Biofuels
The Good, the Bad & the not so Bad

Ron Oxburgh

Biofuels

- Not all are the same –
there are biofuels and biofuels

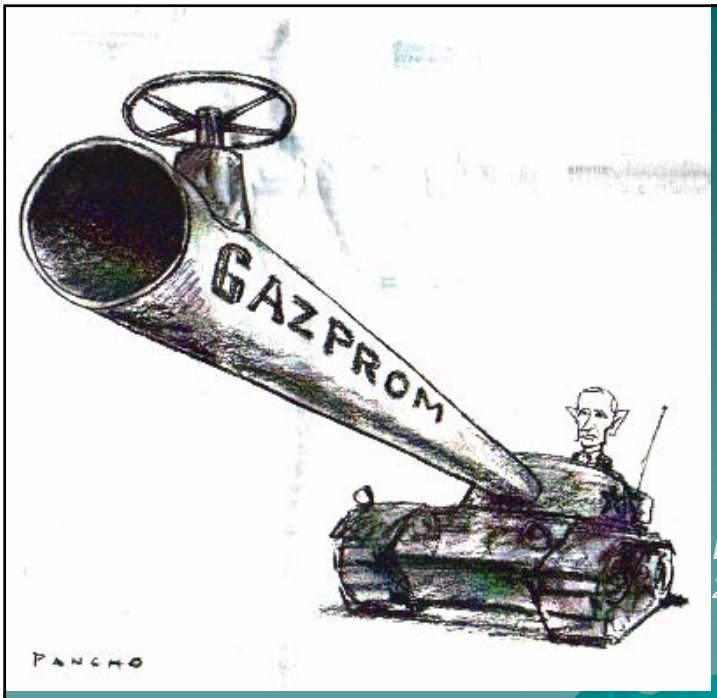
What is a biofuel?

- A fuel derived from animal or vegetable material

Why are Biofuels of interest?

- Should be able to provide energy at much lower CO_2(F)/unit energy than fossil fuels
- Environmental security
- Currently the only practicable alternative to fossil fuels for making fuel liquids for transport
- Security of supply
  - Economic
  - Political

} Diverse sources



Putin's Tank

Le Monde, 4 Nov. 2006

Properties of Biofuels

GENERAL

- Odourless
- Biodegradable
- Low Sox & particulates
- Hygoscopic
- Lubricant properties
- Blending properties
- 5 - 10% mix acceptable in all engines
- 85- 100% acceptable in modified engines

DIFFERENCES between them

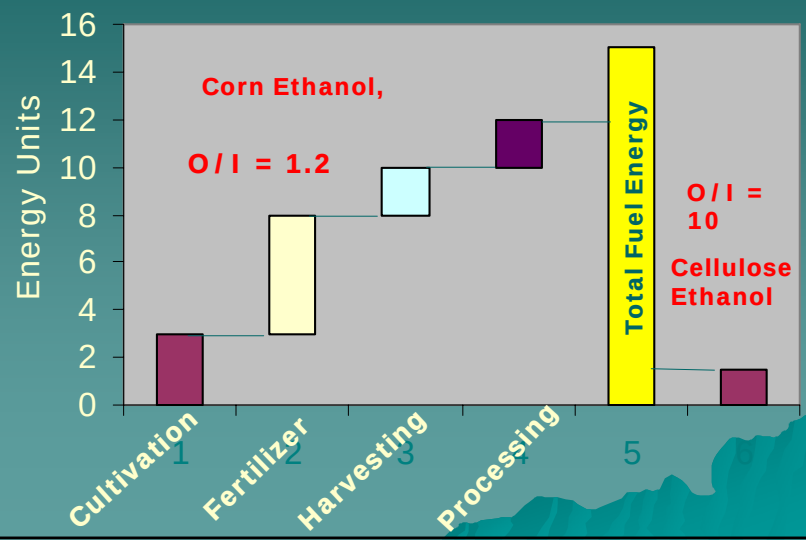
- Ethanol or biodiesel
- Cash cost
- Carbon cost – emissions (F)/unit energy
- Geographical source
- Sustainability
  - Environmental impact – water, habitats etc.
  - Socio/economic impact of production
- Edible or not
- Bye-products use

