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.

EuropaBio

QUESTIONS ANSWERED:

Question 1

ANSWER:
The high use of energy stemming from fossil resources is untenable in the long term. The challenges of increasing CO2 emissions, climate change, increasing import dependence and higher energy prices all send clear signals that society needs to act now to secure sustainable and competitive energy. Liquid biofuels can offer a solution - ensuring an energy supply, in particular in the transportation sector – that is heavily independent of oil and can lead to significant reductions in CO2 emissions. Currently and for the short to mid term, the transport sector will mostly operate with energy in liquid form (fuel) and it is the opinion of EuropaBio that the only realistic alternatives to fossil based energy for the transport sector are biofuels - such as bioethanol, biobutanol or biodiesel - produced from renewable raw materials from agricultural production and (often) with the involvement of advanced enzyme or microbial systems in the conversion processes. The advantage of biofuels is indeed that they can be blended with existing transport fuels, and that they are compatible with existing vehicles and existing fuel infrastructures and logistics. Changing transportation technology (replacing vehicles, logistic of fuel distribution) will take years and probably decades to change in developed countries (much longer in developing countries). Additionally certain types of transport (long distance, heavy duty, aviation or maritime transport) are not well suited for electric or hydrogen technologies as they need high power density. Taking these into consideration, the International Energy Agency (IEA) projects [1] that to achieve the International Panel on Climate Change 2050 climate change targets, bioenergy must provide at least 20% of society's energy demand. [1] IEA, Transport, Energy and CO2: Moving towards Sustainability, 2009 (www.iea.org/publications/free_new_Desc.asp?PUBS_ID=2133)

Question 2

ANSWER:
The development of future lignocellulosic biofuels and bioenergy, present a number of opportunities for economic development of rural areas, especially in developing countries, while limiting the potential impact on food production, but also in the new member states of the EU, where primary agricultural productivity is being kept deliberately low, as part of a Common Agricultural Policy (CAP) that was developed to deal with surpluses and lack of markets for EU farm commodities.. Major changes in agriculture, which will accompany these developments, will need to address repartition of the resources generated in the energy market by ensuring that the farmers get a fair return. In food production in Europe this equilibrium has not been reached. This could be addresses through the diversification of farms production towards biofuels/ bioenergy, especially through local/regional projects.

Question 3

ANSWER:
Yes. EuropaBio is the European Association of biotech industries and one sector of activities of its member companies is the development of advanced biofuels production technologies (essentially ethanol and butanol) from crop improvements to biofuels production and blending, including biomass pre-treatments and fermentation.

Question 4

ANSWER:
The main drivers are indeed climate change, energy security and rural economic development. However their relative importance to drive the development of future generation biofuels and policy priorities will vary from one region or country to the other. This will depend on their unique characteristics such as

demographic trends, geographic conditions, and economic, institutional and political capacity to aggressively develop bioenergy solutions. These challenges are not unique to future generation biofuels and each of them will need the development of an array of solutions and related policy strategies. Nevertheless biofuels including next generation biofuels and bioenergy can contribute to all of them. In addition lignocellulosic crops for biofuels and bioenergy, with careful siting, can improve land and agricultural ecosystem management and deliver significant benefits to biodiversity, water cycle, soil stability and quality, as well as enhancing carbon stocks and food crop production. To achieve these benefits, agriculture and bioenergy policy must be integrated for the sustainable and synergistic production of food, fibre, chemicals and bioenergy. The biomass produced could be directed to multiple divergent or parallel uses in response to changing needs. Examples of the integrative benefits of bioenergy include the simultaneous production of bioenergy and food through double cropping, the exploitation of wastes and residues, recovery of protein and nutrients for animal feed and fertilisers, the use of perennial crops to enhance ecosystem services and redesigning landscapes to enhance resilience and productivity. Political support can also mitigate the risks inherent in these new technologies development, which require huge investments, long time horizons, and are therefore extremely difficult for any company to undertake, Development and commercialization of cellulosic biofuels technology will enable significant production of biofuels in less-developed countries, offering those populations a local source of fuel, and enabling additional access to transportation and mechanization, for example.

