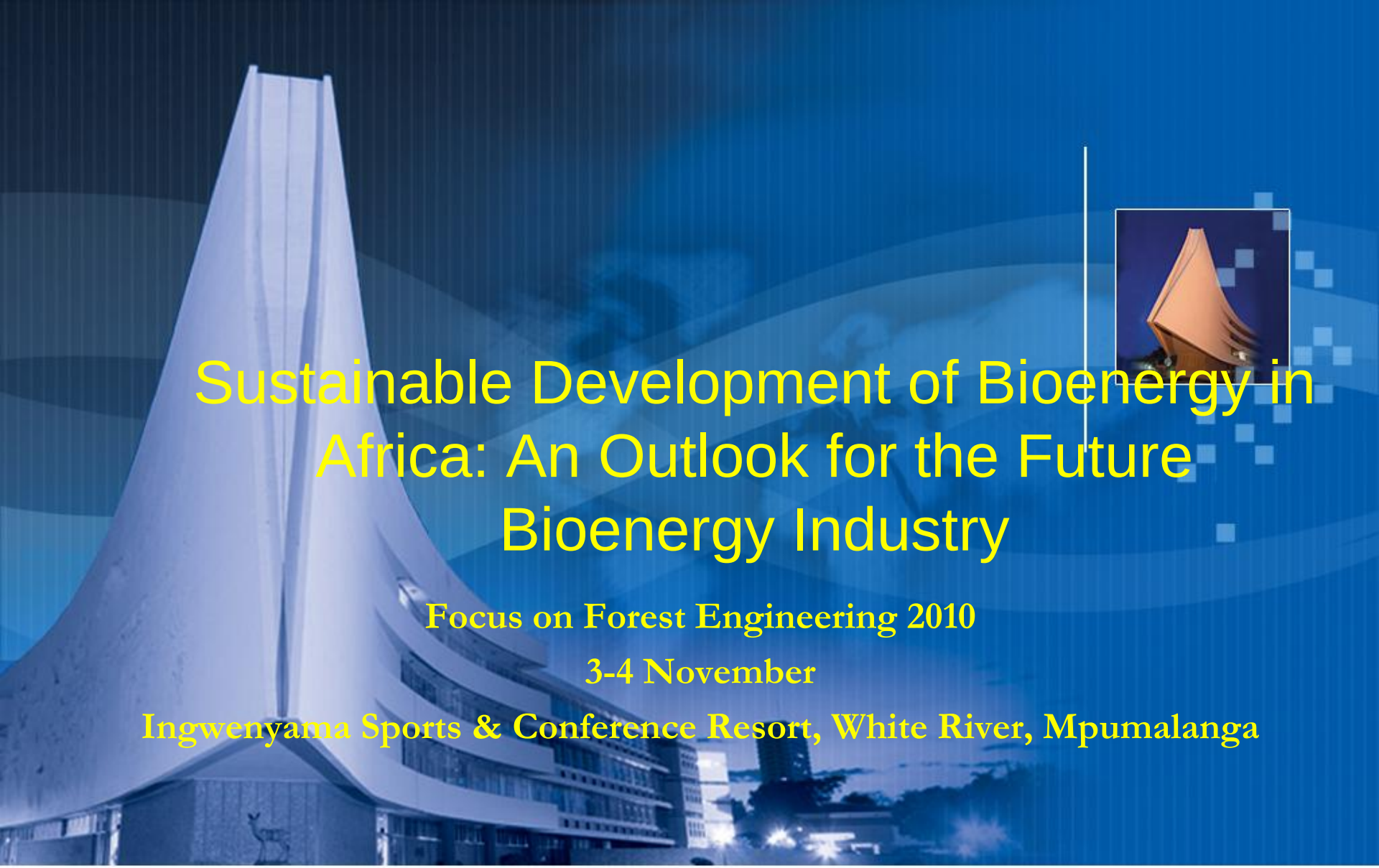

Sustainable Development of Bioenergy in Africa: An Outlook for the Future Bioenergy Industry

Focus on Forest Engineering 2010

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Presentation Outline

- Brief Background
  - Historical Perspective
  - Situation Analysis
- Production Potential
- Bioenergy Markets & Biofuels Potential
- Environmental Impact of Biofuels Production
- Policy & Institutional Framework (Biofuels: Africa)
- Challenges & Opportunities & Entry Points for Bioenergy

Introduction

- Renewable bioenergy, particularly biofuels, has played a pivotal role in Africa in the past & could help address the need for energy expansion in the future.
- Bioenergy is renewable energy made available from materials derived from biological sources.

