

**BIOETHANOL PRODUCTION THROUGH  
SIMULTANEOUS SACCHARIFICATION  
AND FERMENTATION PROCESS: RENEWABLE  
ENERGY OPTION FOR NIGERIA  
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# Introduction

- The consumption of fossil fuels derived from petroleum is one of the main sources of pollution to the environment while its demand is increasing (Jönsson, *et al.*, 2013).
- Bioethanol is sustainable, biodegradable, high combustion efficiency, and has the ability to promote agricultural sector development, and reduce greenhouse gases (Baeyens *et al.*, 2015).

# Introduction contd.

- Simultaneous saccharification and fermentation (SSF) is a process that combines enzymatic hydrolysis with fermentation to obtain value-added products in a single step (Kumagai *et al.*, 2014)

## **Advantages of SSF**

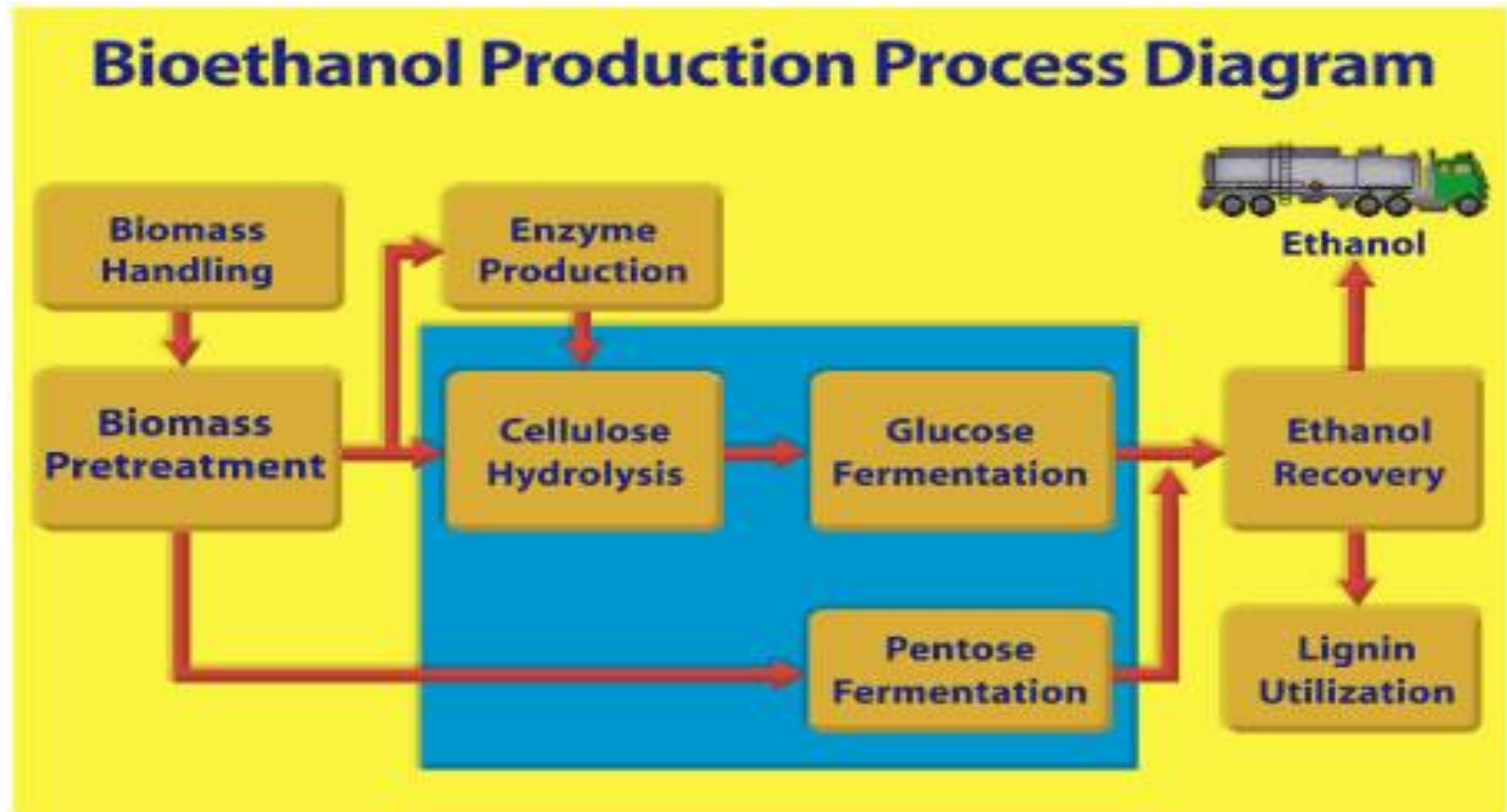
- single vessel
- reducing residence time
- Capital cost reduction (Abdel-Banat *et al.*, 2010).
- reduction of inhibitory (Kumagai *et al.*, 2014).

