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A Sustainable Technology Roadmap for Global Development of Biofuels

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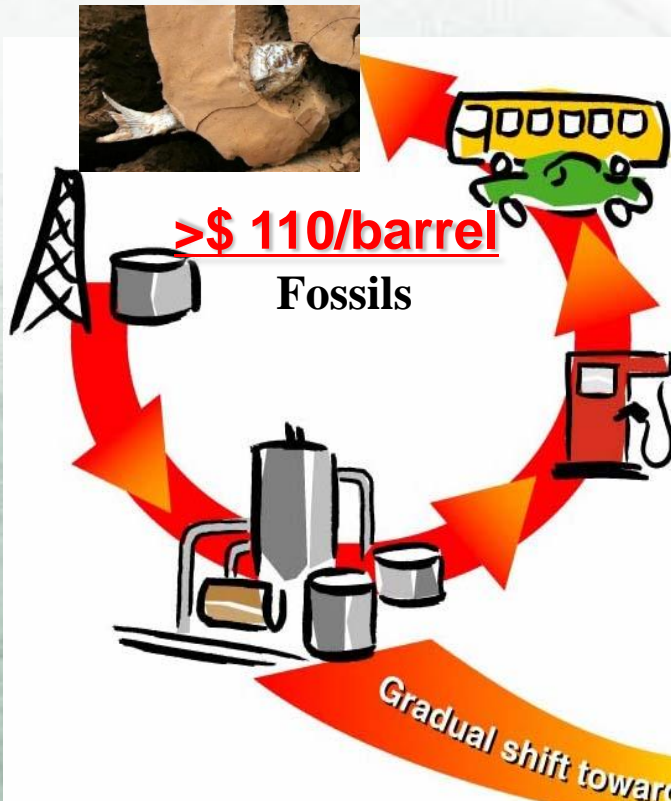


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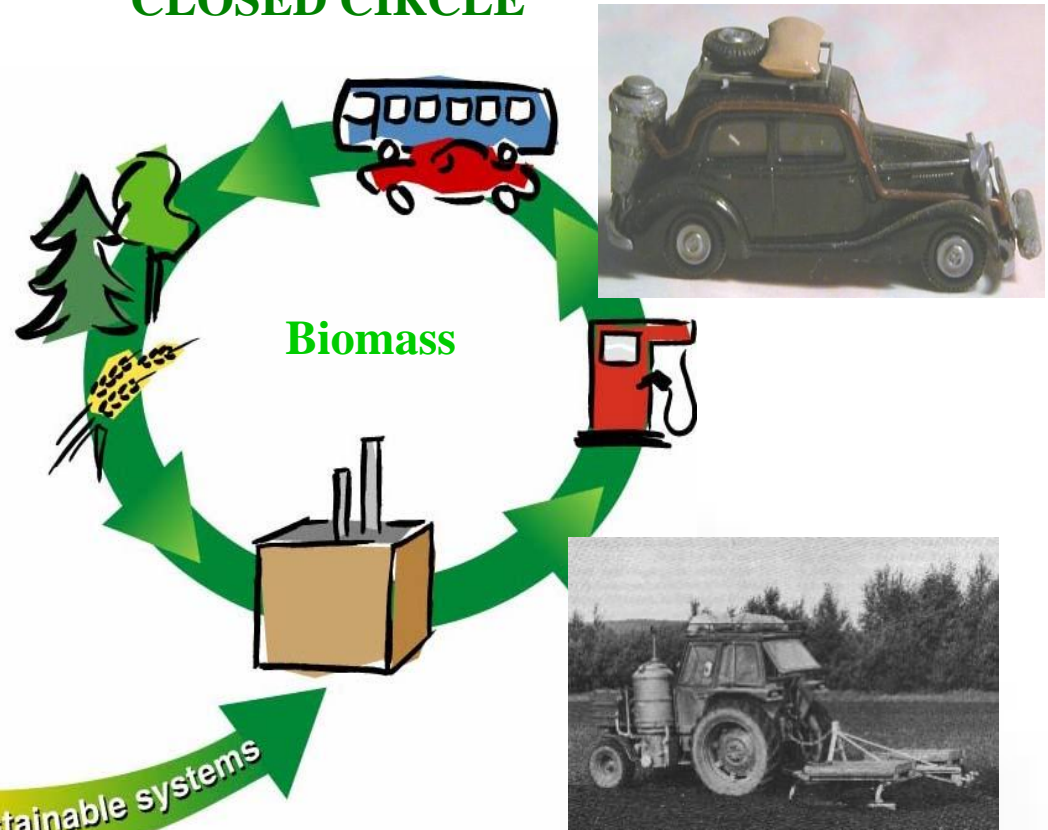
Why biofuels

Biofuels are today the only direct substitute for oil in transport that is available on a significant scale. According to IEA, 1030 billion liters of biofuels (85 billion liters of bioethanol and 18 billion liters of biodiesel) were produced in 2010, and the global share of biofuel in total transport fuel will be 27% in 2050.

