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Biofuels and Sustainable Energy Development Growth in Nigeria

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NIGERIA IN PERSPECTIVE

Nigeria is the most populous country in Africa with an estimated population of 140 million. It is also the biggest producer of crude oil on the continent. The biomass resources in Nigeria consist of wood, forage grasses and shrubs, animal wastes arising from forestry, agricultural, municipal and industrial activities as well as aquatic biomass. According to a 2008 estimate by the Energy Commission of Nigeria, the biomass resources in Nigeria is about 44 million tonnes/year and the annual consumption of fuel wood is about 43 million tonnes.

Introduction

- In order to achieve a stable energy alternative that will satiate world demand while mitigating climate change, it is vital to develop renewable clean fuels
- Most renewable energy initiatives are focused on electricity generation, while the world energy consumption, about two-thirds, is derived from liquid fuels (Hankamer et al. 2007)
- Government organizations and major corporations are beginning to seriously invest in the biofuels market, in both research and commercial production; however the many existing alternatives such as ethanol, hydrogen, and conventional biodiesel fail to be cost competitive with petroleum (Scott and Bryner, 2006)

Nigeria's Potential for Biofuel Production

- Solar radiation intensity varying from an annual average of 3.5 – 7.0 kWh/m^2;daily sunshine hours varies between 4 – 9 hours
- Favourable climatic conditions
- Cheap labour
- Underdeveloped non-arable land
- Large population

Planned/Ongoing Biofuel Projects in Nigeria

- Jatropha-based biodiesel plant in Kogi State by Global Green Field Development Group
- Microalgae-to-Bio-fuel Technology Demonstration and Educational Centre in Badagry, Lagos State by Univerve Ltd(Israel)/Actiview Solutions(Belgium)

Viable sources of biofuels

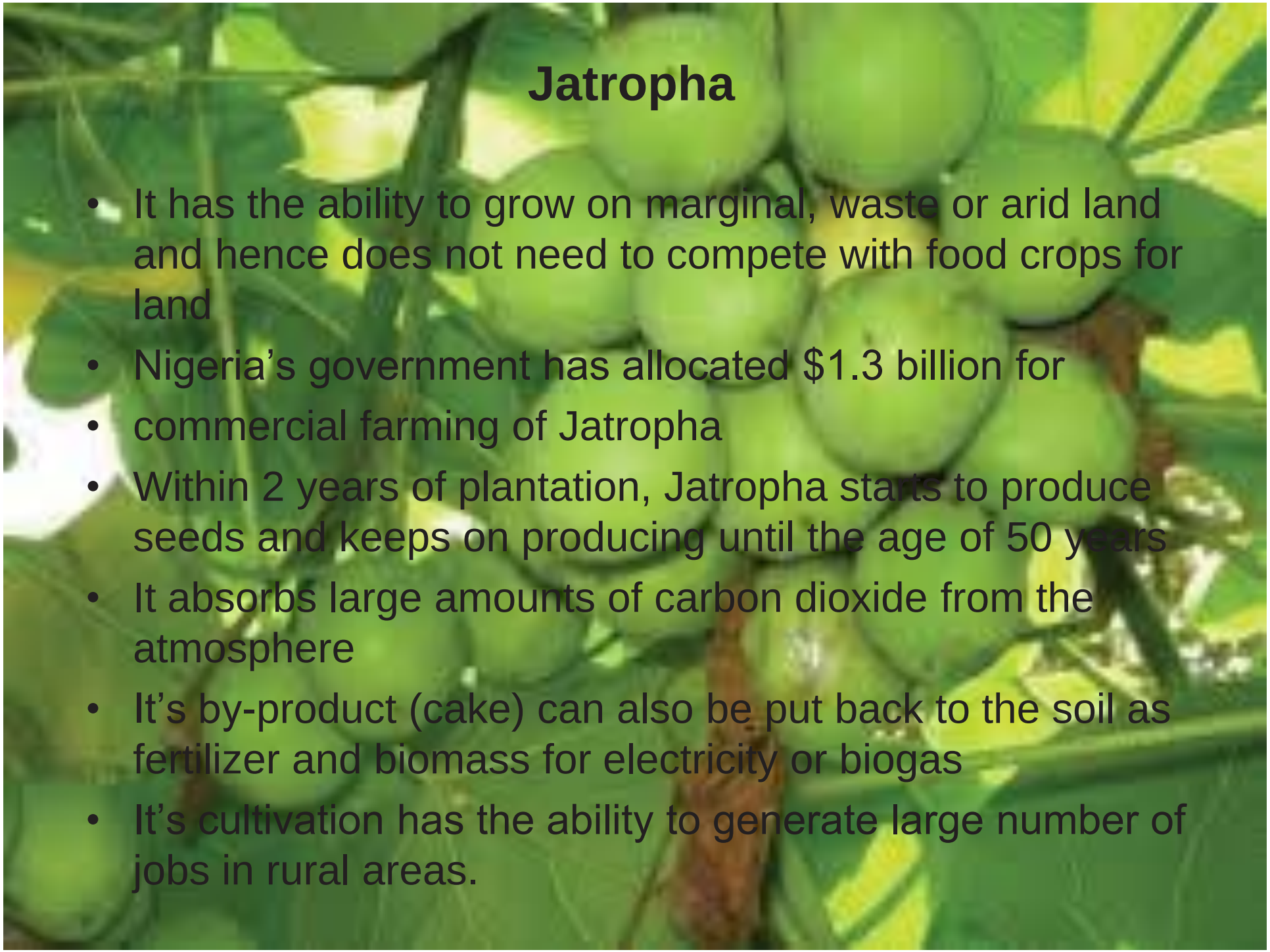
- Vegetable Oils
- Palm Oil
- Jatropha
- Algae