- FAO (2009) defines biofuels into three categories:
  - **Bioresources:-**refer to naturally growing plants including natural forests, grasslands.

  - **Biofuels:-**Biofuels are purposefully grown energy crops including sugar crops and vegetable oilseeds used for manufacture of biodiesel and bioethanol

  - **Bio-residues: -** may include wastes from agricultural, forests or industrial activities.

Introduction Contd:

- Two bioenergy system exist in energy supply
  - I. Traditional biomass extractive system e.g..: firewood, charcoal e.t.c
    - Characterised as low productive and less efficient
    - 80% of Africa rely on this system (Cotula *et al*, 2008).
  - II. Innovative modern system e.g.: biofuels production e.g. biodiesel from oilseeds, ethanol from sugar can, beet root...
    - Characterized as more efficient and environmentally friendly technologies

Historical Perspective:

- Africa still remains a large consumer of traditional sources of biofuels.
- Africa has been projected as having the largest potential for bioenergy production by 2050 in the world (Smeets et al. 2007)

- Access to modern, socially acceptable, environmentally friendly energy technologies still remains low.

- The pursuance of alternatives to fossil energy source has been triggered by:
  1. **increasing global prices of crude oil, and**

  2. **Other anticipated economic, environmental benefits**

  3. **Potential to increase energy supply, open new markets for agriculture surplus, employment opportunities**

Bio-fuel technologies & Feed-stocks

- There are two methods for production of 1st Generation Biofuels depending on source of feed-stocks:

I. Starchy biomass feedstocks account for 53% of all biofuels produced (Maize, wheat, Sorghum & other starchy materials).

II. Sugarcane & Sugar beet biomass

a) Molasses: -has high potential in Africa.

- Tanzania only 30% is put to productive use.

