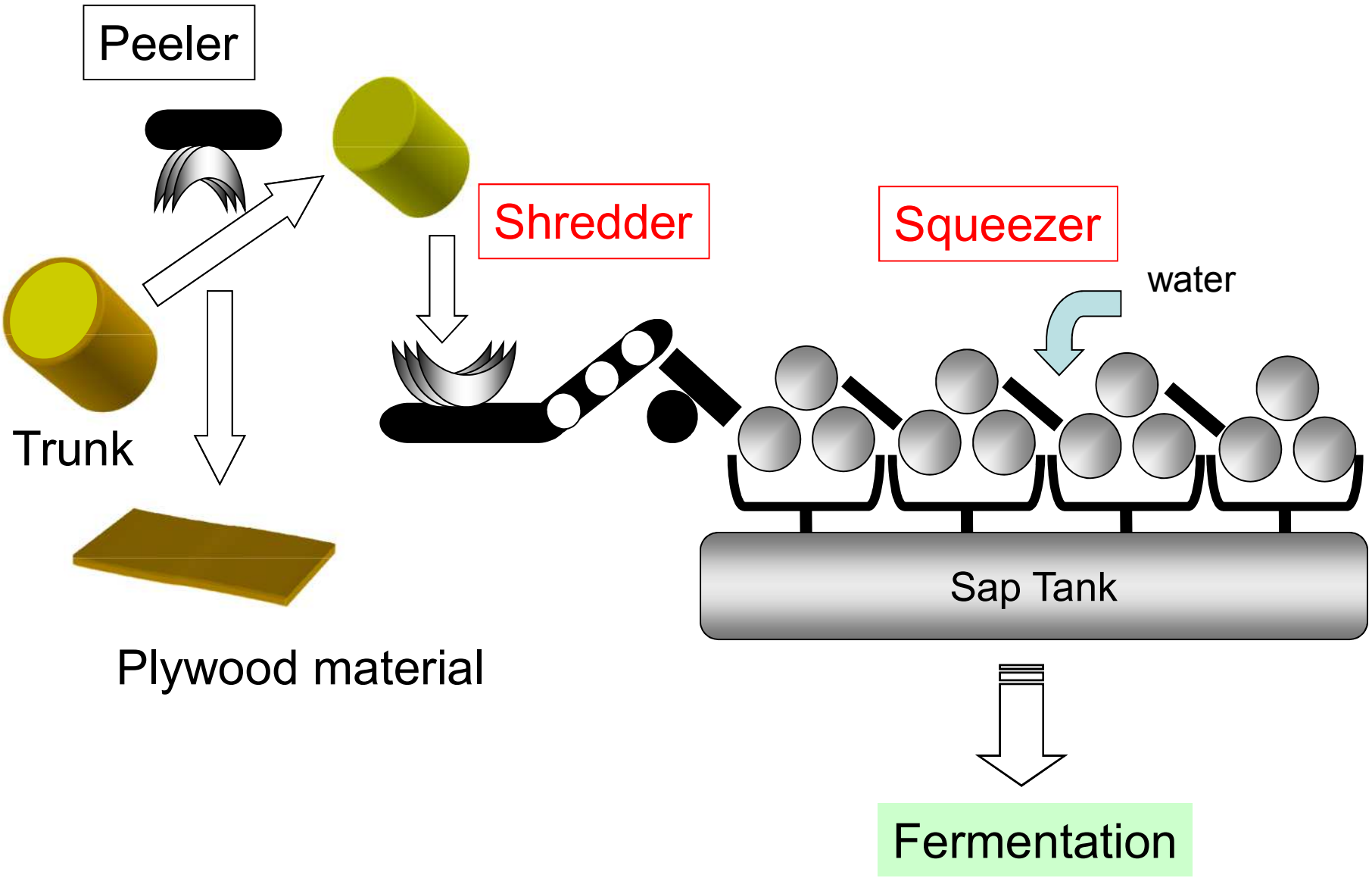
We found out:

sugars in the sap increase significantly during storage.

Comparison of Oil Palm Trunk with Sugar Cane

	Sugar Cane	Oil Palm Trunk (after proper aging)		
		A (Core)	B (Middle)	C (Outer)
Moisture content	70%	83%	75%	68% ×0.8
Sugar content in juice or sap	16%	16%	14%	15%
Amount of sugars contained	112g/kg	95.4g/kg ⇒ 107.8 kg/trunk		
Cane or trunk produced per area	60-90 ton/ha	154-168 ton/ha (136-148 trunks/ha)		
Possible ethanol yield	4.5-7.2 kL/ha	9.5-10.3 kL/ha		

