

Potential of agro-industrial waste biomass
for second generation of bio-ethanol production
as petroleum substitution



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SATU PERSEPSI, SATU TUJUAN





INTRODUCTION



➤ Indonesian fuel reserves decreased

- 1974 → 15.000 MB
- 2000 → 5.123 MB
- 2005 → 4.301 MB

(OPEC, 2005)

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INTRODUCTION



➤ Indonesian Petroleum production decreased

- 2000 → 1.272.500 barrel daily
- 2004 → 1.094.000 barrel daily

➤ (APEC, 2005)

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INTRODUCTION



- Petroleum Consumption increased
- 2000 → 996.400 barrel daily
- 2004 → 1.243.700 barrel daily
 - IMPORT 2004
 - 49.300 barrel daily
 - (APEC,2005)

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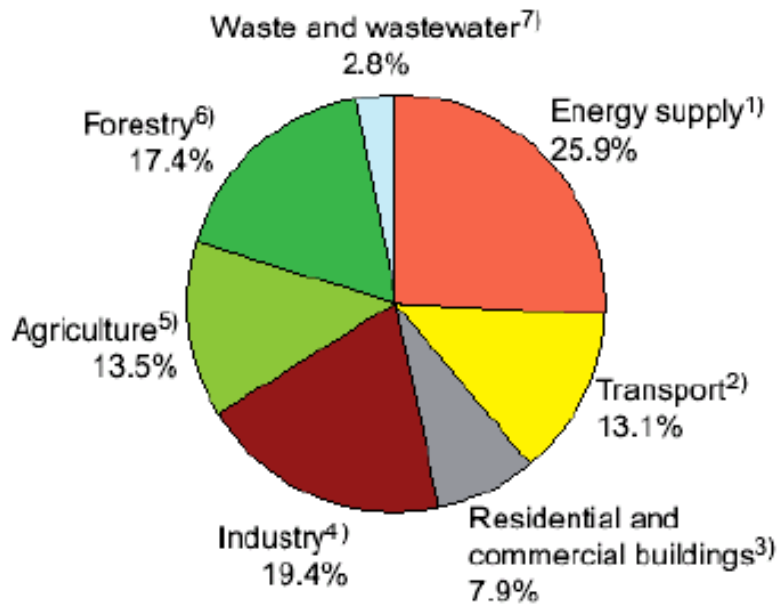
Petroleum Consumption increase causes

Global warming – possible reasons



**Pollution
Gas emission**

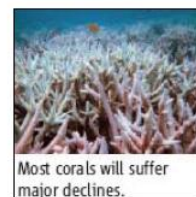
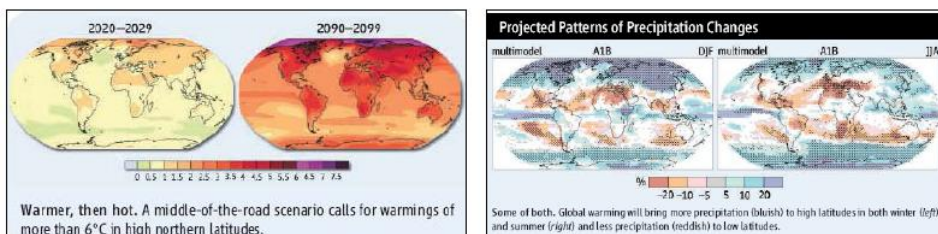
Carbon dioxide (CO₂)
 Methane (CH₄)
 Nitrous oxide (N₂O)
 Hydrofluorcarbons (HFCs)
 Perfluorcarbons (PFCs)
 Sulphur hexafluoride (SF₆)



GHG emissions by sector in 2004 (IPCC, 2007)

Global warming → consequences

“Green-house” effect



Science, 316, 188-190, 2007.



