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.

NNFCC

Question 1
What is your view on society moving towards greater use of biofuels?

Biofuels can be produced from a wide range of feedstock materials and via a number of potential processing routes, each of these will have different impacts, some positive and some negative. In addition it is important to clearly define why biofuels are being used – and there are different reasons why biofuels are promoted by governments.

In the face of declining cheap indigenous fossil fuel stocks, Governments in developed nations are concerned at the degree of exposure to unstable regimes that control the fossil fuel supply. Biofuels offer the potential to diversify at least some of the reliance on import of fossil fuels, and to produce home-produced fuels. However it is recognised that the level of substitution that can be achieved in Europe is limited given the current scale of liquid biofuel use, and the limitation on feedstock availability for biofuels, given that the land resource available is constrained by food and other public demands on its use.

In terms of alternative energy sources, while there are several for power generation, the whole transport infrastructure relies on liquid fuels and biofuels that are compatible with the existing fossil fuel technology. Certain materials, such as vegetable oils, should therefore be preferentially used/incentivised for biofuel production rather than bio-power production.

Secondly, biofuels drawn from appropriate certified supply chains can deliver significant greenhouse gas (GHG) savings, and it is important that any public support for biofuels as a mechanism for delivering GHG saving actually results in a significant GHG saving. In the UK, Greenhouse gas (GHG) emissions from the transport fuel sector are of concern because they currently account for a quarter of annual worldwide carbon dioxide (CO_2) emissions and are growing, whilst emissions from other sectors are declining or stable. Biofuels are the only near term option to decarbonise the transport system, particularly for the existing car fleet
The introduction of the Renewable Energy Directive (RED) in 2011 (which will set minimum and progressive mandatory GHG savings for biofuels) will be an important step in this process and will build on the work of the UK's Renewable Transport Fuel Obligation in developing the process of certifying biofuel supply chains. However, biofuels should not be seen as a diversion from work to increase fuel efficiency. Biofuels represent only one part of a wider strategy to reduce GHG emissions from transport that will also inevitably involve measures to influence pubic behaviour and transport choices.

Thirdly, biofuel feedstocks sourced from developing countries have the potential to provide income and development opportunities for these countries, but again this needs to be carefully assessed and considered on a case by case basis, to ensure that the benefits outweigh any dis-benefits. The development of social sustainability criteria for palm oil production highlights attempts to provide assurance of social care in sourcing of such oils. The introduction of the RED will increase the demand for such assurances in the market.

In summary, biofuels can provide public goods, but it needs to be recognised that biofuels represent a wide range of raw materials and supply chains and that win-win options are possible on both environmental and social sustainability grounds, but these need strong assurance and monitoring schemes in place to guarantee public confidence. It also need to be recognised that development and use of biofuels is only a small part of the approaches that society needs to adopt to reduce emissions in the transport sector

Question 2
What are the most important ethical challenges raised by the prospect of future generation biofuels?

Second and future generation fuels can be produced from a number of different routes – thermochemical and fermentation being the most developed currently. Thermochemical routes are relatively indifferent to bio-feedstock type and so a much wider source of biomass can be used including municipal and other waste streams. This would pose few ethical challenges – other than the usual local concerns raised over the site of plants and unfounded concerns over emissions (all would have to be EA compliant).

For fermentation technologies, again waste streams can be utilised, reducing pressure on land use. Fermentation technologies rely on the development of enzyme technologies, often developed through GM micro-organisms. The constrained use of GM organisms or their expressed enzymes in fermentation systems has to date caused little ethical concern. It is also not seen an important campaigning issue for many environmental organisations – including the WWF. However, the genetic modification of feedstock plants to increase biofuel processing efficiency is an issue of greater public concern, as it represents a wider environmental release. Processing enzymes have already been incorporated into maize in the US as part of developments to help reduce enzyme cost in corn ethanol processing. Such developments are unlikely in the near future in Europe due to heightened concerns over GM issues. However, as concerns over increasing food and raw material increase, there will need to be a wider debate around the potential of biotechnology to improve both productivity and resource efficiency. However, such arguments only relate to certain possible future biofuel pathways.

Question 3
Do you regard yourself as well informed about biofuels? Where do you get your information from?

Yes. The NNFCC works closely with the UK Department for Energy and Climate Change to provide evidence and analysis on biofuels, including next generation biofuel technologies. The NNFCC also commissions industry and academic-led research reviews on biofuels and their potential prospects and impacts. The NNFCC also works directly with the biofuel industry to help understand and address barriers to development and deployment.