Question 5

ANSWER:
Inherently, the solutions providing the most GHG emission savings are those fixing large amounts of atmospheric CO2 in biomass while limiting land use and land-use change. This can either be obtained by choosing solutions with large biomass output per hectare (e.g. sugar cane or energy crops like switch grass or miscanthus, algae) or maximising the use of the production of one hectare by using by- and co-products of a crop and of its transformation (e.g. grains for food or biofuels, residues used for biofuels or energy, residues of grain processing transformation (DDGS) for animal feed, residues of fermentation for process energy or for fertilisers). The best approaches will be selected by encouraging the improvement in term of GHG emissions of existing solutions and the development of the best performing solutions. ALL new approaches addressing climate change should be encouraged. However priority should be given to those delivering significant GHG emissions at the lowest cost for society. [ref McKinsey graph on costs of energy solutions]

Question 6

ANSWER:
For a country, there are essentially three ways of addressing energy security: to reduce or control its consumption, thus reducing its energy needs and more specifically its energy imports, to diversify its energy mix in terms of energy sources (coal, oil, biomass, geothermal, biogas,…) and energy sourcing, thus reducing the impact on their supply would one of these source came to fail to increase its domestic production, thus having a better control on the alignment between its production and needs. Reducing energy consumption (through e.g. car efficiency and building insulation) is of course a must and should be implemented first and foremost as these are the most cost effective way to reducing energy dependence and addressing GHG emissions. However tackling consumption level requires a long lead time and does not address the security supply of the energy still needed. Future generation biofuels contributes to the diversification of the energy mix, especially in transport, which is more than 80% dependant on imported oil in Europe. Though imports will be necessary, especially in the short-term when production systems for biofuels and bioenergy are gearing up, Europe could achieve very substantial shares of its energy needs by using domestic biomass. This can be done by using land that is currently ‘available’ or under-utilised land through sustainable productivity improvements in conventional agricultural and forestry systems in Eastern and Western Europe. Projections have highlighted 40 million hectares of agricultural land that is abandoned or under-utilised in Europe as being potentially available for bioenergy. [IISA report]For countries with limited land availability, the use of organic wastes can be an attractive alternative. Domestic production of biomass for biofuels and bioenergy should be encouraged.

Such plans need to take into consideration the needs of food/feed production both for domestic use and export, as well as other existing outputs of the agricultural system. To achieve this, agriculture and bioenergy policy must be integrated for the sustainable and synergistic production of food, and biofuels/bioenergy, as well as fibre and materials. Agricultural system can be designed so that biomass produced could be directed to multiple divergent or parallel uses in response to changing needs.

Question 7

ANSWER:
The development of a biobased economy (producing biofuels and/or materials) is overall positive for rural development, by providing an additional output for agricultural material. However biofuels development, especially lignocellulosic biofuels which are creating in many areas new agricultural systems, must be profitable for farmers and should support the livelihood of, and employment in, rural communities. In this regard, the solutions delivering the most economic benefits will be the ones taking into account the specificities of region and its economy, and developed wit the engagement of the rural community. These approaches can be supported by conducting detailed analysis of the agricultural potential of different regions (taking into account improvement of 'eco-productivity) and target local energy/biofuels programmes in accordance. Regions that are biomass-rich should also consider local pre-treatment or transformation of biomass to retain the added value locally and, through higher energy density to reduce biomass transport cost. It is likely that few biofuel projects will only deliver liquid biofuel. Almost all will produce a mix of end products, and the total economic value of a biofuel strategy has to be assessed on the added value of these by-products as well. For example, sugar cane production in Brazil, or palm oil production in Malaysia always generate very large amounts of electricity by burning residues to generate heat. Bio-ethanol from grain or grasses produces high value protein co-product, which has become a major contributor to global protein production.