INTRODUCTION

❖ To overcome:

- (1) Depletion of Fossil fuel reserves,
 - (2) Increase of petroleum consumption, and
 - (3) Emmission of green house gas (climate change)
- ❖ Indonesian goverment established energy polycy:
- ✓ Inpres No 1 tahun 2006
 - ✓ Inpres No 2 tahun 2006
 - ✓ Pepres No 5 tahun 2006

➤ FOSSIL FUEL → ALTERNATIF FUEL → BIOFUEL

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INTRODUCTION

Transportation Fuels Global Market

Abundance of Issues

Increasing demand for transport fuel

Increasing concern over environment

Biofuels

Increasing concern over security of supply and rising cost

Increasing demand on agriculture ... food vs. fuel

World is undergoing a historic change...

- Energy is the globes greatest economic threat and opportunity over the next decade

July 29, 2008

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BioFUELS

The race is on...

GAS BIOFUEL : **H₂, CH₄**
LIQUID BIOFUEL: **Biodiesel,**
Biobutanol,
Bioethanol

RAW MATERIALS OF BIODIESEL

Ricinus oil	sunflower	soybean	Palm oil	cotton
				
Yields of the crops (year)				
1.500 kg/ha	1.500 kg/ha	3.000 kg/ha	20.000 kg/ha	3.000 kg/ha
% vegetal oil				
47%	42%	18%	20%	15%
vegetal oil (kg/ha)				
705	630	540	4.000	450

Fonte: diverses (Entorapa, MDA, IBGE, CONAB)

RAW MATERIALS OF BIOETHANOL



**SUGAR CANE
AND CORN
FOR FIRST
GENERATION
BIOETHANOL**

**AGRICULTURAL
WASTE BIOMASS
FOR SECOND
GENERATION
BIOETHANOL**



agro-industrial waste biomass

❖ **DEFINITION OF AWB** (Agro-industrial waste biomass):
**is byproduct of industries which use
agricultural products as raw materials.**

❖ **EXAMPLES OF AWB**

- ❖ Bagasse → by product of sugar industry
- ❖ Palm oil empty bunch → by product of P O Industry
- ❖ Rice straw → by product of rice plantation
- ❖ Corn stover → by product of Corn Plantation
- ❖ Onggok → by product of tapioka industry



agro-industrial waste biomass

Cellulose, hemi cellulose, and lignin contents (%) OF AWB

No	NAME	Cellulose	Hemi C	Lignin
1	Rice straw	37.71	21.99	16.62 a)
2	Bagasse	52.70	20.00	24.20 b)
3	POEB*	45.80	26.00	- c)

a) Dewi, 2002 b) Sansuri *et al.*, 2007 c) Isroi, 2008
 *) POEB = Palm oil empty bunch

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agro-industrial waste biomass

POTENCY OF SECOND GENERATION BIOETHANOL FROM AWB

No	NAME	Total (juta Ton/yr)	Ethanol* (juta kL/yr)
1	Rice straw	286	45,7** a)
2	Bagasse	40	7,9 b)
3	POEB	20	2,0 c)

a) Media, 2008 b) Anonim, 2005 c) Isroi, 2008

*) Calculated using Badger (2007) formula

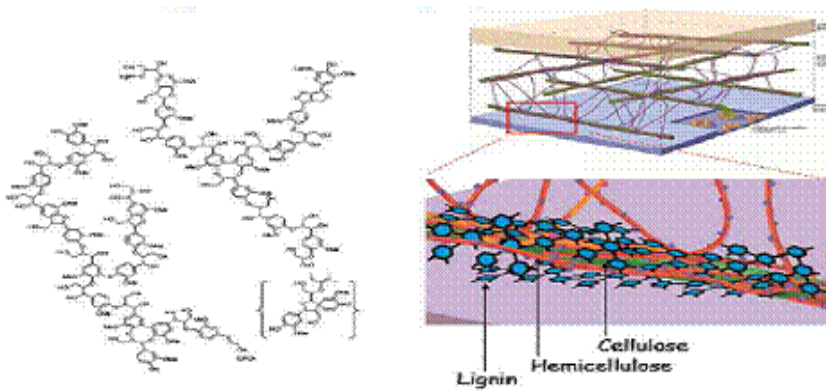
***) Enough for fulfilling premium demand yearly