b) Bagass: Contributing up to 40% of electricity domestic consumption in

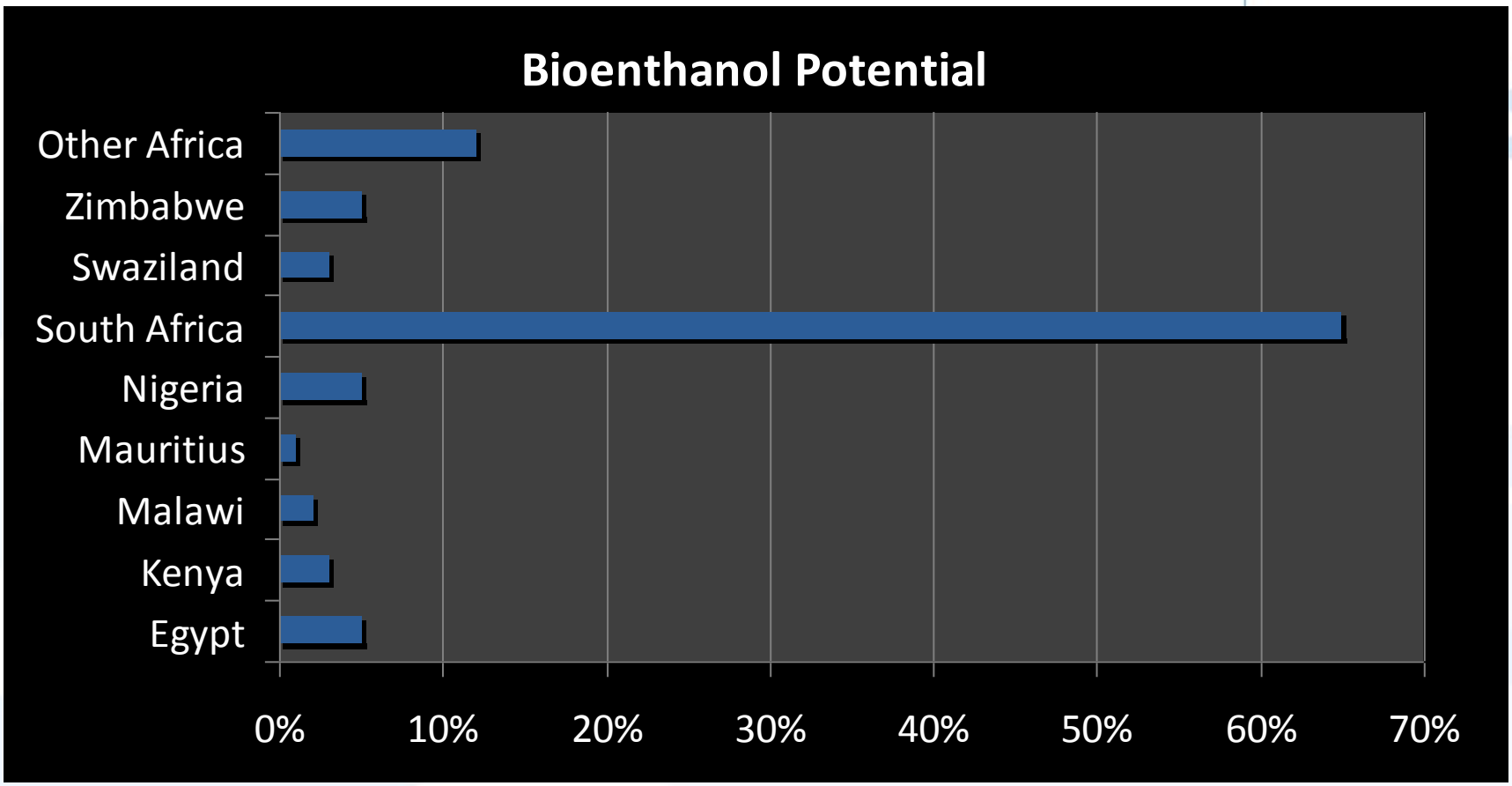
III. Cellulosic materials such as straw and wood biomass (BNDES Communication Department, 2008)

Biofuels potential in selected African countries in mega litres (ML)