BROKEN CIRCLE



CLOSED CIRCLE





Challenges and opportunities

Challenges

- ✓ biofuel trade barriers
- ✓ food security
- ✓ sustainable criteria
- ✓ cost-competitive with oil

- China lowered the tariff on imports of ethanol to 5% from the previous 30 % on 1 Jan 2010
- China is considering to import ethanol from abroad.

Opportunities

- ✓ new feedstocks
- ✓ new technologies
 - 1.5 generation, ethanol from sweet sorghum, Helianthus tuberosus, etc.
 - 2nd generation, cellulosic fuels.
 - 3rd generation, algae fuels.
 - 4th generation, photosynthesis fuels



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Why 1.5 generation

Food crisis! ☹️

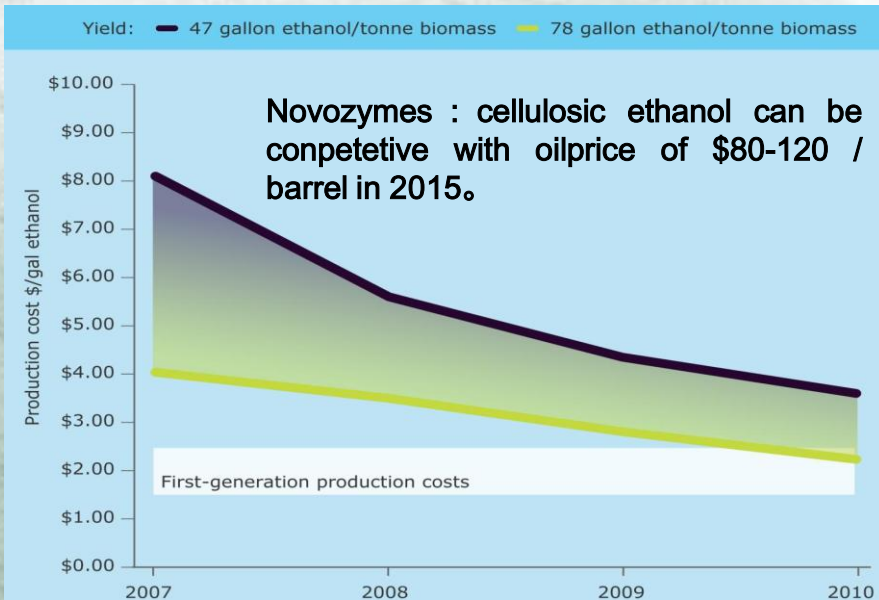


1st biofuels- ethanol from corn and sugar cane

Sweet Sorghum may produce grain, feed, ethanol, and electricity, and its bagasse is the best feedstock of **Celulosic Ethanol**.



1.5 generation- ethanol from sweet sorghum 😊



2nd biofuels- cellulosic ethanol

Cost intensive! 😞



Why sweet sorghum

Sorghum/sweet sorghum characteristics

- ✓ Originated in Africa
- ✓ Greatest diversity
- ✓ Major producers in Sub-Saharan Africa are:
 - Sudan (4.3m ha)
 - Ethiopia (1.6m ha)
 - Tanzania (0.9m ha)
- ✓ In 43m ha in 99 countries.
- ✓ Sweet sorghum (SS) is similar to grain sorghum, and is suitable to more areas. **E.g., according the report issued by FAO, in Tanzania there are 69.5 million ha lands are suitable to grow sweet sorghum, and only 1 million ha for sugar cane.**
- ✓ While cassava and sugarcane are winter crops
- ✓ Sugarcane needs 4 times irrigation water compared with sorghum, and 10-12 months per harvest.