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agro-industrial waste biomass

❖ POLYMER STRUCTURE OF AWB



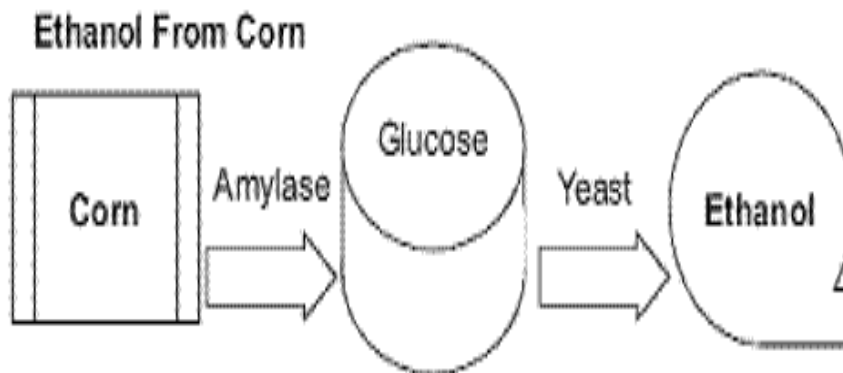
Quintero-Ramirez, 2008

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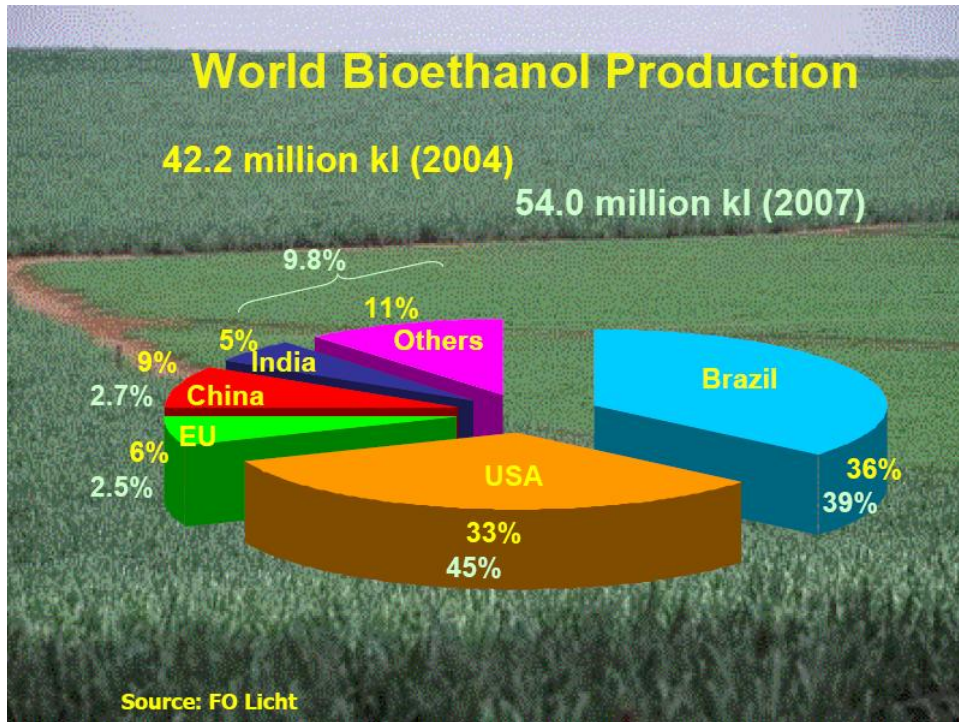
BIOETHANOL PRODUCTION

❖ STEPS OF FIRST GENERATION BIOETHANOL PRODUCTION



McCoy, 1998

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ETHANOL PRODUCTION IN INDONESIA (2005)