Question 4
Which factors are going to be the most important in driving the development of biofuels in the future? To what policy concerns should priority be given? What advantages not mentioned here could and should future biofuel production aim to deliver?

In the UK and across Europe, addressing climate change will be the biggest driver for biofuels as there is already legislation in progress to commit EU member states to binding targets for biofuels and associated carbon savings.

In terms of the biofuel industry, confidence in governments providing long term support is essential to encourage investment in both existing and next generation technologies, the latter will require much higher capital investment and therefore investor confidence will be key to future development.

Future thermochemical biofuel technologies can provide very high grade fuels, suitable for use in aircraft and for blending with lower-quality fossil-fuels to extend their use.

Expansion of use of biomass for biofuels should seek to deliver development opportunities for developing nations. Seeking to use as much of the existing infrastructure, logistics and other local services as possible to ensure as much wealth as possible remains in the biomass producing countries.

Future biofuel production facilities should aim to integrate the production of fuels, chemicals, power and heat. Biomass can deliver into each of these markets and being a limited resource, effective and efficient use must be made to maximise benefits.

Future biofuel production facilities will be much smaller in scale than existing oil refineries, limited by feedstock supply logistics. There may be a need to shift fuel supply paradigms to a more local model.

Question 5
Which of the new approaches to biofuels will be most successful in generating GHG emission savings? How should these be encouraged? Are there any reasons why these new approaches should NOT be encouraged?

Government support measures need to recognise the enhanced GHG benefits delivered by advanced biofuels such as ethanol made from lignocellulosic biomass and diesel/jet fuel made from wastes. These enhanced savings can be close to 100% compared to petrol and diesel providing robust sustainability criteria are met. In some cases, particularly in the case of wastes such as MSW, GHG savings beyond 100% are achievable, realised because of a credit applied because of avoided emissions from the alternative disposal route.
Support should be provided to those processes which recognise where biomass is best utilised. This should be not only in terms of GHG savings per tonne of biomass consumed but also should recognise other aspects such as whether alternative low carbon solutions exist for the application.

The most effective processes should be incentivised either through either Capital Grant support or higher ongoing support/incentive payments.

Question 6
Which of the new approaches to biofuels will be most successful in improving energy security? How should these be encouraged? Are there any reasons why these new approaches should NOT be encouraged?

Processes which in particular can use a range of feedstocks including waste streams should be encouraged, particularly in the UK where there are limited supplies of any one type of biomass. This feedstock flexibility requirement drives firstly the use of thermochemical approaches to produce fuels although exciting biochemical approaches to produce ethanol and perhaps butanol from municipal solid wastes are developing rapidly and may be demonstrated in the UK within 1-2 years.

Approaches using existing waste streams and other biomass waste or residue streams (e.g. straw) plus crops and forest biomass will be the most effective in improving both energy and import security, particularly by re-directing waste from landfill to biofuel generation. Such measures need to be more clearly recognised in waste treatment hierarchies as ‘recycling’ and ‘re-use’ technologies and incentivised accordingly.

Advanced technologies for producing biofuels are historically expensive, particularly some thermochemical routes and new, lower cost technologies using lower temperatures and pressures should be encouraged . Again, such lower cost options are expected to be demonstrated in the UK during the first half of this decade. In particular, options to produce diesel and jet fuel substitutes are needed to service the heavy duty and aviation sectors where few other alternatives such as ethanol are suitable.

Anaerobic digestion of wastes to produce biomethane for transport also offers a potential route to improving transport energy security without affecting land use, but investment in infrastructure is required to encourage any significant uptake. The experiences with LPG show that it is feasible in the UK and can be encouraged with the right fuel duty incentives. However GHG savings are low compared to use of methane for heating applications

Developing multi-production bio-refinery approaches to produce both fuels and high value bulk chemicals will also help to improve energy security, by providing multiple revenue streams to processors to help maintain processing equipment in the UK.

Question 7
Which of the new approaches to biofuels will be most successful in supporting economic development? How should these be encouraged? Are there any reasons why these new approaches should NOT be encouraged?

Development of large scale biorefinery capabilities for fuel and chemical production - either thermo chemical or fermentation based - offer the greatest potential to add economic value to processing regions. These will provide high-tech jobs in processing and refining at the sites of production, but also will generate significant impacts in logistic supply chains and biomass production in a wide radius of the plant.
On a smaller scale in developing countries, algal technologies offer potential where sunlight and heat is naturally abundant but other resources are scarce. This offers the potential for development of high tech jobs and spin-off opportunities, including carbon capture projects.

