Some questions and concerns around the use of genetic engineering for biofuels, biomass and microbial processes.

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Concerns around GMOs in biofuels

Two major thrusts to the debate:

1) Commercial encouragement of biomass (often subsidised) to provide sufficient biomass through GM crops - low lignin trees, insect resistant plants, chemical tolerant plants – the land, water, resource use equation. and,

2) The actual use of GM crops, micro-organisms and other vectors of introducing GM technology; are GMOs safe (biosafety), sustainable, ethical?

Concerns around GMOs in biofuels

Competition between food and fuel – GMOs encourage the commodification of food.

Two primary mechanisms, hence concerns, of GM in biofuel production:

1) **GM crops** specifically developed for ethanol production – trees, crops, algae – outcrossing, gene flow, biosafety, and,

2) **GM microbial processes** with specialised microbes to break down cellulose – which can produce ethanol, butanol, etc. e.g.Termites digest cellulose and produce methane.

1st generation GMO biofuels – food crops

- Does GM/ GE provide any advantage to the biofuel component?
- GMO high starch alpha amalayse maize (Syngenta 3272) + 2% > regular
- Same broad opposition as regular GMOs – safety, risks - human and environmental.

http://earthopensource.org/index.php/reports/58

1st generation GMO biofuels (cont.)

- Enables control of technology by private corporate entities – privatising life, hence ethical and/or moral concerns.
- GM crops increase use of chemicals, particularly herbicides (Benbrook 2009, 2012).
- Supposed reduction in chemical use but 0.7 kg of endotoxin / acre is produced by Mon 88017 and 1.13kg/ acre for Dow/ Pioneers stacked maize to control rootworm - 13 times more than conventional pesticide (Benbrook 2012).

1st generation GMO biofuels (cont.)

- Compete with food stocks for fuel – 40% of US maize crop diverted into biofuel.
- Admixing, outcrossing – eg. GMO alpha amalayse maize (Syngenta 3272) - slap tjips.

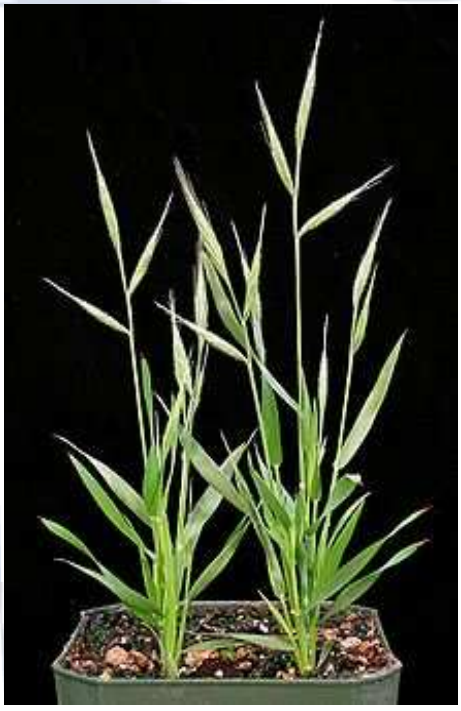
Questions:

- Is 1st generation biofuel (GMO or conventional) competitive/ efficient without subsidies? (cf. Pimental Patzek 2005, Herrera 2006, Hertel et al 2010.)
- Is 1st generation biofuel sustainable – water, erosion, total land use, etc.?

2nd generation GMO biofuels

Generally 2 components – crop and microbe/ enzyme:

- Holy grail – producing fuel from biomass, primarily cellulose, affordably.
- GM almost essential - unless we tame termites.
- GM microbial production systems – biosafety.
- Source: GM and conventional vegetable matter / stover / plant mass for biofuels.
- Compounds industrial agricultural unsustainability, removes compost/ plant materials from soil matrix.