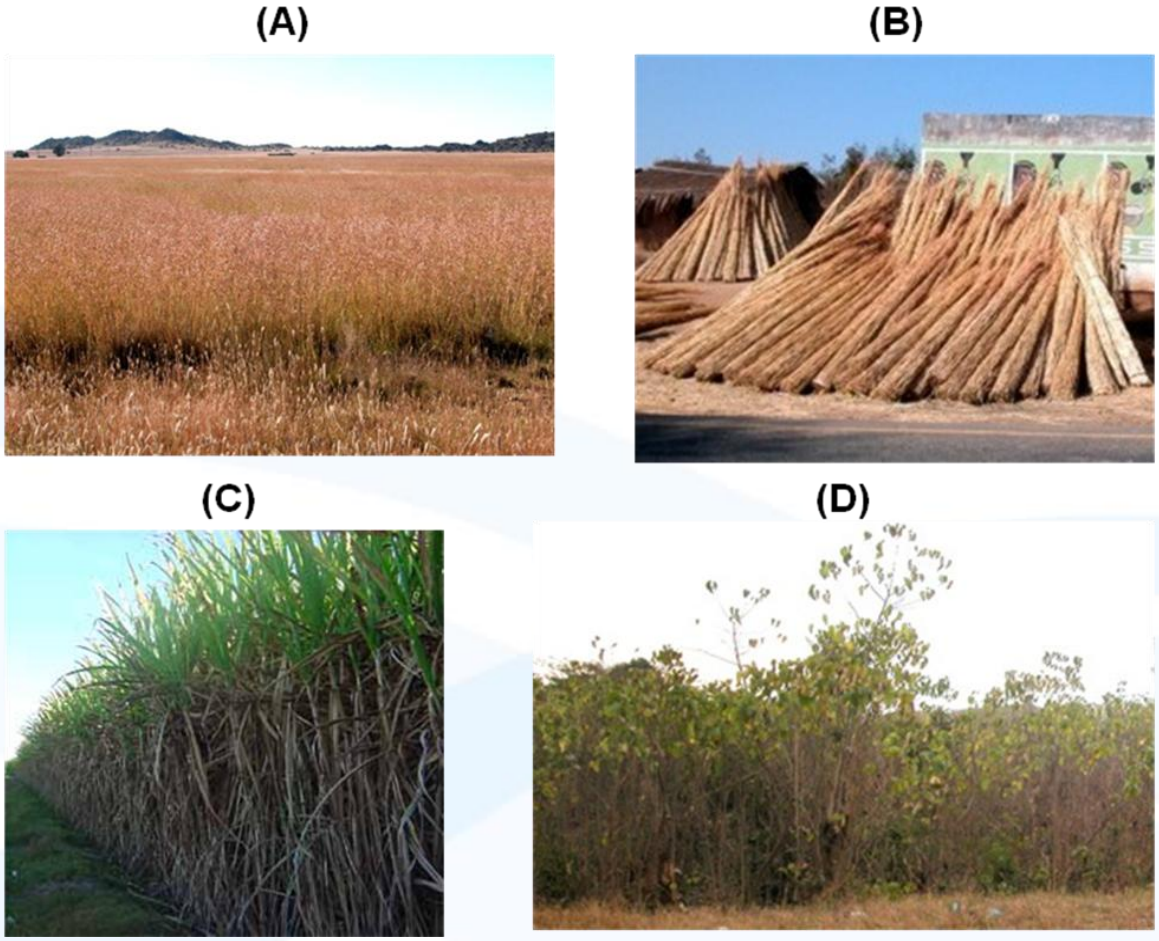
Country	Raw material	Biodiesel (ML)	Ethanol (ML)
Benin	Cassava	-	20
Burkina Faso	Sugarcane	-	20
Ivory Coast	Molasses	-	20
Ghana	Jatropha	50	-
Guinea Bissau	Cashew	-	10
Mali	Molasses	-	20
Malawi	Molasses	-	146
Kenya	Molasses	-	413
Ethiopia	Molasses	-	80
Niger	Jatropha	10	-
Nigeria	Sugarcane	-	70
Sudan	Molasses	-	408
Swaziland	Molasses	-	480
Senegal	Molasses	-	15
Tanzania	Molasses	-	254
Togo	Jatropha	10	-
Uganda	Molasses	-	119

Yields of different energy crops across Africa

Crop	Litres of oil/ per hectare	Countries grow
Palm oil	5950	Angola, DRC, Nigeria, Ghana, and Tanzania
Soya bean	446	DRC, Malawi, Republic of South Africa, Tanzania and Ghana
Coconut	2689	Nigeria, Ghana, Senegal, Mozambique and Tanzania
Jatropha	1892	All countries
Sunflower	952	Angola, Malawi, Nigeria, Ghana, Botswana, DRC, Mozambique, Republic of South Africa, Namibia, Zimbabwe, Zambia and Tanzania
Cotton Seed	325	Angola, Malawi, Nigeria, Ghana, Mozambique, Tanzania, Zimbabwe, Zambia and Republic of South Africa
Avocado	2638	DRC, Republic of South Africa, Tanzania, Nigeria, Ghana, and Senegal
Groundnuts	1059	Malawi, Angola, Ghana, Nigeria, DRC, Gambia, Senegal, Mozambique, Tanzania, Zimbabwe and Zambia
Cashew nut	176	Angola, Mozambique, Tanzania, Ghana, Nigeria and Senegal
Castor beans	1413	Angola, DRC, Tanzania, Republic of South Africa and Mozambique



Comparison of ethanol production in different African countries (% contribution)