Question 8
Of all the new approaches to biofuel feedstock development, pre-treatment and processing (including any additional to those mentioned here), which is looking most promising for eventual commercial and sustainable use? Over what timescales might such developments be commercialised? Are there any risks associated with these developments?

Low cost processes that can use a range of feedstocks on a daily basis, in particular waste materials such as MSW show promise. As noted above, thermochemical technologies provide this flexibility. However, recent developments over the past six months indicate that new processes will be demonstrated within 1-2 years, possibly in the UK, which use fermentation to produce ethanol from municipal solid waste (MSW) and potentially chemicals such as succinic acid.

Although ethanol is suited to use in road transport, heavy duty applications such as HGV's and aviation require a mid distillate fuel. This is more difficult to achieve compared to ethanol although there are developments ongoing.

Such technologies are currently moving from the pilot scale to sub commercial demonstration scale. Choren in Germany are just completing the start up of their 15,000 tonnes/year thermochemical wood to diesel plant in Germany while in the UK, Ineos Bio plan to build a MSW to ethanol demonstration facility on Teesside by 2013 and BA recently announced plans to build a plant to produce jet fuel from MSW in the South East. Significant work is ongoing in this area in Scandinavia where there are at least 4 significant wood to biofuel/bionatural gas projects under construction.

There is potential to establish commercial-scale BTL plants in the UK by 2020, but this relies on immediate actions to facilitate development (grant or loan schemes) that could lead to demonstration scale projects being up and running by at the latest 2016. High capital costs, in particular for plants producing diesel and/or jet fuel, and uncertainty over future levels of support are barriers to development currently.

Question 9
Is the use of the following technologies to develop new approaches to biofuel production appropriate? Why?

- Advanced plant breeding strategies and Genetic engineering
- Synthetic biology

Advanced plant breeding offers the potential to increase biomass productivity, increase the efficiency of biomass to biofuel conversion (e.g. through reducing plant lignin content), and increase the range of land use types and climatic zones from which high levels of biomass can be derived – through increasing water use efficiency and drought tolerance etc.

All possible options for increasing productivity and efficiency of biofuel production should be considered to ensure that costs of biofuels are kept as low as possible, use of land is optimised through high biofuel production per unit area, and that processing efficiency is optimised.

Containerised and controlled use of GM organisms for biofuel production poses no risk to the wider environment and so there should be few concerns in uptake and adoption of technologies in this area for optimising biomass processing.

In Europe, control over the release of GM organisms to the environment is controlled by legislation and peer review (co-ordinated through EFSA) that requires assessment of ecotoxicological and environmental pollution risks to enable assessment of whether release of organisms to the environment should be permitted or severely constrained. Following this risk assessment procedure, assessing GMO crops on a case by case basis should ensure that there are no risks posed by wider exploitation of GMO's.

Metabolic manipulation of cells is a difficult process often requiring hundreds of individual pathway modifications. In addition outputs are often in aqueous media which means expensive separation is required. While synthetic biology shows promise considerable further development is required to prove its commercial value in the biofuel sector.

Question 10
What are the most important intellectual property and access issues raised in new approaches to biofuels? What is the best way of governing these?

There will be a number of IP issues around access to enzyme technologies and thermochemical processes. This is reflected in a number of joint ventures in this sector designed to co-develop and share IP within industrial partnerships. This is an important consideration for investment capital in large projects.

However, public funded R&D in this sector is more easily accessed, though this can dissuade industrial partners from involvement in some publicly funded projects.

International initiatives such as GBEP and by the IEA are looking to encourage technology transfer in best available technologies. Working with International Biofuel Corporations will provide some spin-off developmental benefits for developing countries that are likely to be slow to emerge otherwise.

Question 11
What are currently the main constraints to R&D in new approaches to biofuels?

Lack of confidence in future levels of support for biofuels to encourage investment
High costs of dedicated biomass feedstocks – hence interest in waste streams
Uncertainty over European legislation relation to GMO release – Research and biotech organisations in Europe are either shunning GM routes to development currently, or putting effort into parallel track (GM/non-GM) routes, which dilutes funding. In contrast, international companies are focusing on GM approaches in areas where commercialisation is not a problem. This could leave the EU trailing in future developments.

Question 12
Where should R&D for new approaches to biofuel be targeted, and who should decide about future biofuel R&D strategies?

R&D approaches need to be targeted at;

- Increasing utilisable biomass production/unit area of land
- Assessment of impacts of land use change on soil carbon balances
- Developing low cost lignocellulosic processes, both thermochemical and biochemical, for mixed biomass streams
- Assessing the value of algal technologies and how costs might be reduced/offset
- Optimising the use of ethanol in flex fuel engines so that advantage can be taken of ethanol's high octane number to offset its lower energy density.