Question 8

ANSWER:
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? Many technologies are currently developing for lignocellulosic and waste biofuels based on different biomass, pre-treatment technologies (enzymatic, chemical or mechanic), transformation (fermentations, anaerobic digestion, gasification and pyrolisis). Different regional specificities will call for different solutions. Due to this diversity, it is very difficult to estimate which technology is more promising at the moment, except through discriminating on costs. But even then these technologies are at different maturities and we have seen how the production costs of first generation have sharply declined in 5 years of industrial production due to process scale-up and optimisation. Considering the status of development, the European Commission SET plan, is providing a reasonable analysis of the development status of different technologies and their likely time to market. However besides to technological hurdles, time to market will be mostly influenced on the resources put behind the various technologies. If today Brazilian sugar cane ethanol is the cheapest and the biofuel (produced at a large scale) delivering the most GHG emission savings, it is largely the result of 30 years political and financial support of research and industrial development. We estimate that major biofuels technologies are at the following stages of development today [see figure 2 on EuropaBio factsheet http://www.europabio.org/positions/white/PPIB_090625_Advanced_biofuels.PDF]. It should be noted that the technology development status (especially for the demonstration stage) is not homogenous in different part of the world. A number of demonstration plants to produce ligno-cellulosic ethanol are now operating or under construction in the EU and in North America [1]. Regular updates on the development of production facilities are provided by the International Energy Agency on its website[2] Enzyme technology for making ligno-cellulosic ethanol will be available soon[3]. Full scale commercialisation is expected to happen over the coming years, most probably before 2015 Biobutanol from fermentation was a process used in the first half of the 20th century. Biobutanol has a higher energy density than ethanol and can easier be transported in existing fuel pipeline systems. New biobutanol production technologies

show higher yields and lower overall cost. DuPont and BP, in joint venture, have developed plans to convert an existing bioethanol plant for biobutanol production as soon as the technology is available. They are constructing a pilot plant to further develop the technology. It is expected to be operational in 2010. More recent development concerns the fermentation of sugar to oil rather than alcohol. This technology is promising as it would allow a greater flexibility between diesel and gasoline needs in the transport sector. For biodiesel, with new processes under development, it is now possible to re-use a by-product of the current biodiese production process, glycerol[4], for biodiesel production. Biotransformation of glycerol into oils by means of algae and yeasts[5] as well as the re-introduction of the residual glycerol in the biodiesel synthesis process means that 100% of the feedstock is used[6]. This process should be commercially available within the next five years. The development of BTL (biomass-to-liquid) for the production of synthetic diesel is most advanced in Europe, particularly in Germany. Industry[7] expects to have its first industrial scale production plant operational within the next three to five years. The use of algae for the production of biomass and oils for biofuels is still in its early stages[8]. In the production process, algae can be cultivated in open ponds to capture carbon dioxide from the atmosphere or industrial sources of CO2. [1]http://www.grainnet.com/pdf/cellulosemap.pdf [2] http://biofuels.abc-energy.at/demoplants/projects/mapindex [3] Novozymes [4] 100 kg of glycerol are produced for 1 ton of biodiesel, http://www.theglycerolchallenge.org/ [5] Neuron BPH, http://www.neuronbp.com/ [6] Institut de Ciència i Tecnologia (IUCT), http://www.iuct.com [7] Choren [8] http://www1.eere.energy.gov/biomass/pdfs/algalbiofuels.pdf

Question 9

ANSWER:
Advanced plant breeding strategies and Genetic engineering The early phase of second generation biofuels will rely on current biomass (mainly crops and wood) and their agricultural residues as well as on improved enzymes and other technologies to make the process more effective. In the longer term horizon, the necessary increase in yield may probably only be achievable with modern plant breeding techniques - including plant biotechnology - and state of the art plant production methods, including the use of modern fertilization and plant protection systems. As already seen in other parts of the world modern plant varieties produced by biotechnology lead to far higher and more consistent yields. Also in Europe plant biotechnology can thus optimise land use and increase competitiveness and sustainability of European agriculture. Likewise, modern plant biotechnology may contribute to also grow energy plants in areas with marginal agricultural conditions, such as drought and saline zones or areas with very heterogeneous production conditions (frost, heat, flooding etc.). This would open unique opportunities for marginal rural areas to play an economic role again in future and contribute to raising their countries Gross Domestic Products (GDP). Further to improving plant, resources should be dedicated to research and development in agricultural systems management (e.g. doubling cropping) Synthetic biology Metabolic engineering is already commonly used to optimise current ethanol production, and for the development of biobutanol or sugar to diesel pathways. Synthetic biology is an extension of these methods towards the development of completely new micro-organisms dedicated to the production of certain molecules. It may indeed play a role in future development in biofuels though the technology is at a too early stage of development to evaluate its impact.