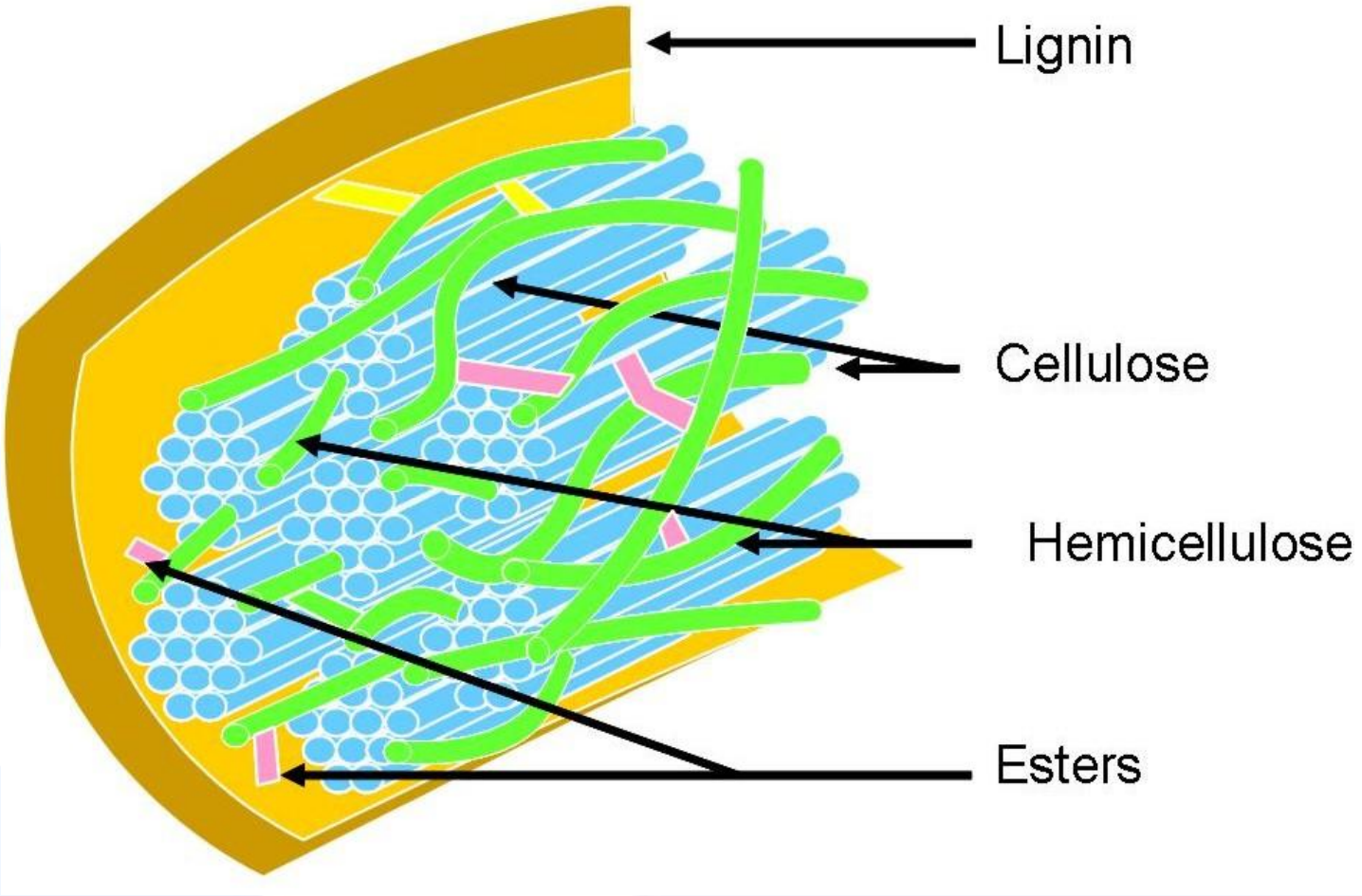
Examples of potential energy crops available for biofuels production in sub-Saharan Africa: (A) *Themeda triandra* (red grass) in the Free State, South Africa, (B) red grass collected for thatching in Malawi, (C) sugar cane as energy crop in subtropicals and (D) *Senna siamea* as evergreen fast-growing fire wood in Malawi (Source Prof van Zyl).