Traditional Routes to Biofuel Liquids

1. Fermentation & Distillation
   - Cane sugar
   - Corn
   - Sugar beet etc.

→ ETHANOL

Carbon Cost (energy ratio) of Corn vs. Cellulose Ethanol



Routes to Second Generation Biofuel Liquids

1. Fermentation & Distillation
   - Sugars made by enzyme action from cellulose in straw,
   - Forestry residues, miscanthus etc.
   - Specially bred plant varieties

   → **ETHANOL**

2. Crushing oily plant material
   - from hardy, inedible plants e.g. Jatropha, ?algae

   → **BIODIESEL**

3. Gasification
   - Any organic starting material e.g. wood, organics of urban wastes sewage sludge

   → **BIODIESEL** & other products

Second Generation - Three Illustrations

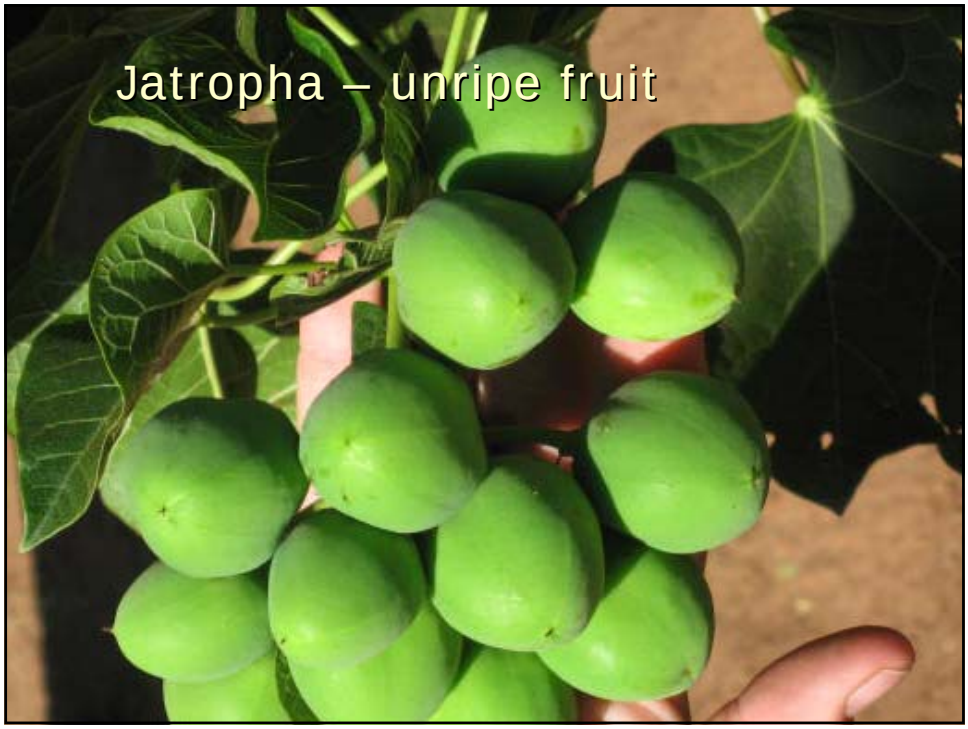
- Straw to cellulosic ethanol
- Miscanthus
- Jatropha to biodiesel