Private companies will set their own R&D agendas, but in relation to Public-funded support, in Europe the EU commission should bring together industry and academic stakeholders to identify the most promising routes to development and the R&D required to deliver these. Member state government funds can then focus on key areas of particular relevance to their own resources and needs, and provide support for proof of concept demonstations to encourage adoption at a regional scale. At an international scale, the IEA provides a forum for R&D exchange and discussion on priority actions.

Question 13
Are new approaches to biofuels likely to raise problems related to land use? If yes, how? If not, how do new approaches avoid these issues?

Algal technologies do not need fertile land and as such offer opportunities for developing and arid countries, where water is recycled effectively.
Development of native and drought tolerant biomass crops, such as Jatropha, can help reduce the pressure on fertile land used for food production, that would otherwise have little value. However, it will be difficult to restrict use of such crops to use on land of only marginal value for food production.

Wastes from agriculture (e.g. straw) and from the food and other waste streams (5m tonnes of waste wood, 3.4 m tonnes of garden waste) will in the future be used to produce biofuels with no impact on land use change (up to 3 million dry tonnes of surplus straw is available in the UK). However, it will be necessary to compensate for nutrient removal on land where straw is repeatedly removed.

Development of lignocellulosic and thermochemical processes will shift the focus from food crops to biomass in its widest sense, reducing pressure on the arable land area. Grassland is a resource that is currently underutilised due to falling livestock numbers (the grass resource could be used for bioethanol production, or where possible converted to energy crop or forestry production with no impacts on food production). Much of the planted forestry in the UK is also of low value currently and thinnings from this as well as timber provide an important potential biomass resource (1.3 million dry tonnes of sawmill waste and forest thinning are available in the UK).

Where biofuel processes can use a wide range of feedsock this reduces pressure on land to supply specific crops and overcomes seasonality issues. It also allows biofuels processesto utilise materials from a wider range of land resources – such as brownfield and transport margin infrastructure etc. Recent work by FERA has estimated that there is up to 0.9 m hectares of idle land in the UK capable of producing up to 1.1 million toe of biomass primary energy output.

Question 14
What differences are there between the developed world and developing countries with regards to the potentially problematic effects of future generation biofuel production on land use?

Developing nations with abundant warmth and moisture have the potential to produce very high biomass outputs and to exploit the biomass demands of developing nations with constrained land resources for biomass production. However, in developing nations with more arid climates there is a risk of diversion of scarce water and other resources to biofuel production at the expense of food production and other land uses. Sourcing through ethical and environmentnal assurance schemes should ensure that detrimental impacts are minimised.

In developing nations, agricultural production is optimised, environmentally sensitive areas are well recognised and protected from development. The potential for expansion of biofuel cropping is therefore more restricted than it might be in less regulated environments.

Question 15
Should iLUC be considered when evaluating the GHG emissions savings of new approaches to biofuels, and if so, how?

iLUC should be considered for all potential uses of land, not just for biofuel production. If areas are deemed too valuable (from a biodiversity or soil carbon perspective) to be used for food or biofuel production then they should be protected appropriately, and not rely on controls applied to biofuels only. The best way of addressing this in the short-term is to certify the sources of origin of biomass materials – as done through the RTFO, to ensure any detrimental LUC is avoided.

Question 16
What advantages and disadvantages for environmental security could new approaches to biofuels have? How could harms for environmental security be dealt with?

The RED and RTFO will ensure that biomass from areas of high biodiversity, forested land, peatlands and drained wet-lands are excluded from counting towards renewable energy targets, to protect such environments from development.

Recent NNFCC, RELU and TSEC-Biosys research indicates that there is a potentially large positive effect on biodiversity by growing lignocellulosic crops for bioenergy production compared to crops such as wheat. However, this must be balanced against food production requirements.

Question 17
Are new approaches to biofuels likely to raise problems related to food security? If yes, how? If not, how do new approaches avoid these issues?

By expanding the types of biomass resources that can be utilised and procedures available for biofuel generation, impacts on the arable land resource will diminish through wider use of underutilised agricultural resources (straw and grass) and waste streams.

Question 18
What differences are there between the developed world and developing countries with regards to the potentially problematic effects of future generation biofuel production on food security?

The impacts in developing countries will depend on the competitive value position of biofuels and food outlets. Where biofuels offer greater returns there will be a drift towards production at the expense of food production. Similar trends have been seen in other sectors – for example cut flower production in Kenya. The returns from higher value crops, and higher wages paid to workers outweigh the detrimental impacts of loss of agricultural production as all are better off financially. A significant issue is whether the land is tied into short-term or long term crops which makes it more difficult to convert land back to arable croppping. The problems of addressing food production in developing nations are wider than the impact biofuels alone and should not be used as a barrier to adoption which could constrain local regional development opportunities.