Next generation technologies for total biomass conversion

- Lignocellulose represents the most wide-spread and abundant source of carbon in nature thereby potentially providing a sufficient amount of feedstock to satisfy the world's energy and chemicals needs in a renewable manner.

- Lignocellulosic material comprise of three major components, namely cellulose, hemicellulose and lignin.

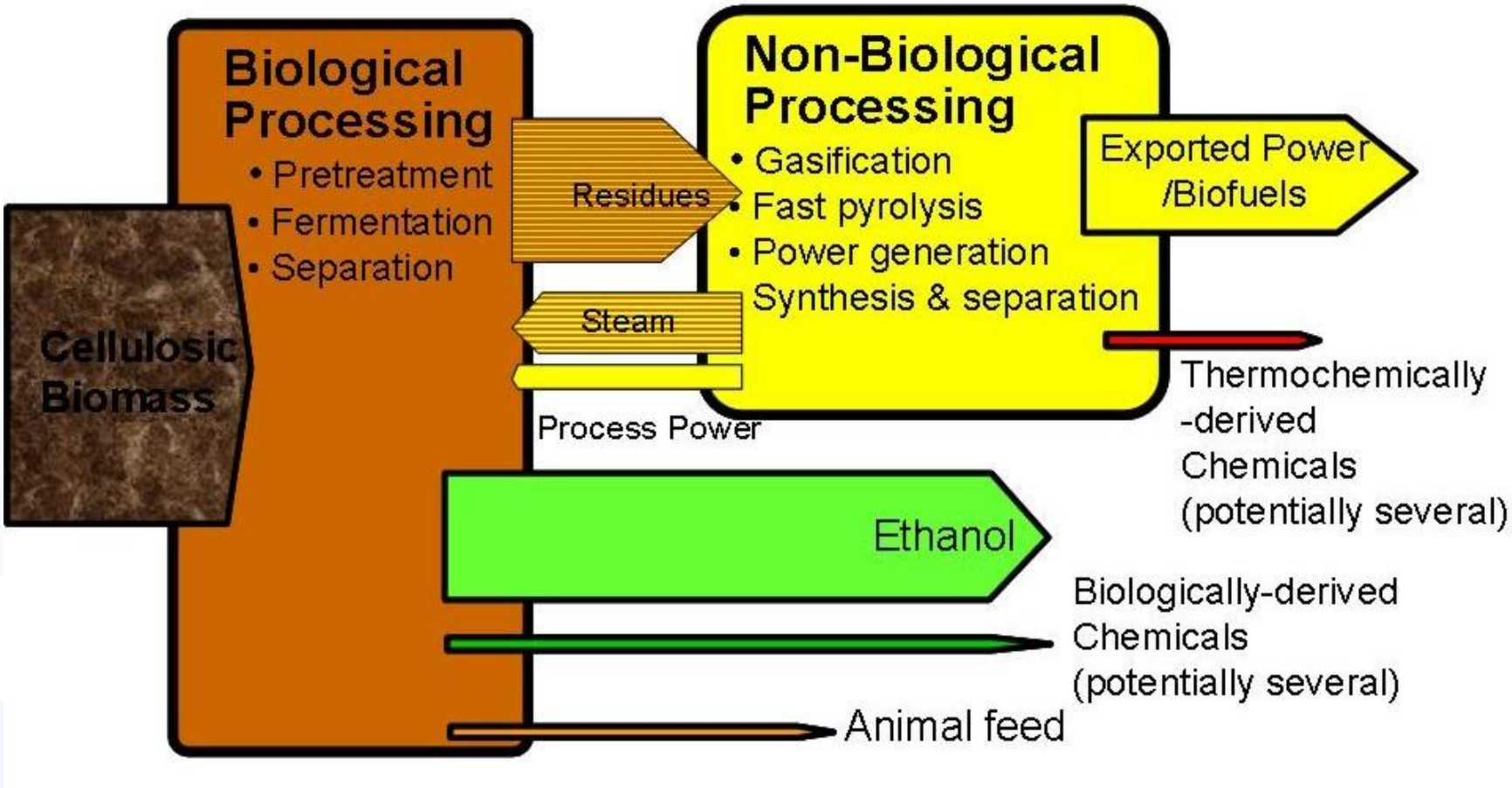
- Both cellulose and hemicellulose are polymers of fermentable sugars, with glucose and xylose as the major constituents



