



Sugar Palm (*Arenga pinnata* Merr) Plantation for Bioethanol Production, Sustainable Development and Environmental Conservation

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Introduction

Sugar biomass,

sugarcane, *arenga pinata*,
Coconut



Fermentation

Starch biomass

Sagoo, cassava,
corn, sweet potato,
shorgum



Liquifaction
Hydrolysis

Fermentation

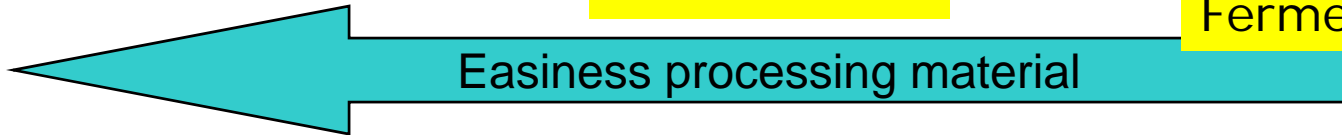
Cellulosic biomass

- Stalk
- Wood waste

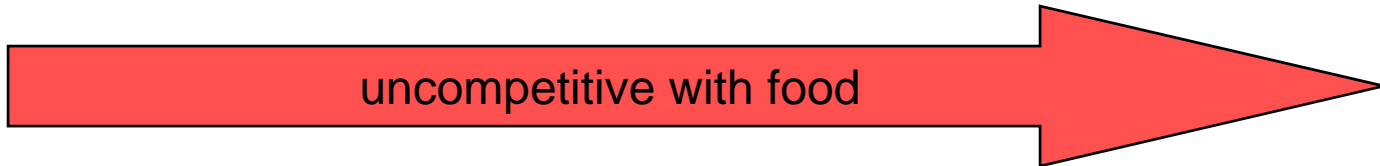
Pre-treatment

Hydrolysis

Fermentation



uncompetitive with food



Sugar Palm (*Arenga pinnata* Merr)



- Sugar Palm (*Arenga pinnata* (Wurmb.) Merr) has high economical value; almost all of part of plant (stem, leaf, fruit, palm blossom, fiber, root) are useful for human life.
- Sugar palm has potency for about 60 kind of products that economically viable and potential for export.



Product of Sugar Palm

- Sugar palm sap consist of sucrose : 84 %
- Starch : 60-70 kg/ tree
- Sugar palm sap is tapped at 6 years of plant age, from productive 3-12 stalk or equal to 900 – 1600 liters/tree/year with sugar content of 15-20%.
- Sugar palm has potency of 40 000 liters bioethanol per hectare per year.



Growing Conditions

- Growth at 500 – 800 m from sea level with rainfall more than 1200 mm per year.
- Tolerant to some kind of soil, but not tolerant to acid soil
- Sugar Palm (*Arenga pinnata* Merr) grows scattered almost all of part of Indonesia, especially for about 14 provinces, such as: Papua, Moluccas, North Moluccas, West Sumatra, West Java, Central Java, Banten, North Celebes, South Celebes, South East Celebes, Bengkulu, South Borneo and Nangroe Aceh Darussalam.
- With total area 70 000 hectares