Many developing nations are dependent on energy imports, allowing them to produce their own fuels would be a significant means of retaining income and reducing foreign debt.

Question 19
Are new approaches to biofuels likely to raise problems related to rights of farmers and workers? If yes, how? If not, how do new approaches avoid or benefit these issues?

Again such problems cannot be laid solely at biofuels, as the issues are common to any commodity crops. Ensuring that biomass is derived according to certified social standards should ensure that best efforts are made to ensure equitable treatment of workers in developing countries

Question 20
What differences are there between the developed world and developing countries with regard to the effects of the production of future generation biofuels on the rights of farmers and workers?

In developed countries the rights of workers are more strongly enforced and complied with. Hence there is a need to drive the equivalent in developing nations through ethical procurement routes. Fairtrade is an example of how such mechanisms can be implemented.

Question 21
Where do you think investment in new approaches to biofuels should be directed and where should it come from (public sector, private sector or public-private partnerships)?

Traditionally the public sector invests in basic research and where there are market failures. The private sector is expected to invest in commercially relevant research. This model works well, but where the financial driver is incentive-based this model does not work so well, particularly where large investment capital is required. In such cases, public grant funding or public/private partnerships offer a way forward as long as the public goods can be clearly defined.

Much of the basic information is already developed for next generation technologies, what is now required are larger scale demonstration of technologies to prove their value to industry and investors. This is an area where public/private partnerships have a key role to play and to share the rewards.

Question 22
Which policy issues in relation to new approaches to biofuels would you like to bring to our attention?

Answers to previous questions have shown where the RED and RTFO and the associated Fuel Quality Directive (FQD) will address some of the issues raised in your questions to help minimise and undesirable impacts associated with biomass development in developing countries and other suppliers outside the EU. The EU is currently reviewing how sustainability standards could be developed for use with the RED and is expected to report very soon on this.

Currently the sustainability standards in such legislation only pertain to biofuel production. Clearly biomass can be used for biomass, power or raw material production, and sustainability criteria need to apply equitably to all uses to avoid unsustainable biomass production being targeted for power generation for example. The review mentioned above will address this issue.

Current policies in the UK supporting use of biomass including the Renewable Obligation order (RO), the RTFO and the forthcoming Renewable Heat Incentive (RHI) all reward biomass use in different ways. This could skew how and where biomass is used rather then directing it where it is most appropriately used or required. Transport relies on liquid biofuels, other energy use sectors typically have alternatives.

Incentives offered at the duty point will be paid to the big oil companies involved in fuel distribution. This leaves smaller biofuel producers having to negotiate with the large fossil fuel suppliers for a share of the incentive offered.

Question 23
What would be the most effective policies a) to promote and incentivise; and b) to regulate the development of new approaches to biofuels?

a) The RTFO and duty rebates have been proved to effectively kick start biofuel production in the UK. The move towards a wholly RTFO incentivised approach is now in place with the demise of duty rebates. However, this does not provide any incentive for advanced biofuel technologies in terms of more support for those processes offering higher GHG savings. Currently there is therefore no additional incentive to develop such technologies through the RTFO alone, and capital grants are a possible option. Another option would be to offer duty rebates on specific processes where it can be demonstrated that GHG savings significantly over and above the mandatory minimum are achieved.

b) Mandatory reporting of sustainability criteria for biofuel batches, as opposed to the voluntary reporting required under the RTFO, would address a significant number of the issues raised in

this questionnaire in relation to reducing the undesirable impacts of biofuels, by restricting the land types from which biofuels could be derived, and ensuring workers rights are respected.

c) The US mandates that part of its renewable fuel targets should come from lignocellulosic processes. Adopting a similar approach in the UK could encourage development of the sector.

Question 24
Are there any other issues not mentioned in this consultation that we should consider in the ethical evaluation of new approaches to biofuels?
Please expand below.

There is no specific evaluation of the positive benefits that biofuels can deliver in terms of developmental opportunities for both developed and developing nations. This can offer high tech and high value jobs for developing nations and help provide significant add-on value in the supply chain industries that can outweigh losses from traditional industries and lifestyles – any detrimental impacts of biofuels need to be balanced against this.

In developing countries like the UK older manufacturing industries are closing down. The UK needs to develop new low carbon technologies and high tech industries to replace these and lever advantage from our high tech knowledge and excellent world-leading higher education system.