Major components of lignocellulose (courtesy of Prof. Van Zyl, Stellenbosch University)

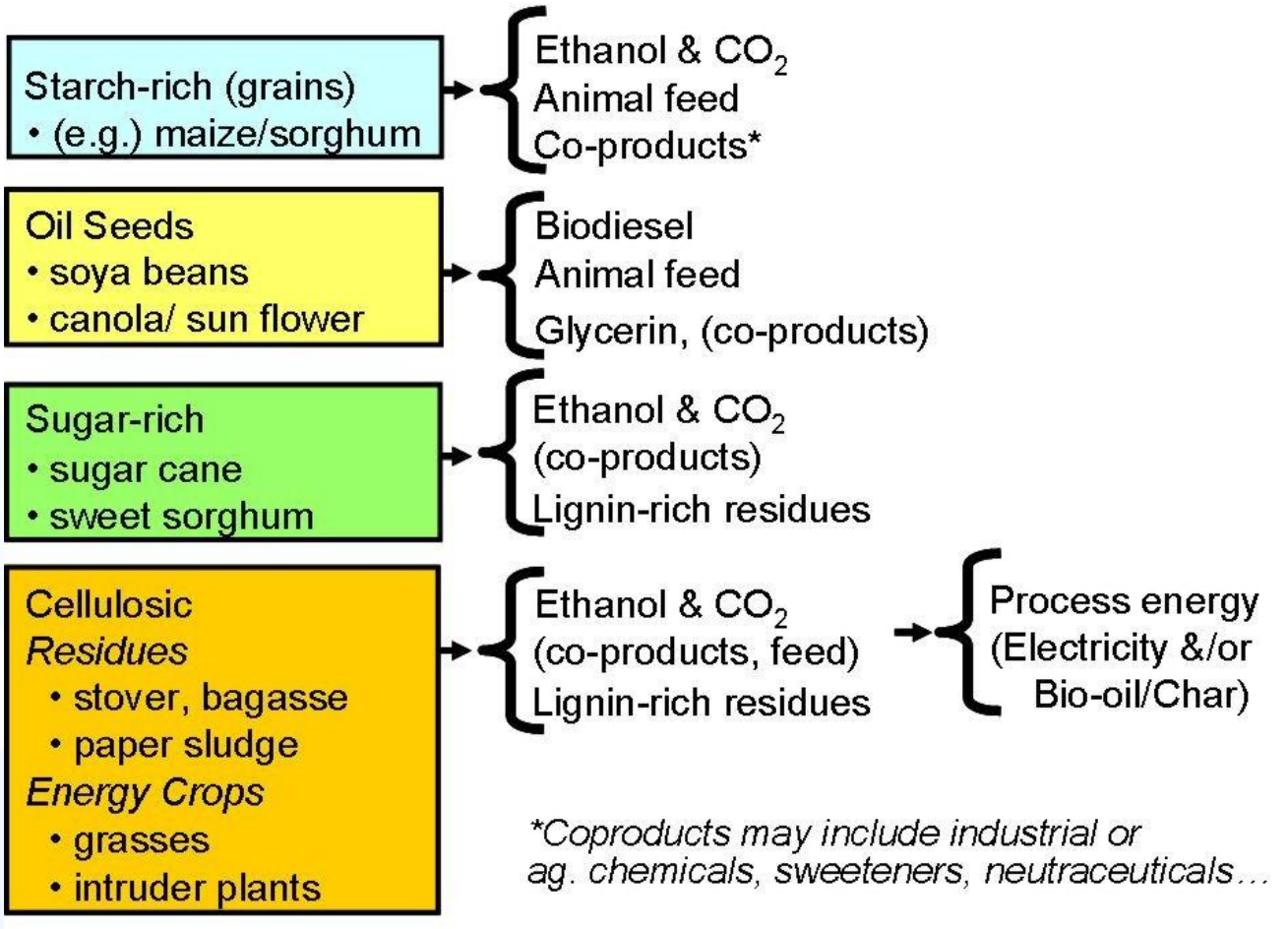
Lignocellulose ConversionTechnologies

- Current lignocellulose-to-bioethanol processes are not deemed economically viable without government subsidies
- Thus low-cost substrates, such as agricultural bio-wastes available locally are preferred to reduce processing costs
- There is potential for Biochemical conversion of lignocellulosics to ethanol (enzymatic processes)
- Lignocellulose thermo-chemical processes (pyrolisis)
  - ***heating for a few seconds to about 400-500°C in the absence of O2, followed by rapid cooling, under atm pressure or vacuum = thermal cracking of the polymeric structure of biomass= conversion into gaseous, liquid ("bio-oil") + char products***



A possible biorefinery outcome incorporating both biochemical and thermo-chemical processes (Lynd *et al*., 2003).

Evolutionary transition to cellulosic biofuels production



Evolutionary path to complement food production with second generation technologies for the production of cellulosic biofuels (suggested by Lee Lynd, Dartmouth College, USA).

Bioenergy Markets in Africa

- Biofuel energy markets in general are in infancy stage. but undergoing developmental phase (FAO, 2008)
- Market potential for biofuels in Africa is varied, Sub-Saharan Africa has most potential & North Africa has the least potential.
- The potential value of biofuels for Sub-Saharan Africa 2010 to 2013 as estimated by Frost and Sullivan is between **US$ 1.54-1.83bn**
- Lead Phase Programs in most African countries create new demand/opportunity.
- On supply side: --its argued that Africa has land & can meet demand even from molasses alone for some countries (Jumbe et al, 2009)

Bioenergy Markets in Africa

Factors stimulating demand & supply

- The SADC region has great potential.
  - Current cultivation figures are (6%) suggesting that land is likely not a constraint.
  - Sugarcane production, important feedstock is also on the increase due to rehabilitation programs in post conflict zones (Angola & Mozambique) (Gnansounou et al, 2007)

Impact of Biofuels on the Environment