# Introduction contd.

## Why renewable Energy (Bioethanol) in Nigeria

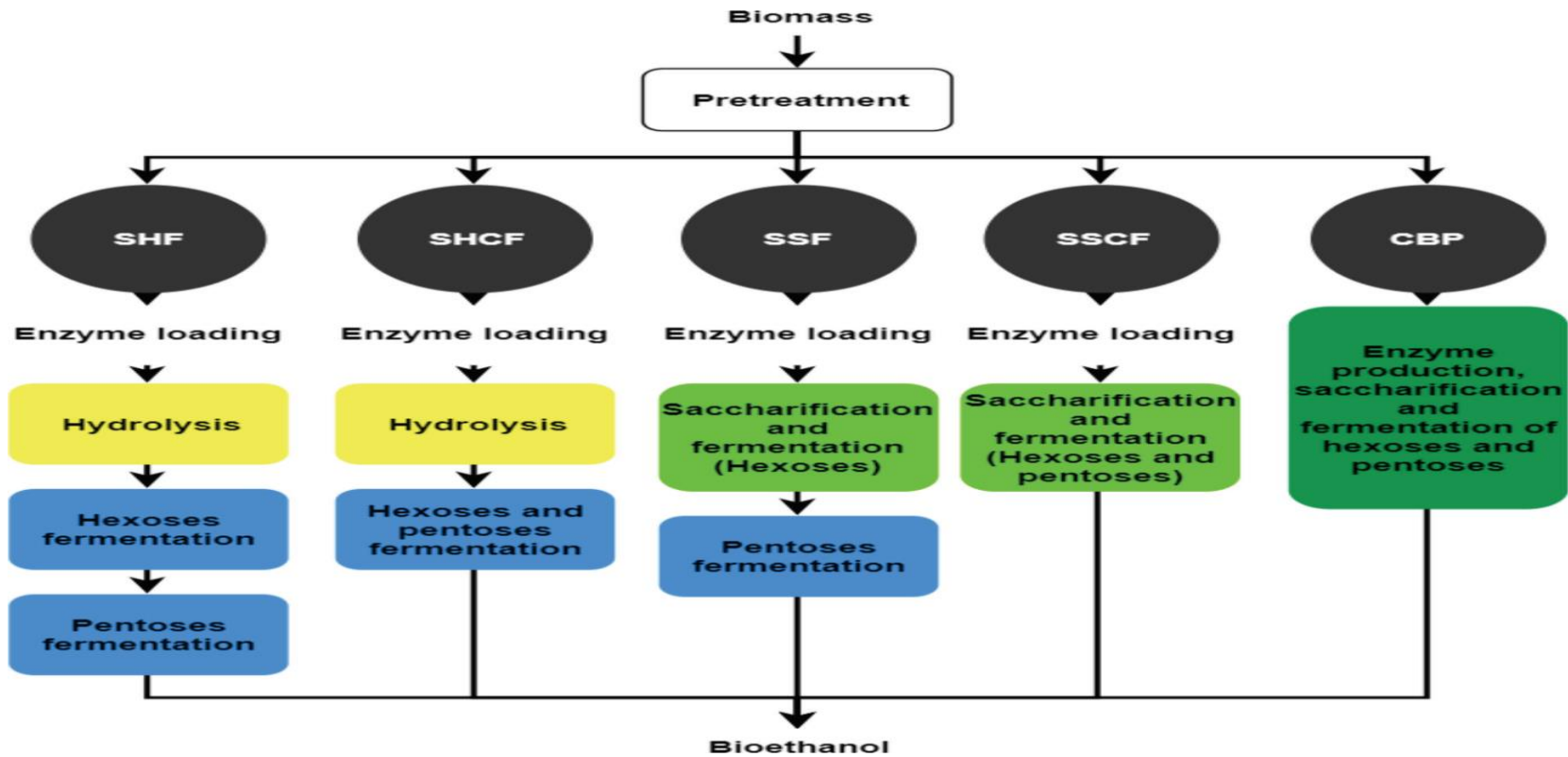
- To secure access to energy
- To mitigate climate changes
- To develop and maintain agricultural activities
- To ensure food safety
- Affordable energy
- Social stability(Bhaskar *et al.*, 2011; Bhaskar T *et al.*, 2007).