Question 10

ANSWER:
Intellectual property rights (IPRs) are a key driver of investment in R&D, innovation, and dissemination in the public and private sectors. According to data assembled by the World Business Council for Sustainable Development, patent rights are not a primary barrier to greater deployment of advanced technology in Least Developed Countries. Much more critical are: - Economic viability - Capital availability - Supporting infrastructure - Governance and regulatory stability - Local capacity Much of the advanced biofuel technology will be developed and patented by private firms. Published patent documents offer a vast accessible source of global technological information, partially also in local languages, on which others may build and so facilitating technology transfer. However, the trend is for more and more of this technology development being done by industry leaders in emerging countries: Brazil, India, China,

Malaysia, etc… This is a logical consequence of their evolution towards a knowledge economy, and a recognition of their current technical and economic strength in this sector.

Question 11

ANSWER:
Advanced biofuels provide promising opportunities which several companies have already embraced in order to invest for the future. These investments aim notably to reduce the relatively high production costs, to improve the efficiency of biomass to biofuels conversion and to reduce the costs of biomass transportation, notably via a better biomass logistics system. Various technologies, which can optimise the use of crops or provide more efficient biomass pre-treatment, are being investigated. Pre-treatment of biomass is technically challenging and constitutes a large part of the processing cost. In the case of enzyme-based ligno-cellulosic ethanol for example, a package of enzymes/microbes will be required for hydrolysis (breakdown of cellulose to sugar) and fermentation; this package leads to significant process costs and will need to be developed and optimised for the different types of biomass to be used. The commercialisation of biofuels and advanced biofuels will also mean that infrastructure to harvest, transport, store and refine biomass must be developed. To avoid unnecessary transportation, biofuels and advanced biofuels production could be coupled with the production of other bio-based products in integrated biorefineries.

Question 12

ANSWER:
R&D should focus on: - Optimisation of current technologies such as biomass pre-treatment mentioned above and cost reduction - Improvement of energy plant and traditional crops productivity (output/hectare) in agronomic systems maximising land management and agricultural ecosystem services, hence reducing pressure on land use. - Integration of biofuels production (biomass, by-products, “wastes”) into existing systems (feed, materials production, paper, etc) looking at synergies between those systems.

Question 13

ANSWER:
Land is a limited resource, which in the future is going to supply an increasing population with food, feed, fibres, energy, materials and chemical. The extent and efficiency off land use for agricultural production is highly variable. The need of the developing country to develop their agricultural production and their economy has to be addressed when addressing land use change. While animal husbandry occupies 70% of all agricultural land [1] – a percentage that is steadily growing – both desertification and urbanization continue to erode what remains of arable land. Biofuel can help counter this and contribute to rural development. Some biofuel crops revitalize arid lands as well as stop desertification. Jatropha is a particularly good example of a biofuel crop with these abilities. The plant is resilient enough to grow in arid environments, such as those bordering deserts. Today Jatropha is already providing energy, protection from further desertification, and adding productive land in a number of developing countries. A number of perennial crops and grasses have similar abilities. Emissions attributed to land use change from agricultural activities are mainly due to subsistence agriculture and deforestation (FAO 1980 and 2005). There is a need to address the challenge of land use efficiency, and the GHG emissions caused by land use change (LUC) in a coordinated way through agricultural practice and policy. To single out one use of land, namely biofuels, would not address the larger issue of emissions from land use change in agriculture or biodiversity preservation and could harm the development of the emerging biofuels sector. New approaches are being developed based on the use of organic wastes (from e.g. household or food industry). These approaches do not cause negative land use change and on the contrary they could reduce space used for landfills and help to solve the issue of waste management & its consequences) One should also not underestimate the positive aspects on biofuel by-products produced in Europe (DDGS or in the future silage from energy grass) which can replace imports of soy based proteins from other regions of the world and therefore also reduce pressure on the use of land in these geographical areas. [1] FAO, “bioenergy, food security and sustainability – towards an international framework”, June

