This response was submitted to the consultation held by the Nuffield Council on Bioethics on *New approaches to biofuels* between December 2009 and March 2010. The views expressed are solely those of the respondent(s) and not those of the Council.

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As an academic whose research examines the drivers of recent developments in UK and EU biofuels policy, I welcome the opportunity to contribute to this consultation. I do not feel qualified to respond to all of the questions posed by the Council however, and therefore limit myself to discussing issues of 'climate change', 'land use, environmental and food security, and human rights' and 'investment, policy and governance'. A brief summary of my main contentions is provided below:

1. The majority of 'advanced' biofuels generate significant opportunity costs for the environment, both in terms of their local impact upon biodiversity and their global impact upon climate.
2. Advanced biofuels also generate significant opportunity costs for alternative energy sectors, by precluding the more efficient and cost-effective application of biomass resources to generate heat, or heat and electricity.
3. Some evidence indicates that the purported superiority of advanced biofuels' productivity compared to so-called 'first-generation' varieties is often *not* borne out 'on the ground'.
4. Whilst biofuel production is often promoted as a means of alleviating rural poverty in developing countries, this argument dangerously assumes that it is ethically defensible to enforce upon such populations a particular means of earning a living.
5. Arguments which construct 'advanced' biofuels as essential to the UK's future economic competitiveness are based upon an extremely narrow conception of how science and technology should interact with society, informed exclusively by the value choices of scientists and other technical experts engaged in relevant research fields.

1. Advanced biofuels as a source of environmental "opportunity costs":

In exactly the same manner as their first-generation counterparts, the majority of 'advanced' biofuels necessitate biomass cultivation, and may therefore directly stimulate biodiversity loss, particularly where wetlands, grasslands or tropical rainforests are cleared to make way for arable land. Moreover, since these landscapes usually help to mitigate climate change by sequestering vast quantities of carbon dioxide, their clearance will also exert a potentially catastrophic impact upon the global climate, both by precluding further carbon sequestration and by generating a one-off release of large quantities of greenhouse gases (GHGs) into the atmosphere. Scientific research indicates that these 'pulse' releases of GHG would take decades to centuries to recoup through the subsequent use of any biofuels cultivated under such circumstances (Fargione *et al*., 2008; Searchinger *et al.*, 2008).

It is important to recognise that these local and global environmental impacts can also operate *indirectly*. Even when biofuels are produced using land that is already under cultivation, this merely displaces existing agricultural activity into as yet uncultivated areas. Given that the nature and impacts of such indirect land-use changes cannot be monitored accurately, it seems doubtful that the *full* environmental impacts of biofuel production can ever be effectively policed.

Finally, even if one disregards biofuels' potentially deleterious environmental impacts, the present context of a rising global population, coupled with growing demands for land-intensive meat production in many reasons, certainly raises serious concerns over our ability to cultivate significant quantities of 'advanced' biofuels without impacting upon global food security.

2. Advanced biofuels as a source of energy "opportunity costs":

Advanced biofuels inevitably preclude the application of biomass resources in other energy sectors, where they might be used to generate heat, or heat and electricity. Given that these applications are both more cost-effective and more thermodynamically efficient[1] than liquid transport biofuel production, their

[1] Even the UK Government's Biomass Strategy, published in 2007, recognises that transport biofuels constitute the *least* efficient use of biomass for energy production, in terms of their cost per tonne of carbon dioxide abated (DTI, DfT and DEFRA, 2007).

very real viability as climate change mitigation strategies should not be downplayed. Unfortunately, it seems that these alternatives have been excluded from political debate by the initial framing of liquid biofuels as a 'magic bullet' in the fight against climate change[2]. Given that this view of biofuels is no longer valid, a wholesale political reconsideration of *all* potential means by which biomass resources might be employed to mitigate climate change is urgently required.