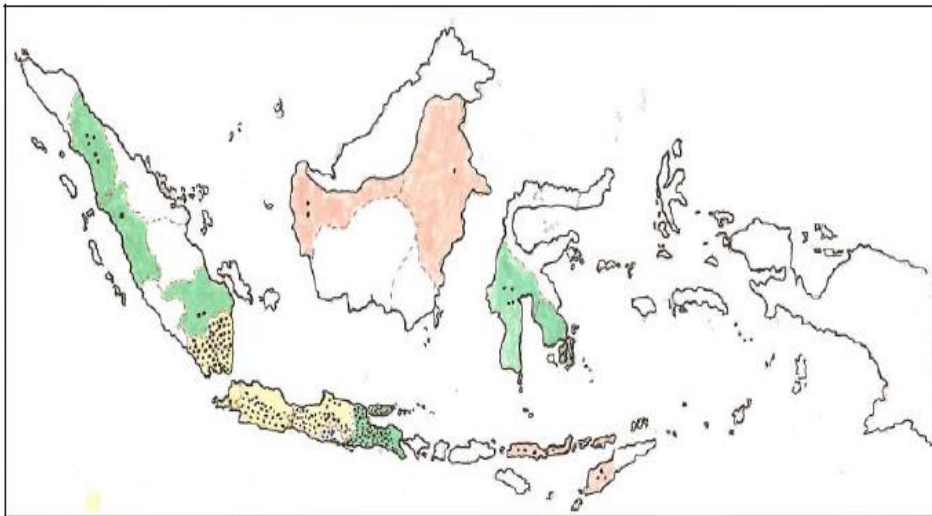
Name of Company	Location	Production Capacity (Kiloliter/y)	Feedstock
PT Aneka Kimia Nusantara	Mojokerto	5.000	Molasses
PT Basis Indah	Sulawesi	1.600	Molasses
PT Bukitmanikam Subur Persada	Lampung	51.282	Molasses
PT Indo Acidama Chemical	Surakarta	42.000	Molasses
PT Madu Baru	Yogyakarta	6.720	Molasses
PT Molindo Raya Industrial	Malang	10.000	Molasses
PT Perkebunan Nusantara XI	Bondowoso	6.000	Molasses
PT Rhodia Manyar	Gresik	11.000	Molasses
B2TP, BPPT	Lampung	~ 30	Cassava

Source : Kompas. April 19. 2006. Product : technical grade ethanol and raw spirit (ethanol: 95-97 % v/v)



Source: Legowo 2007; Total land suitable for sugar cane production is 500,000 ha; Dark green – very suitable land; light green – suitable land; yellow – not suitable land.

Land suitable for sugar cane in Indonesia



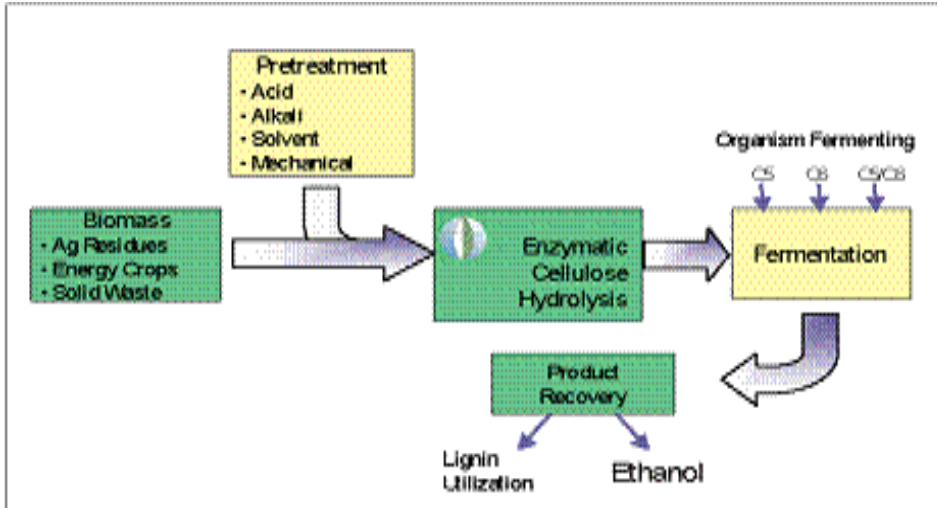
Source: Legowo 2007; Suitable land: white (less than 75 ha), yellow (75-200 ha), green (200-400 ha), red (400-1.800 ha). Each dot represents production potential of 100 tonnes.