Ethanol from Straw

First Cellulose Ethanol Shipment: April 21, 2004

Co-production of food and fuel

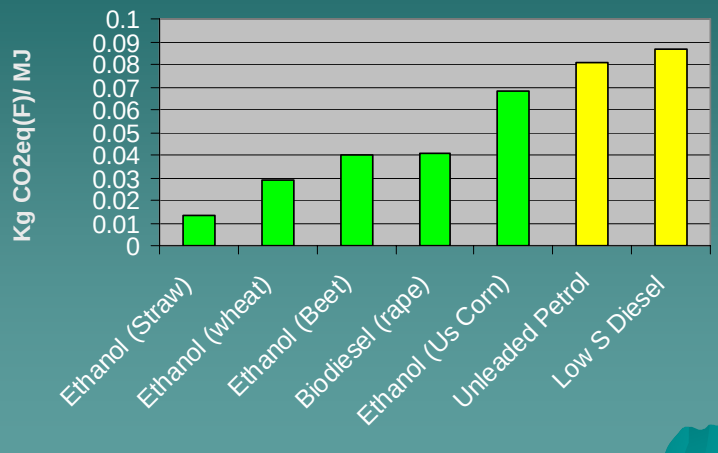
Miscanthus


Jatropha – unripe fruit


Jatropha Seeds

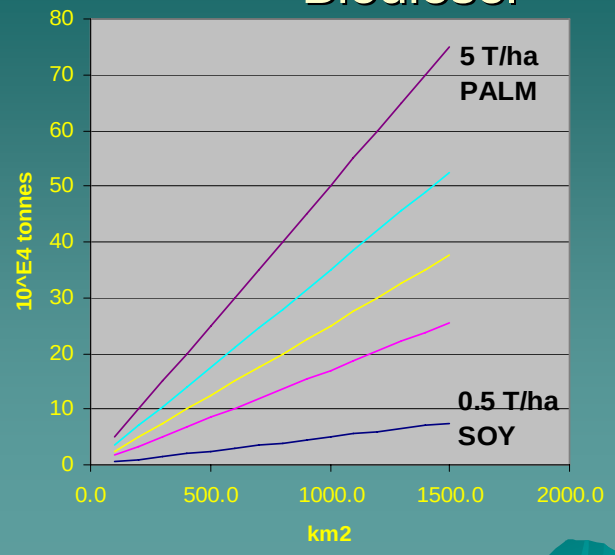
Jatropha, Swaziland with okra intercrops

Biofuels & Biofuels



Data from Elsayed et al 2003

Can Biofuels make a difference?
Biodiesel



NOTE:

The cash economics of any particular feedstock are separate from the carbon economics and depend on:

- Cultivation requirements
- Other uses
- Bye products
- Transport & other logisitics

World Diesel demand $2*10^9$ T/yr

How much land would be needed?

@ 2T/ha ➡ 10^7 km²

= 50%area of Russia

Or @ 6T/ha

= area of Canada

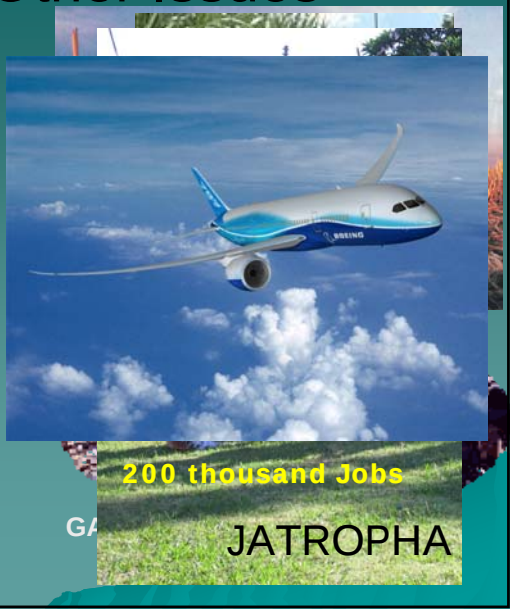
Earth Surface Cover Types
millions of square km

Tropical Forests	17.6
Temperate Forests	10.4
Boreal Forests	13.7
Tropical Savannahs	22.5
Temperate grasslands	12.5
Deserts & semi-deserts	45.5
Tundra	9.5
Wetlands	3.5
Croplands	16.0
To provide world biod.(?Jatropha)	3 - 10
Total	**$151*10^6$ km²**

Data United Nations, FRA 2000

Biofuel – Other Issues

- Cash cost
- Refining
- Quality control
- Competition with food
  - Land
  - Water
- The Future - Residues & Special Crops
- Aviation



Conclusions

- The biofuel industry is immature – still a great deal to learn – productivity can improve
- At present costs are high
- Biofuels can help reduce transport emissions but not alone
- Responsible biofuel production can be a win-win
  - Reducing GHG emissions
  - Helping alleviate poverty
- Judge biofuels by: cash cost
  carbon cost
  socio-economic value
- Not all biofuels are the same!