In addition to these concerns, it should also be noted that technical constraints on the *blending* of biofuels will ultimately limit their overall contribution to climate change mitigation. Thus, whilst cellulosic bioethanol, once commercially viable, *might* generate 80-100% less GHG emissions than petrol or diesel, this will only reduce *total* emissions by c.8-10%, since c.90% of transport fuels will still have been derived from fossil oil[3]. Crucially, this also illustrates why the present political obsession with transport biofuels will ultimately operating to *prolong* the road transport sector's dependence upon fossil oil, whilst potentially diverting investment away from *genuinely* renewable solutions such as hydrogen fuel cells and electric vehicles.

3. Advanced biofuels as a false promise?

Whilst advanced biofuels have often been championed as a fruitful development mechanism for rural economies in the global south, first-hand accounts of their success in this respect have thus far been ambivalent at best. Jatropha farmers from countries as widespread as Brazil, Kenya, India, China and Myanmar, for instance, have all complained of poor yields, and of a lack of buyers for their produce, in spite of the persistent claims and reassurances to the contrary issued by Western scientists and local politicians alike (TIME Magazine, 2009*a*; 2009*b*). This raises the worrying possibility that considerable uncertainties in the science underpinning advanced biofuel cultivation might have been neglected or downplayed by the scientific community, presumably as they bid to 'sell' such technologies to developing countries as quickly as possible.

4. **Advanced biofuels as a human rights issue?**

Even if advanced biofuels *do* perform to their full potential, one must still consider whether it is ethically defensible to enforce upon the rural populations of developing states a particular means of earning a living. Such a scenario may sound extreme, but already in India, China and Myanmar large numbers of citizens are legally obliged to grow Jatropha. This raises very probing questions about the potential impact that Western states' biofuel policies might have upon access to human rights in developing states. More broadly, it is also difficult to see how such initiatives can *avoid* perpetuating the present global division of labour between a 'south' that has traditionally been economically dependent, often to a debilitating extent, upon natural resource exports, and a 'north' that has persistently refused to curtail its voracious resource consumption.

5. Advanced biofuels as a product of *unreflexive* science and technology governance:

Frequently, proponents of advanced biofuels contend that, whatever their potential social and environmental impacts, the UK has little choice but to invest in this technology, for fear of being left behind in the emerging global 'knowledge economy'. Even if we accept that sustained economic growth is a legitimate objective, such arguments remain weak in that they implicitly discredit alternative means for achieving this aim. Thus, a raft of alternative options[4] for the reduction of road transport GHG emissions are excluded from political debate by proponents of advanced biofuels.

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[2] As Prof. Roland Clift stated in giving evidence on biofuels' sustainability to the House of Commons' Environmental Audit Committee in late 2007: "A reliable, small scale combined heat and power process...will be far more beneficial [than biofuels], albeit it is lower technology and therefore does not attract the sort of capital and engineering interest which it merits" (EAC, 2008: 104).

[3] Even this estimate assumes that 'overly ambitious' (*Birdlife et al.*, 2009: 2) biofuel targets stipulated under the EU's Renewable Energy Directive (2009/28/CE) have been met by 2020.

[4] In the words of the Royal Society, 'progress towards a sustainable solution for transport…requires an integrated approach, which combines biofuels with other developments, including vehicle and engine design, the development of hybrid and fuel cell vehicle and supporting infrastructure, public transport,

At another level, these arguments are also symptomatic of *unreflexive* science and technology governance - governance that is either ignorant of, or which actively seeks to conceal, the very *un*scientific social and moral *value* choices upon which it is fundamentally based. Adequately acknowledging these choices and opening them up to wider debate is essential if the governance of emerging science and technologies, such as 'advanced biofuels', is to generate truly 'socially robust' decisions (Stirling, 2008), particularly where large complexities and uncertainties exist. A far more *inclusive* and *deliberative* mode of decision-making is therefore ultimately required, and in this instance should focus not just on the form of specific biofuels policies, but also upon their more normative *objectives* and *goals*.

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better urban and rural planning to address the increasing demand for transport as well as more specific policies to reduce demand and encourage behavioural change' (Royal Society, 2008: 3).