Vegetable Oil

- It is abundant and widely available
- Biodiesel can be made from vegetable oil by a chemical reaction with methanol and lye (NaOH)

Palm Oil

- It can serve as an alternative vehicle fuel
- Its physical properties are not very different from the properties of Grade 2 diesel fuel except that the former has a higher specific gravity and viscosity and a lower cetane index and calorific value
- Technically, it is suitable for use in diesel engines. The power output of the engine using palm oil as fuel is higher than that of diesel fuel as expected since palm oil has a higher specific gravity



Jatropha

- It has the ability to grow on marginal, waste or arid land and hence does not need to compete with food crops for land
- Nigeria's government has allocated $1.3 billion for
- commercial farming of Jatropha
- Within 2 years of plantation, Jatropha starts to produce seeds and keeps on producing until the age of 50 years
- It absorbs large amounts of carbon dioxide from the atmosphere
- It's by-product (cake) can also be put back to the soil as fertilizer and biomass for electricity or biogas
- It's cultivation has the ability to generate large number of jobs in rural areas.

Algae

- It is one of the most versatile renewable resources which can be converted to fuel, electricity, heat and fine chemicals
- It can utilize saline water
- It can grow quickly
- It can be used in conjunction with waste water treatment
- Its has greater yield than its land-based counterparts
- It is a non-food resource
- It can reduce carbon emissions depending on where it’s grown.

Comparison of Microalgae with other Biodiesel Feed Stocks

Plant Source	Seed Oil Content (% oil by wt. in bm)	Oil Yield (L/oil/ha/yr.)	Land use (m^2yr/ Kg bd)	Biodiesel Productivity (Kg bd/ha/yr.)
Corn/Maize	44	172	66	152
Hemp	33	363	31	321
Soybean	18	636	18	562
Jatropha	28	741	15	656
Camelina	42	915	12	809
Canola/ Rapeseed	41	97	412	862
Sunflower	40	1070	11	946
Castor	48	1307	9	1156
Palm oil	36	5366	2	4747
Microalgae[1]	30	58 700	0.2	51 927
Microalgae[2]	50	97 800	0.1	86 515
Microalgae[3]	70	136 900	0.1	121 104

[1] (low oil content)

[2] (medium oil content)

[3] (high oil content)

bd = biodiesel

bm = biomass

Source: Adapted from Mata et al., (2010)

Four most important microalgae groups in terms of abundance

Microalgae	Known species	Storage Material	Habitat
Diatoms	100 000	Carbohydrates and Triglycerides	Oceans, freshwater and brackish water
Green Algae	8 000	Starch and Triglycerides	Freshwater
Blue Green Algae	2 000	Starch and Triglycerides	Different habitats
Golden Algae	1 000	Triglycerides and carbohydrates	Freshwater

Algae Development in Nigeria

- Samples studied consisted of green algae strains and diatoms such as: Scenedesmus bijuga, Chlorella vulgaris, Chlorella sp., Chlooroococcum sp. and Chlymadomonas

BOLD BASAL MEDIUM (BBM) SOLUTION

SALTS/NUTRIENTS	CONCENTRATION
Stock A	**g/400mL ddH_2O**
$NaNO_3$	10.0
$CaCl_2.2H_2O$	1.0
Stock B	**g/400mL ddH_2O**
$MgSO_4.7H_2O$	3.0
K_2HPO_4	3.0
$Na_2HPO_4.2H_2O$	2.4
KH_2PO_4	7.0
NaCl	1.0

Recommendations to Policy Makers

- Encourage subindustry collaboration
- Clarify roles and responsibilities within government agencies
- Begin life cycle analysis (LCA) at the fuel production design phase
- Conducting environmental impact assessments (EIA)

Recommendation to Industry

- Conduct a water balance
- Conduct energy and carbon balances
- Consider energy and carbon balances
- Conduct environmental impact assessments (EIA)
- Consider the toxicity of materials and resource consumption

References

- Hankamer, B.;Lehr, F. ;Rupprecht, J. ;Mussgnug,J.H.; Posten, C. and Kruse, O. “Photosynthetic biomass and H2 Production by Green Algae: From Engineering to Bioreactor Scale-Up”, Physiologia Plantarum, Vol.131, 2007, pp.10-21
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THANK YOU