Land suitable for cassava in Indonesia



BIOETHANOL PRODUCTION

❖ STEPS OF SECOND GENERATION BIOETHANOL PRODUCTION



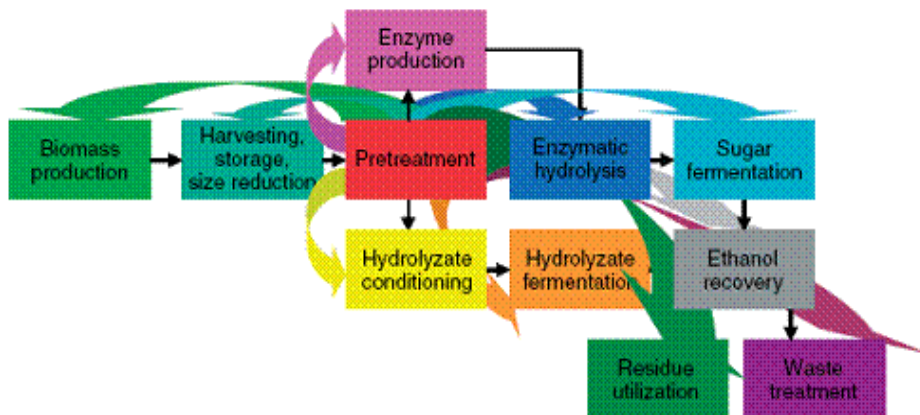
Knauf and Moniruzzaman, 2004

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SECOND GENERATION BIOETHANOL PRODUCTION

❖ PRETREATMENT STEP IS A KEY TO UNLOCK LOW COST OF THE SECOND GEN ETOH



Yan and Wyman, 2008

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SECOND GENERATION BIOETHANOL PRODUCTION

- ❖ The pretreatment generally refers to the disruption of the naturally resistant carbohydrate-lignin shield that limits the accessibility of enzymes to cellulose and hemicellulose (Yan and Wyman, 2008).
- ❖ The pretreatment can be performed (1) **physically** e.g mechanical size reduction, ball milling, compression milling, high temperature, high pressure, (2) **chemically** e.g using sulphuric acid, HCl, H₂O₂, ozone, lime, NaOH, (3) **biologically** e.g using white rot fungi, or (4) **combination** among the three approaches.

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SECOND GENERATION BIOETHANOL PRODUCTION

- ❖ However, the choice of pretreatment technology is not trivial and must take into account sugar-release patterns and solid concentrations for each pretreatment in conjunction with their compatibility with the overall process, feedstock, enzymes, and organisms to be applied.
- ❖ Therefore, researches to find out the best pretreatment for certain agro-industrial waste biomass in Indonesia should be carried out intensively

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CONCLUSION

- ❖ Since Indonesia has abundant and cheap agro-industrial waste biomass, **productions of the second generation bioethanol from the biomass are essential in order to overcome our excessive dependence on petroleum for liquid fuels and also to address the build-up of greenhouse gases that cause global climate change.**
- ❖ **Pretreatment step** is the key cost element in the biological conversion of agro-industrial waste biomass to bioethanol and **must be advanced and carefully** integrated with the rest of the process **to realize the full potential of cellulosic ethanol** or other biologically derived products.
- ❖ **It is now time for far more aggressive and intensive to carry out fundamental and applied researches on the pretreatment step and its integration with the rest of the second generation bioethanol process.**

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Thanks a lot for your attention;
I am sure ,
we can work together
to achieve better performance !

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