2008

Question 14

ANSWER:
Developing countries often have minimal regulations in place to control land use change and protect sensitive areas, or have limited means to enforce them (e.g. illegal logging of hardwood in spite of international agreements). The economic development drive is often more important than preservation of the environment. This problematic does not apply solely to biofuels current or future generations but to all use of land or biomass (including food) and needs to be in a coherent framework such as AFOLU - Agriculture, Forestry and Other Land Uses international agreements. On the other hand, developing countries have the fastest growing needs for increased energy supplies, and development of biofuel capacity there can be done as part of an energy sector that is still growing rapidly. These countries also have 90% of the world's farmers, and creating a strategic, sustainable new category of markets for these farmers, if well managed, will be a major asset to address rural poverty, and the flow of economic value from the urban to the rural environment. The development of biofuels from agricultural residues does not only address energy production but synergies exist with other outputs of agriculture. For instance: - The need for large volumes of agricultural residues for lignocellulosic ethanol production can provide an economic incentive to increase the productivity of grain crops, or increase their cultivation surface (on underutilised or abandoned land). - Higher grain yields provides more food/feed for domestic use or export - The by- products of biofuel production (press cakes or DDGS) can be used as animal feedwith high protein content - And the production of biofuels can provide a fuel source for agriculture or local communities, which reduces the need to purchase imported fuel or crude oil.

Question 15

ANSWER:
Indirect Land Use change (ILUC) is not a well understood phenomenon and requires further scientific evaluation. Land use change has often multiple and complex causes which cannot be reduced to a single factor causing a domino effect. Efforts to control the emissions of agricultural production (through for instance good agricultural and forestry practices and soil restoration) would remove the need to address indirect land use change. Proposed measures should encourage positive behaviour in the farming community (inside and outside the EU) such as improvement of farming practices, rather than driving producers away from a market by introducing heavy penalties on biofuels for potential iLUC. EuropaBio believes that the best approach to tackle any land use change is through the development of integrated and global measures to address agriculture land use efficiency and emissions. Such approach could be based on existing international agreements. Most importantly, any extension of the land used should be avoided as much as possible, by focusing on increasing productivity of existing land before considering any form of new land clearage. Current economic model assessing iLUC do not address the complex causes of land use change and does not take into account improvement of land productivity or agricultural practices. Additionally current economic models cannot rely on complete land use data or carbon stock, and are based on a number of assumptions or empirical data, which is affecting the significance of their results. Major efforts are still needed to improve economic models and to take into account parameters such as yield increase or the interconnection between biofuels, energy and feed production.

Question 16

ANSWER:
In current EU legislation, areas of high biodiversity and natural grassland have been excluded from biofuels production. In the short to medium term lignocellulosic biofuels is more likely to come from agricultural residues, energy crops or coppice production than wood. The main challenge of lignocellulosic biofuels being the cost reduction of the process, the biomass supply need to constant and secure which is best achieved by high productivity agricultural practices or managed plantations for coppice. Wood is unlikely to be used for biofuels production, except through the use of wood industry

residues (bark, saw dust), as it is more profitable and efficient to use wood for wood product, paper or for heat and power production. The issue of unsustainable tree 'harvesting' in natural environment is therefore not an issue for advanced liquid biofuels.

Question 17

ANSWER:
It will entirely depend on how the transition is managed. The bulk of farm land of the world currently produces far below its potential. A major drive towards technology transfer to developing world farmers, particularly in Africa, will have much more effect on global food security than current plans for biofuel. It is NOT possible to develop a large biofuel sector without such a commitment to generalize the availability of production technology to these parts of the world, particularly as they tend to also have the fastest growing populations. Despite contradicting reports during the 2008 food crisis, it has been widely recognised afterwards that the main reasons for the increased price of food commodity has been the correlation of all commodities with high petrol price, a low dollar, speculation on agricultural materials in the market place, and poor cereal harvest due to draughts in Ukraine and Australia.[1] Lignocellulosic biomass doe not compete in the market with food demand, and therefore fluctuation of the lignocellulosic biomass market will not influence food price. On the contrary, and especially in developing countries, energy crops can be used as cash crops increasing revenues in rural areas which can be used for improving food production or purchase the food which cannot be grown locally. [1] Banse et al., Why are current world food prices so high?, June 2008 http://library.wur.nl/way/bestanden/clc/1880664.pdf