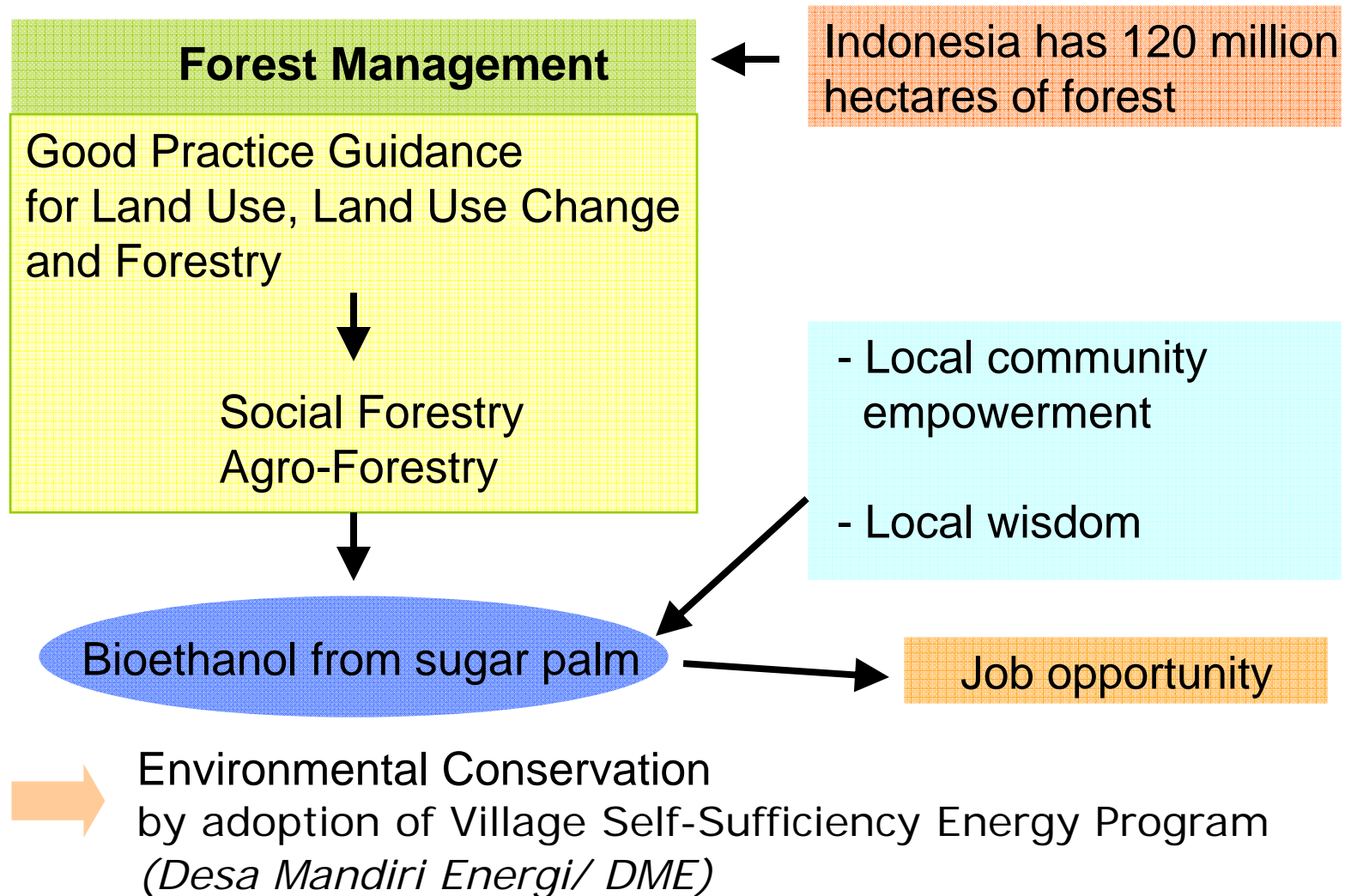


Functions

Sugar palm has multifunction such as

- resources of sugar, food, medicine
- resources of material for rope, roof, broom, handy craft, etc
- resource of biofuel
- environmental conservation.
 - to prevent erosion
 - to increase soil porosity and to capture rain water
 - to improve microclimate

Sugar Palm Plantation





Bioethanol Research and Development at ICAERD (2007)