Potential adaptation of *S. bicolor*





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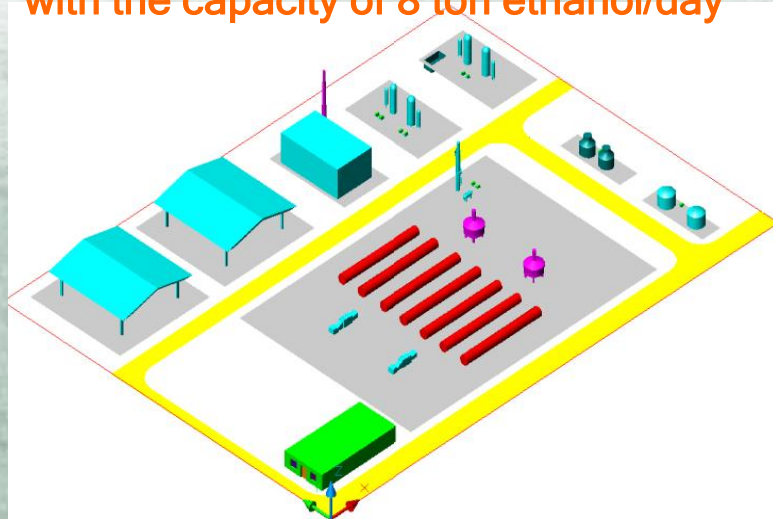
Why ASSF



3.6X55m continuous solid state fermentor with the capacity of 8 ton ethanol/day



Fermented bagasse as cow feed

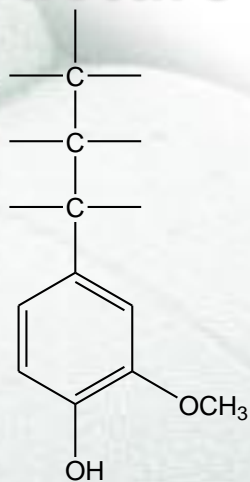


Layout of a 10,000 ton/a ethanol plant

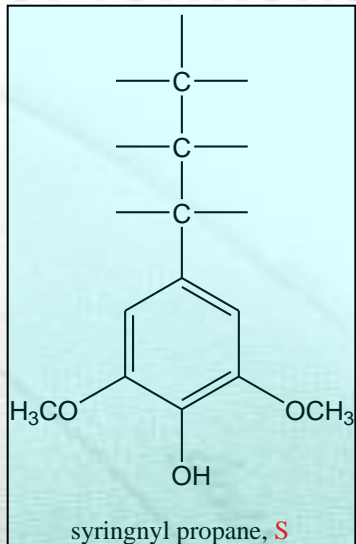




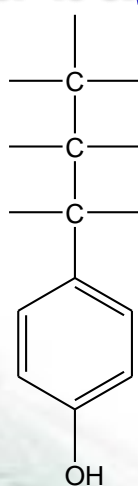
Effect of fermentation on structure of fermented bagasse