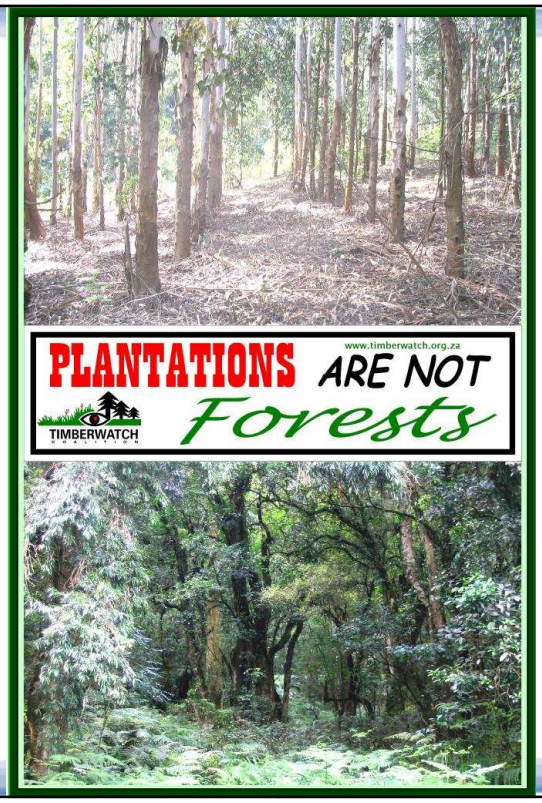
2nd gen - cont

Brachypodium distachyon

- *Match sugarcane for yield,*
- *Lots of research being carried out but no GM (yet),*
- *Source of cellulose,*
- *Therefore need cellulose digestors,*
- *Same principles involved with sawdust (trees), stover, bagasse (cane residue), other plant based materials.*

2nd generation GMO biofuels (cont.)

- Shift away from food based biofuels – good!
- Wounded biomass (GM low lignin trees),
- Concerns – outcrossing – genetic transfer to related tree/ plant species, weediness,
- Increased chemical use in herbicide tolerant crops/ endogenous toxins,
- Similar concerns as conventional mono-crop plantations – unsustainable agriculture.



2nd Generation – microbial aspect.

- Less public/ scientific concern about contained, use of biotechnology and GM organisms, microbes, etc.,
- Concerns centre around biosafety, management and monitoring,
- e.g.: Variety of *Klebsellia planticola* engineered to turn crop waste into ethanol had unexpected side-effect of halving mycorrhizal fungi in soil (essential for nitrogen fixation.) If this GE microbe survived and spread could be difficult, impossible and / or expensive to control (Holmes and Ingham 1994).

2nd Generation – microbial aspect.

- *K. planticola* and *E. coli* both being further investigated for breakdown of cellulose into ethanol,
- Touches on fundamental issues of biosafety – managing horizontal transfer – across species, Geno/phenotypes; waste control,
- Oversight – who represents the public interest against the power of the profit motive?

3rd Generation Biofuels

- Algae – potentially a magic bullet!
- Algae have far greater biofuel potential than conventional monocot and dicot plants – faster turnover time, high oil content etc.,
- However: GMO Algae raises concerns re invasiveness, out-crossing, control, biosafety.

For instance: Toxic blue-green algae are a global problem – Cyanobacteria produce microcystins – hepatoxic and neurotoxic – kill livestock and implicated in cancers (Charmichael 2010).

3rd Generation Biofuels (cont.)

Problems with algae:

- Very difficult to contain algae in open ponds – bird, insect transfer readily between water bodies,
- If engineered to be super robust can have environmental implications / biosafety concerns. (Snow, Smith 2012),
- This GM technology of less public concern – German Green Party supports second and third generation biofuels.

GMOs and Biofuels: Conclusion.

- Similar concerns to all GM processes, i.e. biosafety, public oversight and interaction,
- The power of profit vs. public interest,
- Sustainability – first and second generation biofuels are questionable re. efficiency, sustainability, reductionist world-view,
- Third generation biofuels – big possibilities but equally big challenges as far as containment, proprietary concerns, public access to research and information.

Some references and further reading

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That's all for now folks!

Thank you

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