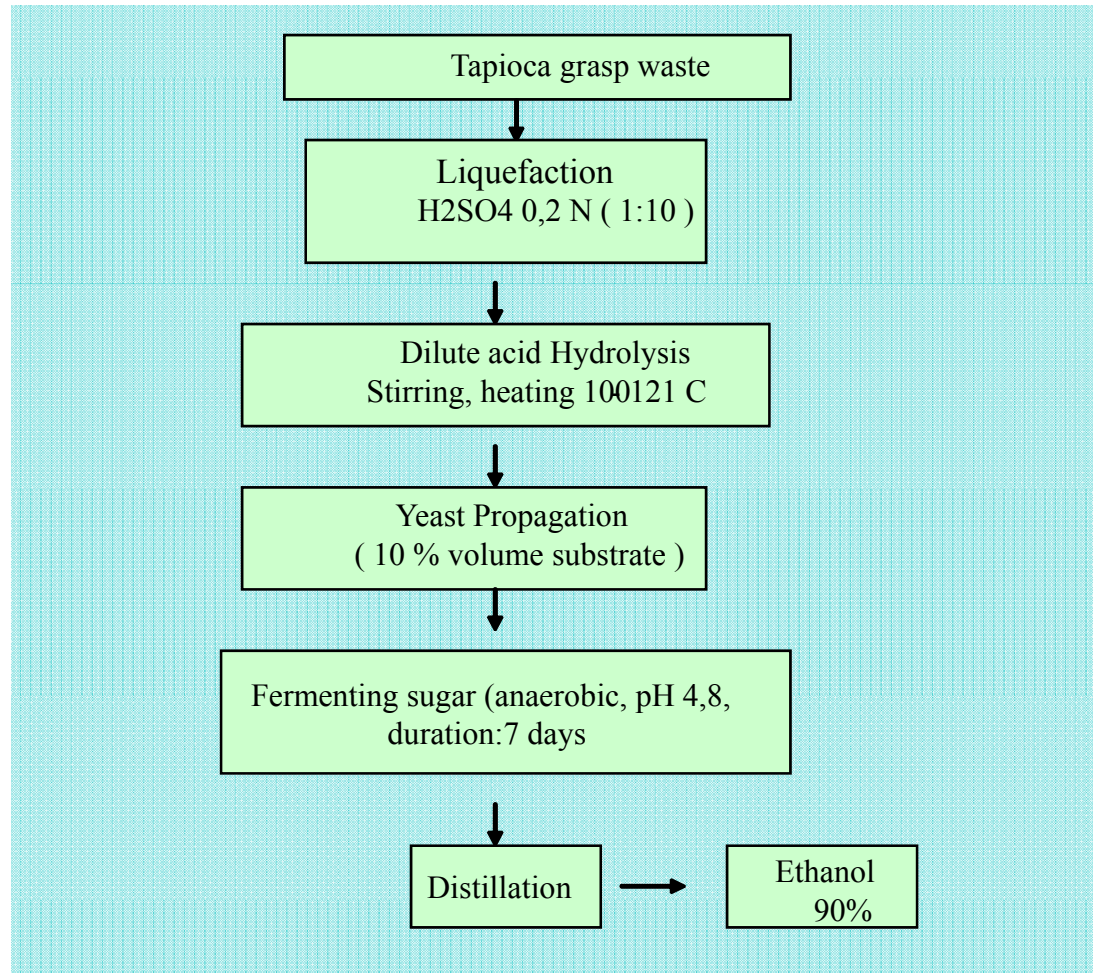
Prototype of small unit installation for bioethanol production