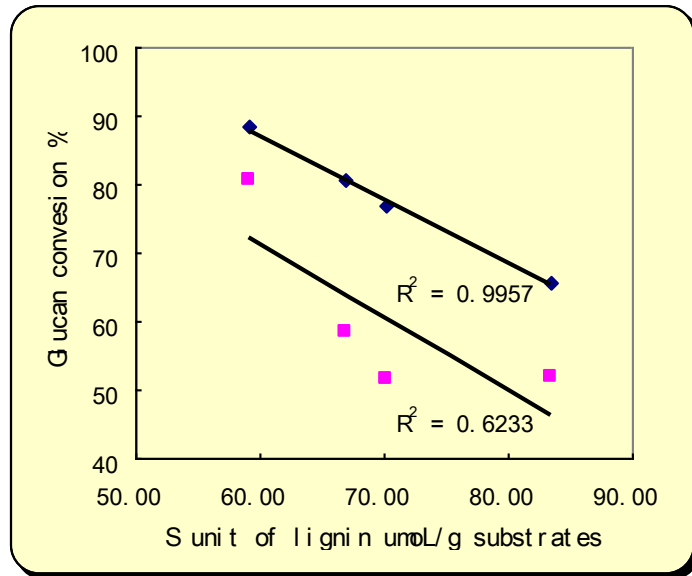
guaincyl propane, G



syringyl propane, S

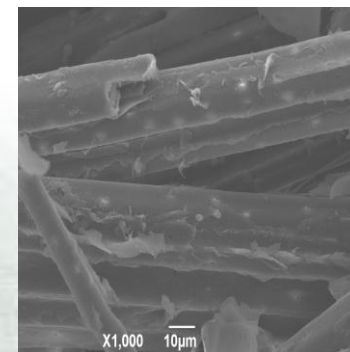
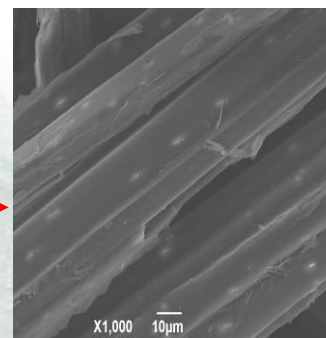


p-hydroxyl phenyl propane, H



Composition of lignin

Sweet sorghum stover	H (μmol/g)	G (μmol/g)	S (μmol/g)
before fermentation	144.45	90.37	114.90
after fermentation	135.01	180.14	82.91