# Figure 1: Bioethanol Production Process



Source: Bioethanol process green and practical 2022

# Figure 2: Processes for second-generation bioethanol production

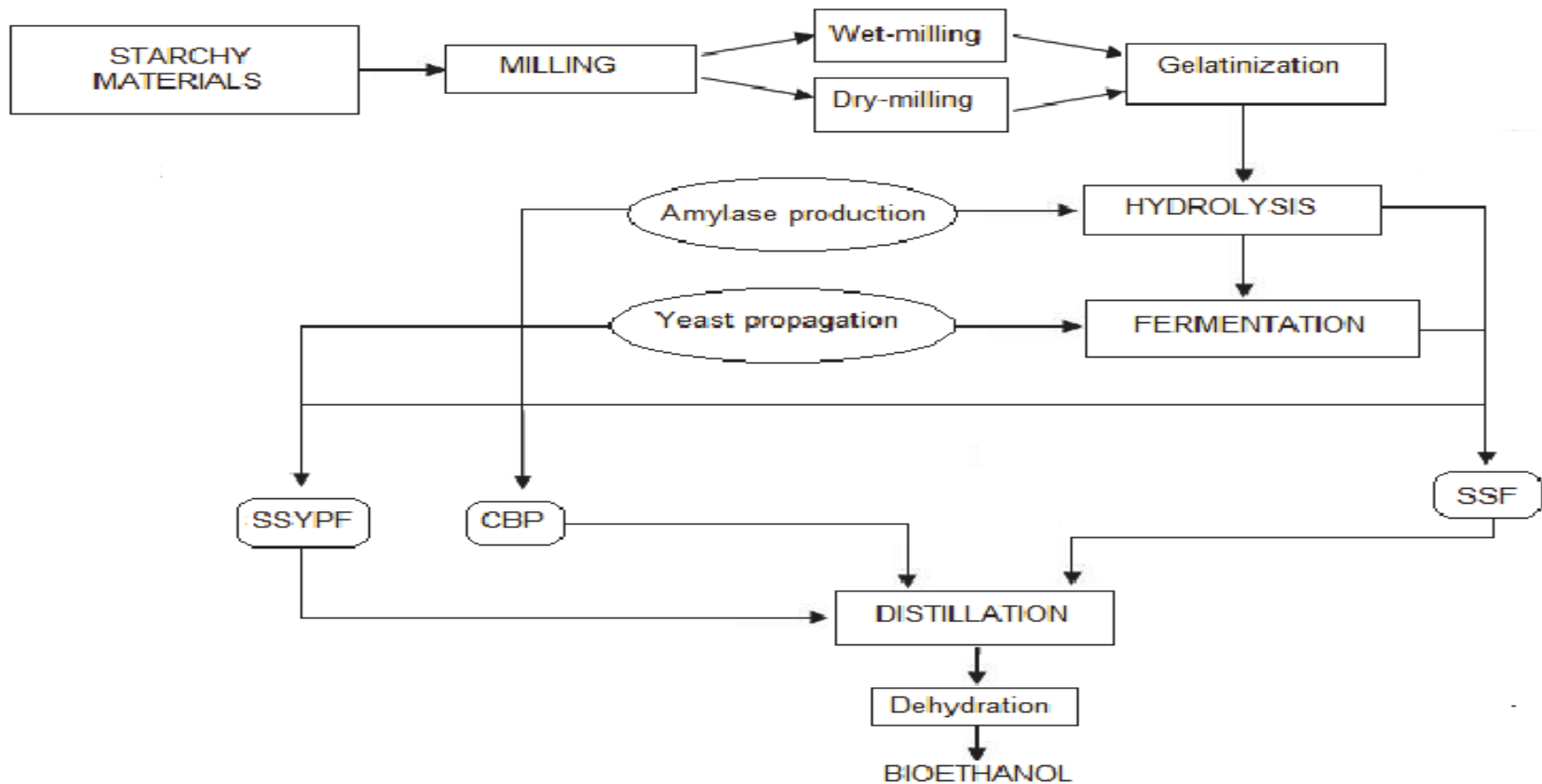


# Conditions for Bioethanol Production

- Rapid fermentative potential
- Improved flocculating ability
- Appropriate osmotolerant
- Enhanced ethanol tolerance
- Good thermo tolerance

(Benitez *et al.*, 1983; Diwanya *et al.*, 1992)