- Saccharification unit
- Fermentation unit
- Distillation unit

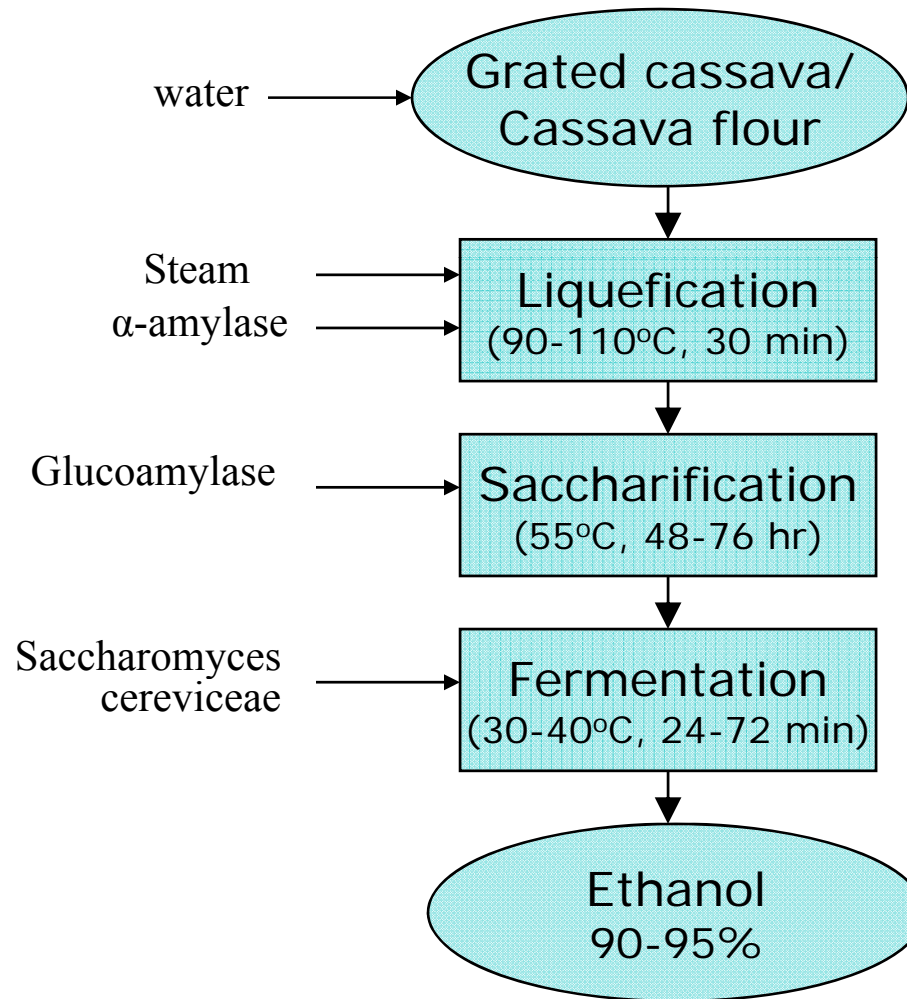
Method

- Acid Hydrolysis of cassava grate waste (using H₂SO₄)
- Enzymatic Hydrolysis of tapioca
- Develop small scale bioethanol processing unit : Hydrolysis tank, Fermentation tank and distiller

Bioethanol from cassava grasp waste



Bioethanol from Tapioca



Result

1 tone Cassava : 300 kg grasp waste,
80 kg peelings, tapioca starch 250 kg.



Cassava grasp waste



Development Bioethanol Processing Unit

- Liquefaction /saccharification tank : volume 100 liter, stirrer, LPG heater
- Fermentation tank : 100 liter, stirrer
- Distiller : adopt packing bed column distiller. Packing material SS Scrubber, LPG Heater

Testing

- Functional Test





Result

Cassava grasp waste before fermentation

Material	Method	Result	Unit
Protein	Kjedahl	1.21	%
Fat	Soxlet	0.32	
Serat kasar	Gravimetri	1.16	
Starch	Spektro	12.41	
Reduction sugar		0.14	

Hydrolysis after fermentation

Material	Method	Result	Unit
Starch	Spektro	3.46	%
Protein	Kjedahl	1.61	%



Testing for packing bed column distiller

Testing for packing bed column distiller :
-Control variable vapor temperature

Result :

Setting Vapour Temperature (°C)	Ethanol content (% v/v)	Ethanol yield (litre/hour)
60 – 65	90 – 92	0.2
78 – 82	87 – 92	0.98
85 – 89	70 – 75	1.2
90 – 95	40 – 55	1.8



Conclusion (1)

- Sugar Palm (*Arenga pinnata* (Wurmb.) Merr) has high economical value; almost all of part of plant (stem, leaf, fruit, palm blossom, fiber, root) are useful for human life. Sugar palm has potency for about 60 kind of products that economically viable and potential for export.
- Sugar palm has potency of 40 000 liters bioethanol per hectare per year. In addition, sugar palm has multifunction such as resources of sugar, food, medicine, biofuel and environmental conservation.
- Generally, sugar palm is growing naturally. It is not cultivated yet on large scale like as plantation. The plantation able to create job opportunity at rural area; it employs many farmers as palm-sap tapper.
- On development and to ensure sustainability of feedstock for bioethanol production, it should consider to several factors as environmental impact by agro forestry approach, local wise, rural community empowerment and institutional establishment.



Conclusion (2)

- ICAERD developed a small unit installation for bioethanol production with capacity of 100 liter. It comprises saccharification unit, fermentation unit and distillation unit.
- Testing of bioethanol production from solid waste tapioca factory was done by proceeding with acid hydrolysis pretreatment. While bioethanol production from tapioca, it was done by enzymatic hydrolysis. Distiller testing revealed the 92% ethanol in a step of distillation.
- Economic analysis showed that it was feasible in small scale production with capacity of distillery may be around 600 -1200 liter broths per day.
- Based on this experience, scaling-up of the installation for bioethanol production from sugar palm at farmer group level is possible to be conducted.