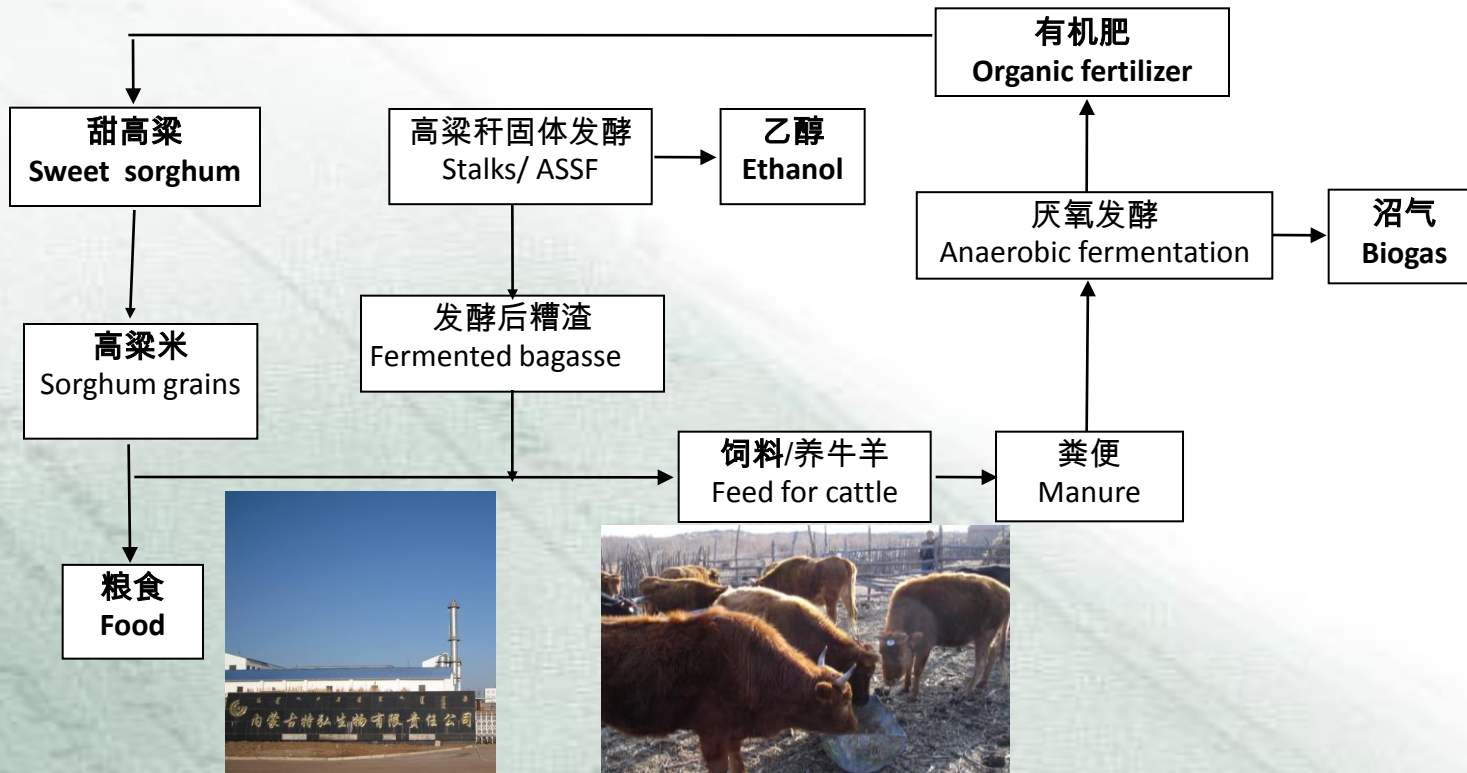
Decrease 28.4%



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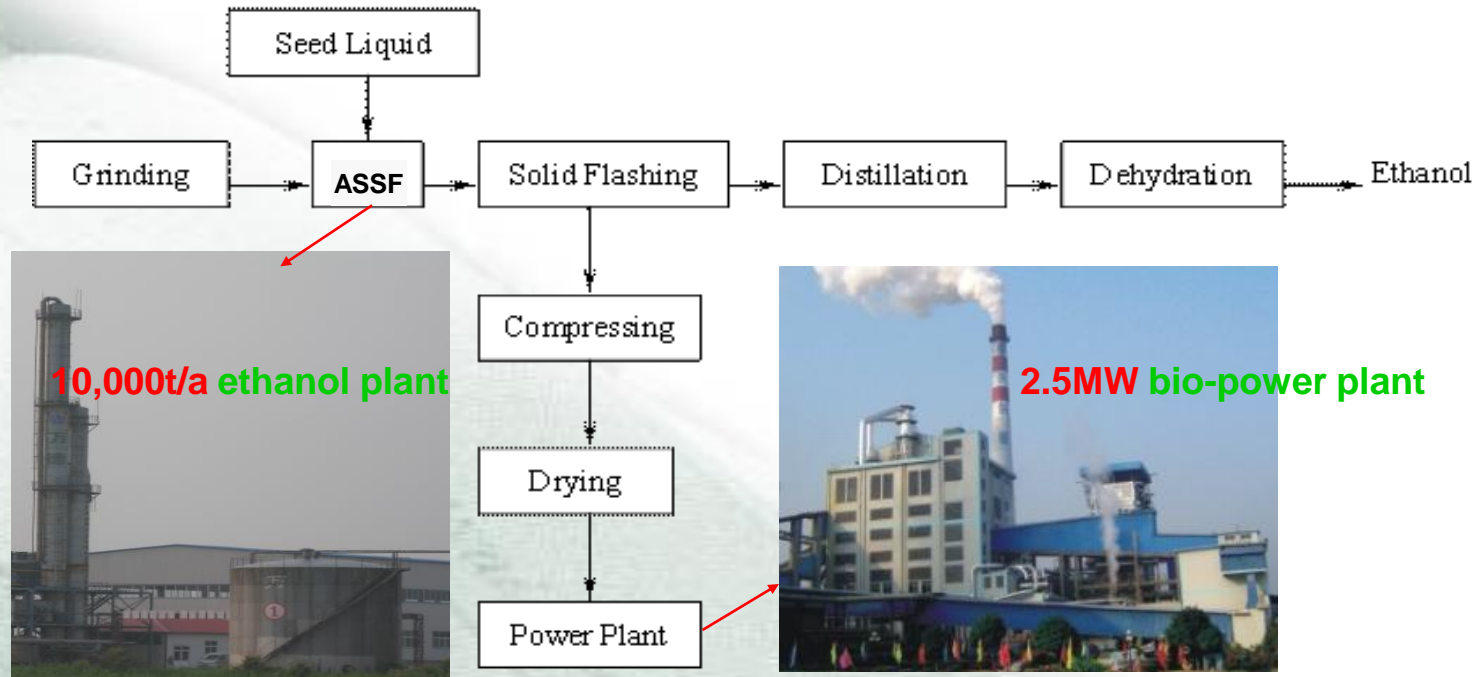
Fuel & power module

A 'closed loop'/'zero waste' sustainable biofuel system is established





Sweet sorghum to FUEL and POWER



- Using 2,300 hectares land to grow sweet sorghum to annually produce **10,000 tons** of ethanol, and supply **12 million Kwh electricity** to national grid.
- During this module, the energy input of ethanol is only fossil fuel in plantation and transportation, has much environmental benefit.
- Ash from bio-power plant is rich of K, can be used as K fertilizer.



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Sustainable roadmap

1980's-present 1st generation

Present-**1.5 generation.**

2015- 2nd generation

2020- 3rd generation

2030- 4th generation

We should not wait for emerging technologies! We should use available technologies to realize our goal.

Thank you