Question 18

ANSWER:
Developing countries have 90% of the world's farmers, and cultivate >75% of the under-utilized farm land (FAO). The biofuel development could be a major economic opportunity for them, if global strategies are tuned to tapping these resources and assets. Problems of food security in developing countries have multiple roots such as poverty, lack of distribution network or political instability, which have to be addressed along with food availability or food price. A number of developing countries have seen their agriculture systems destroyed by a combination of poor management of their resources, lack of access to funds, and by low cost imports. The reconstruction of their agricultural systems in a sustainable way (taking into account local agronomic specificities and environmental and geographical constraints) is essential for global food security. In such agronomic systems, lignocellulosic crops could be used for instance for soil restoration or water management, as well as a source of energy for local use or revenues if exported.

Question 19

ANSWER:
Right of farmers and workers should be the same as for other uses of biomass whether for food/feed production, leisure, industrial uses and energy. International agreements exist regarding the rights of framers and workers and all parties should endeavour to respect them. The European Renewable Energy Directives has included those in its sustainability criteria for biofuels. Projects developed together with and in the respect of local communities will favour the implementation of farmers and workers rights. Many non-food/feed productions already exists (flowers, cotton etc) and can serve as examples for how can such projects be set-up in the respects on those rights.

Question 20

ANSWER:
In the coming decades, most of the population growth and demand for food and bioenergy will come from developing countries, which exacerbate the problems faced by agriculture developments. Additionally these are the countries where protection of those rights and enforcement thereof are limited. This only

makes the challenge greater. But the development of new outputs for biomass also offer the opportunities to do things right.

Question 21

ANSWER:
EuropaBio supports the EU legislation which encourages the use of biofuels and advocates a step-by-step approach from the current first generation to more advanced biofuels. Specifically, the industry: - calls upon the Member States to implement, as soon as possible, the binding targets for blending biofuels with petrol and diesel; - supports the change in fuel standards to permit a higher biofuel content in blends of petrol and diesel; and - advocates performance based regulation that encourages efficient delivery of biofuels which are most effective in reducing green house gas emissions. Public investment should be targeted towards research for instance on biofuels or other alternatives delivering greater GHG emission savings, and on the development of eco-efficient agricultural systems (incl. crop improvement, agricultural systems and land management practices). There is a clear need in Europe to accelerate the development of future generation biofuels based on lignocellulosic biomass and wastes by investing in public private partnership for large scale demonstrators.

Question 22

ANSWER:
In Europe biofuels have to comply with sustainability criteria, which are extremely important to demonstrate the sustainability of this industry and orientate future developments towards increasingly sustainable solutions. However these criteria do not apply to biomass use in bioenergy production, nor to industrial use of biomass or food. (e.g. 95% of palm oil is used today for detergent, personal care and food industries and 5% only for biofuels) In order to address global issues such as land use change and more generally sustainable agriculture, such criteria will have to be extended to all use of biomass.

Question 23

ANSWER:
a.Promote and incentivise: Setting specific targets/ carve-outs for advanced biofuels in the implementation of the renewable energy directive by Members States. These carve-outs can be paced to enable a progressive industrial and agricultural development. b. Regulate: the current EU sustainability criteria for biofuels is appropriate to regulate undesired impact. In addition, when addressing issues such land use change, farmers right, deforestation, etc, it must be recognised that those are not specific to biofuels production and concern all use of biomass including food and feed. Regulating these issues solely in biofuels legislation will fail to address the root cause of the problem and therefore provide real solutions to address them.

Question 24

ANSWER:
Only a small fraction of agriculture in general and non-food biomass is being used for liquid biofuels. Any policies that are being developed need to take into account the complexity of agriculture applications. Trying to address environmental impact (such as deforestation) or farmers' right by regulating less than 2% of agriculture output cannot deliver the expected results. This answer to the consultation reflects the consensus position of EuropaBio members without precluding their potential individual answers to this consultation.