**Figure 3: flowsheet for bioethanol production through SSF**



**Source:** Giovanni Di Nicola 2011



# Table 1: Emerging Bioethanol/Biofuel projects in Nigeria

Project	Cost	Location	Owners	Feedstock	Feedstock quantity (tonnes / year)	Project summary, ethanol production / year	Land take (ha)	Project phase
Automotive biofuel project	\$306M	Agasha, Guma, Benue State	NNPC/private sector	Sugarcane	1.8 million	75 million litres, 116,810 metric tonnes (sugar), 59 MW (electricity)	20,000 (16,000 will be cultivated)	Planning
Automotive biofuel project	\$306M	Bukaru, Benue State	NNPC/private sector	Sugarcane	1.8 million	75 million litres, 116,810 metric tonnes (sugar), 59 MW (electricity)	20,000 (16,000 will be cultivated)	Planning
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Automotive biofuel project (Kwali Sugarcane ethanol project)	\$80 - 100M	Abuja, FCT	NNPC/private sector	Sugarcane	1.8 million	120 million litres, 10-15 MW (electricity)	26,374 estimated	Planning
Automotive biofuel project	\$125M	Ebenebe, Anambra State	NNPC/private sector	Cassava	3-4 million	40-60 million litres	15,000	Planning
Automotive biofuel project	\$125M	Okeluse, Ondo State	NNPC/private sector	Cassava	3-4 million	40-60 million litres	15,000	Planning
Ethanol refinery and Sorghum farm	\$70M	Arigidi Akoko, Ondo State	Global biofuel Ltd.	Sweet sorghum	1.05 million estimated	84 million litres bio-refineries + farm estimated	30,000 acquired	EPIC
Ethanol refinery and Sorghum farm	\$92M	Illemso, Ekiti State	Global biofuel Ltd.	Sweet sorghum	385,000 estimated	30.8 million litres bio-refineries + farm estimated	11,000 acquired	EPIC
Ethanig (via Starcrest Nigeria Energy)	\$300M estimated	Kastina Ala/Benue River Basin of Benue State	Private	Sugarcane	3.25 million estimated	100 million litres, sugar, and electricity	50,000	Planning
Ethanig (via Starcrest Nigeria Energy)	\$300M estimated	Kebbi State	Private	Sugarcane	3.25 million estimated	100 million litres, sugar, and electricity	50,000	Conception
Savannah sugar company	\$167M	Numan, Adamawa State	Dangote Industries Ltd	Sugarcane	1 million	Expansion to produce 100 million litres, 1 billion tonnes sugar, 100,000 metric tonnes fertilizer and 300 MW electricity	36,000 (Lau, Taraba State)	Planning
Kwara Casplex Ltd.	\$90M estimated	Kwara State	Private/government	Cassava	300,000 estimated	38.86 million litres	15,000	EPIC
Oke-Ayedun Cassava ethanol project	\$18M	Oke-Ayedun, Ekiti State	Ekiti State Government/ Private	Cassava	238,500	38.1 million litres bio-refinery + farm	15,000	EPIC
CrowNet Green Energy ethanol plant	\$122M	Iyemero, Ekiti State	Ekiti State Government/ Private	Cassava	150,000	65 million litres, (100 t of starch and 50 t CO <sub>2</sub> /day)	12,500	Operational (4 Sept. 2008)
Cassava ethanol plant	\$115M	Taraba State	Taraba State	Cassava	300,000	72 million litres, 360,000 t of cassava flour, 1.87 million tonnes CO <sub>2</sub> and 57 MGy of liquid fertilizer, 1600 MW electricity	30,000	EPIC
Niger State Government ethanol plant	\$90M estimated	Niger State	Niger State	Cassava	150,000	27 million litres, bio-refinery + farm estimated	15,000	EPIC
Cassava bioethanol project	\$138M	Niger Delta region	NA	Cassava	0.32 million estimated	58 million litres/year bio-refinery + farm	20,000	Conception
Bioethanol from sugarcane/molasses	\$85M	Niger Delta region	NA	Sugarcane	0.857 million estimated	60 million litres	67,692 estimated	Conception
Cassava industrialization project	\$16.4M	Ogun State	Private + Government	Cassava	75,000	3 million litres	5000	Conception
National Cassakero cooking fuel programme	\$1B	36 states + Abuja	Private	Cassava	8 million	1.44 billion litres	400,000	EPIC

Source : Ohamian 2010

# conclusion

SSF is unique process which will produce high volume of bioethanol for blend with gasoline.

- Nigeria ranked 15<sup>th</sup> in plaintain and banana production with over three million MT/ Annum.
- 15 rich countries such as USA, Europe had through NNPC supported Nigeria in developing 19 bioethanol projects.
- SSF will enhance Nigeria's bioethanol production for greener environment.