- Monocrops are likely to replace indigenous traditional rotational agriculture, pastoralism etc affecting biodiversity.
- In dry areas, competition for water may arise between production of biomass for food vs. fuel
- Existing processing facilities can discharge organically contaminated effluent (IFAD, 2008)
- Proper studies on the eco-biology of energy species/crops need to be done to avoid invasiveness

Policy & institutional Frameworks

- Conducive policies are essential for biofuel industry development
- Characteristics of good policies include:-
  - Policies that are predictable and consistent over time,
  - civil society buy-in and support,
  - **clear niche for small and medium entrepreneurs' benefits,**
  - **policy coherence, private and public investment, transparent governance**

- In general, most African government have not taken a proactive step to institute clear policies to spur biofuels development- except for RSA & Mauritius

Challenges & Opportunities

- The paradox of producing biomass for fuel in countries which can not feed themselves
  - The potential effect of substitution of food crops for feedstock in land allocation.
  - However, studies on land in Southern Africa indicate that only 6% is utilized suggesting potential exist.

Development and implementation of certain pro-poor policies to optimize the “biofuel revolution” can make it truly pro-poor

Challenges & Opportunities

- Substitution of pastureland to biomass for biofuels
  - incentive of higher returns from land put to biofuels may trigger this phenomena.

- Land tenure security issues.
  - Current land tenure system is likely to favour investor at the expense of smallholder farmers.

  - Government tend to negotiate contracts without contributions from civil society

Challenges & Opportunities

- Global prices of food stuffs are likely to increase and alter trade patterns.

- There are two aspects of the climate change regime that are of significance to small farmers in developing countries:
  - opportunities for carbon sequestration and

  - funding for mitigation action; and the possibility of new funding for adaptation (see IFAD, 2008, FARA, 2008).

THANK YOU