Oil palm sap squeezing system

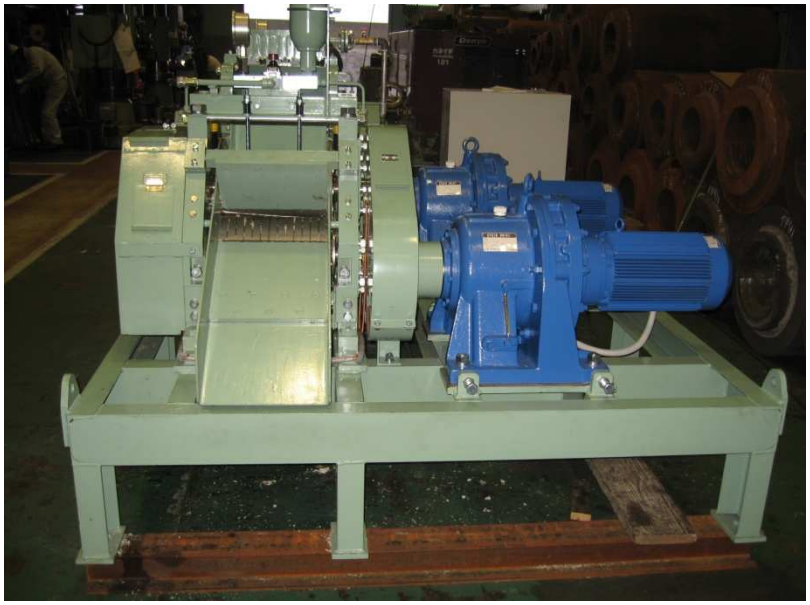


Prototype Shredding machine

Capacity; 550 kg/h

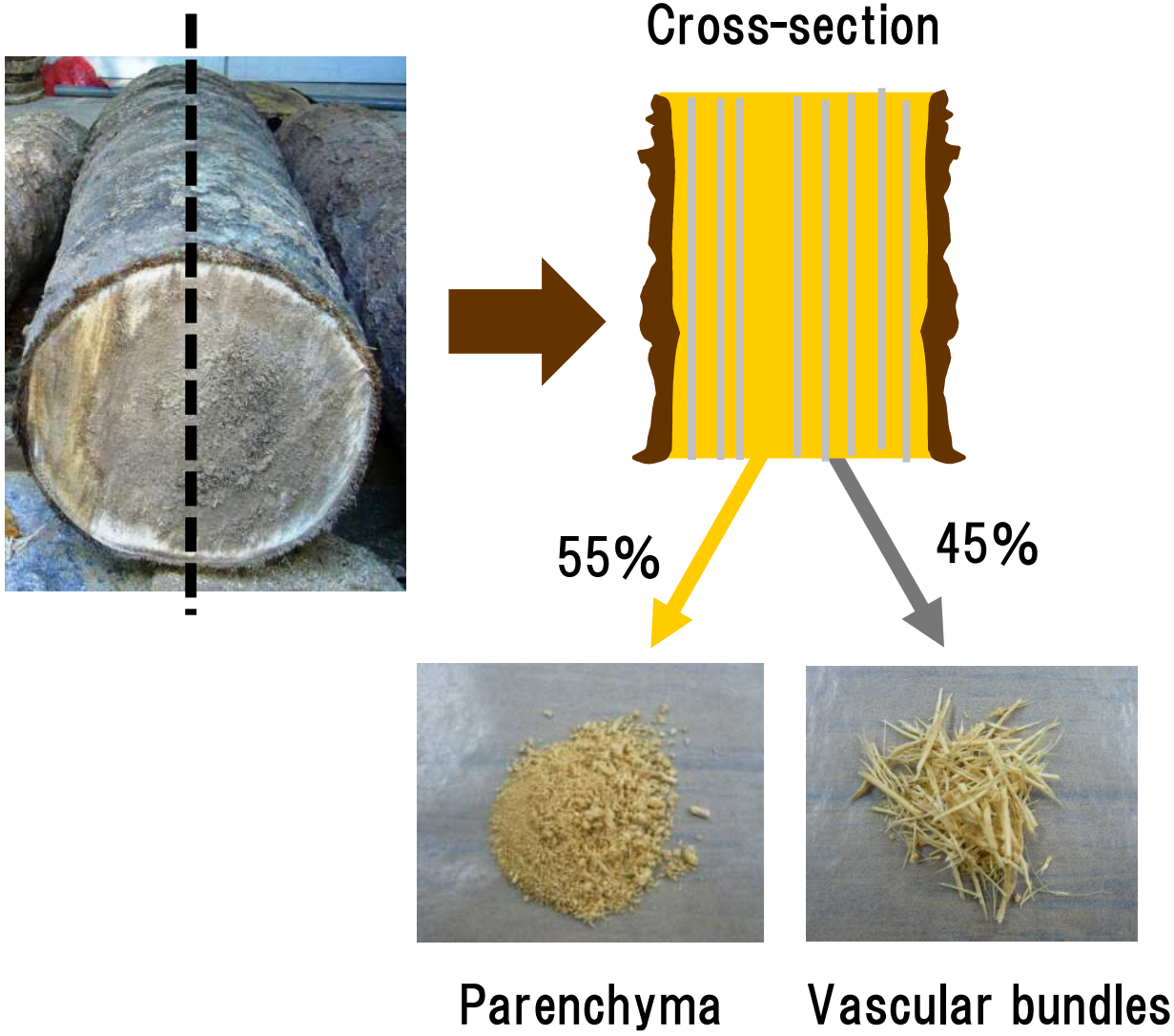
Shredded oil palm trunk

Squeezer

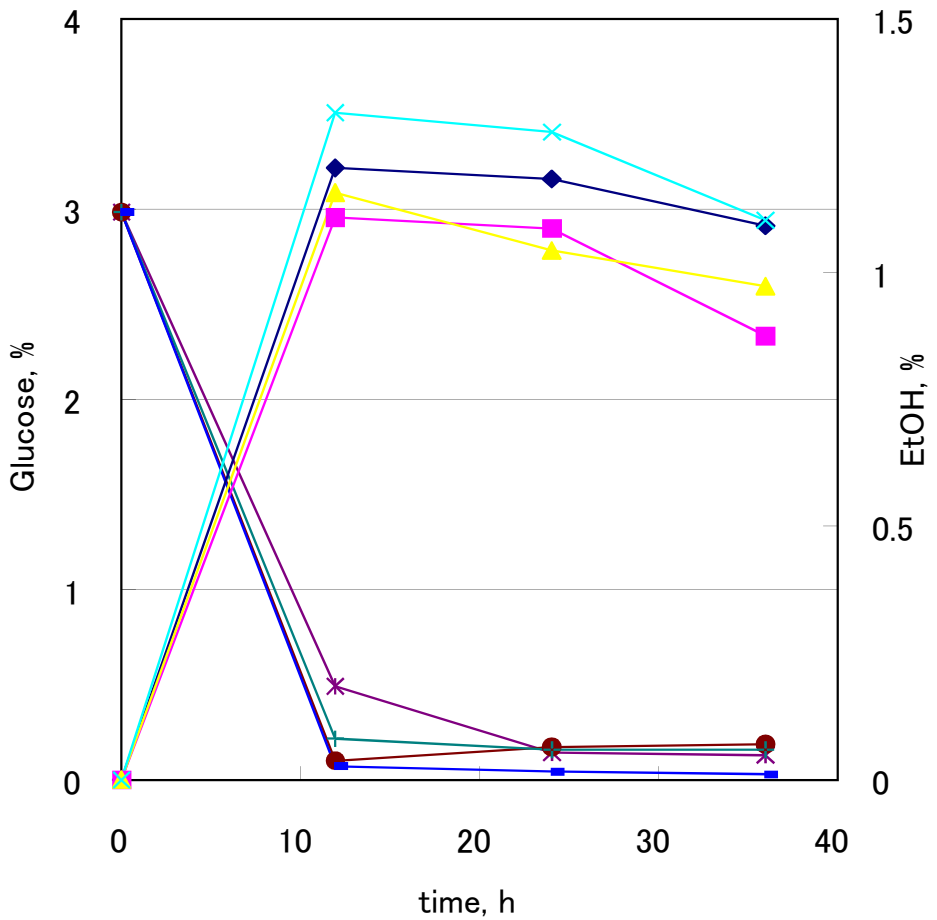


Specs :
3 roller hydraulic press
Size of roller : φ240mm, 340 w
Capacity: 500kg/h
7.5kw x 2 (AC415Vx50Hz)
8RPM variable
2450 x 2030W x 1800H

Solid residues of sap-squeezed trunks



Ethanol production from parenchyma hydrolysate



Ethanol yield（A8）: 86%
（control: 80%)

A5 hydrolysate
A6 hydrolysate + 1% polypeptone, 0.5% yest extract
A7 hydrolysate + 1% $(NH_4)_2SO_4$
A8 hydrolysate + 1% polypeptone, 0.5% yeast extract
Control glucose + 1% polypeptone, 0.5% yeast extract)

Parenchyma separating equipment

Parenchyma and vascular bundles separated by the separator

Possible amount of ethanol and lactate produced from oil palm trunk

Diameter : 38cm
Length : 10m
sp. gr. : 1.0

Fermentable sugars:
16.8kg (core)
39.7kg (middle)
51.3kg (outer)

From one trunk

Sap

Solids (317kg)

Fermentable sugars
(107.8kg)

Parenchyma
(174kg)

Vascular bundles
(143kg)

Lactate: 107.8kg
63.9kg

Ethanol: 69.8L
41.4L

Fermentable sugars
(63.9kg)

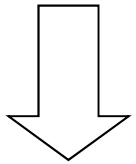
Fermentable sugars
(59.6kg)

Heat etc.

Characteristics and advantages of the OPT as the resource for fuel ethanol and lactic acid production

- Large amounts of sap
- High sugar content
- Easily degradable parenchyma

- Constantly discharged waste
- Very large amount
- Available all year around



Promising feedstock for ethanol and lactic acid

Potential: Malaysia (4.3M ha) 2.7M kL (1.7M kL) ethanol /year

4.2M ton (2.6M ton) lactate /year

Indonesia (7.0M ha)* 4.4M kL (2.8M kL) ethanol /year

6.8M ton (4.3M) lactate /year