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ARTICLES

Bioenergy and Land Use: Framing the Ethical Debate

C. Gamborg · K. Millar · O. Shortall · P. Sandøe

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Abstract Increasingly, ethical concerns are being raised regarding bioenergy production. However, the ethical issues often do not stand out very clearly. The aim of the present paper is to improve on this situation by analyzing the bioenergy discussion from the perspective of land use. From this perspective, bioenergy production may give rise to ethical problems because it competes with other forms of land use. This may generate ethical problems mainly for two reasons. First, bioenergy production may compete, directly or indirectly, with food production; and as consequence the food security of poor people may be adversely affected (social aspects arguments). Secondly, the production of bioenergy may directly or indirectly lead to deforestation and other changes of land use that have a negative effect on greenhouse gas emissions (environmental arguments). So from this perspective the main challenge raised by bioenergy production is to secure responsible land use. The purpose of the paper is not to advocate, or promote, a specific ethical position on bioenergy, but to structure the main arguments found. The paper falls in two parts. One part addresses social aspects arguments for using agricultural land for bioenergy—where food insecurity, malnourishment, and significant food poverty are the main concerns. The second part scopes environmental implications—notably greenhouse gas emissions impact, as affected by deforestation and other (indirect) land-use changes. Alongside showing some of the current dilemmas presented by wider land-use changes, arguments are analyzed from two ethical angels: a consequentialist and a deontological.

C. Gamborg (✉) · P. Sandøe
Danish Centre for Bioethics and Risk Assessment, University of Copenhagen, Rolighedsvej 25, 1958 Frederiksberg C, Denmark
e-mail: chg@life.ku.dk

K. Millar · O. Shortall
Centre for Applied Bioethics, University of Nottingham, Sutton Bonington Campus Loughborough, Nottingham, UK

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Introduction

On the 13 April 2011 BBC News ran a story with the headline "Biofuels targets are "unethical," says Nuffield report." This report raises two key questions: In what sense are the targets "unethical"? Why would biofuels, in particular, be criticized as unethical?[1] To address these questions we need to examine the way in which bioenergy is conceptualized and ask how the wider social and scientific debate is currently framed.

It is valuable to firstly start by examining the emergence of this energy source and the associated technologies. Early technical and political discussion of biofuels—and more broadly bioenergy—focused on solutions to some of the key energy challenges facing many developed countries, i.e., on ways to improve the security of energy supply in an environmentally sound way. Thus, bioenergy was considered as a promising option alongside other renewable energy sources, such as solar, and wind energy and hydropower.[2] The arguments presented for biofuels highlighted the benefits of reducing dependence on fossil fuels and the countries producing them; and therefore in this context the development and use of bioenergy, as originally presented, appeared to have been viewed as an ethical necessity, an inherently good practice. This can be seen in key policy documents of the time, such as the 2009 EU Directive on Renewable Energy (hereafter the "RED Directive"),[3] with its target of 10% of transport fuels to be delivered by biofuels by 2020.

More recently, however, biofuel production has itself become one of the major issues in an increasingly fierce debate over climate change and global food security. The debate is somewhat akin to previous discussions of the industrialization of agriculture (Thompson 2008) and the GMO debate of the late 1990s (Mol 2007), both of which involved innovations held by some to be the solution to many food-related problems and by others as sources of new, intractable ones. Similarly, biofuels are now being criticized on the grounds that they promote food shortages, utilize much needed agricultural subsidies, offer little or no greenhouse gas (GHG) mitigation, and drive deforestation in developing countries (Wenzel 2007).

One approach that may be used to examine the ethical issues raised by bioenergy is to start by focusing on land use as a pivotal issue. Clearly, a key feature of current ways of producing bioenergy is the reliance on land. Until the late 20th Century, in an increasingly globalized world with more trade, land was considered to be less

[1] www.bbc.co.uk/news/uk-13056862.

[2] There is a whole discussion to be had on deciding on which type of renewable is the most feasible and desirable, taking into account conversion efficiency, availability, potential, cost, and many other factors, see. e.g., the International Energy Agency (IDEA) http://www.iea.org/subjectqueries/index.asp.

[3] DIRECTIVE 2009/28/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0016:0062:en:PDF.

and less of a limiting factor on production; it was considered a virtually limitless resource. However, in recent years it has become apparent that it is a much scarce resource, and it is now clear that its use in energy production may well compete with food production, and indeed with so-called "ecosystem services". Hence, the cultivation of biofuel crops may displace food crops. This could make access to food problematic for some and distort food markets for others, which is most likely to affect poor urban and rural communities. This aspect is still much debated and more work needs to be done (and is being done) to determine how influential different factors are on food prices. Turning to the environment, it was originally asserted that, as biofuels displace fossil fuels, the carbon emitted when biofuels are used would be counterbalanced by the original biomass production. However, in recent years, a number of studies have shown that a more comprehensive and detailed environmental assessment is needed: early expectations relied on simplistic calculations for GHG emissions in which indirect land-use effects of biofuel production were mainly overlooked.

In order to conduct an assessment of land use and bioenergy, it can be useful to apply a simple yet workable distinction between social and environmental effects, with each presenting unique challenges. A further set of issues revolves around the nature of the ethical framework being applied to determine what may be acceptable ways of producing these fuels. A key question here, for bioenergy, is whether the ethical framework to be deployed should be consequentialist or should have significant deontological elements; as examined below.

This paper firstly sets out the current policy context on bioenergy within the EU. Then it critically analyses the ethical framing of the debate. The analysis is divided into two sections, one scoping the social issues raised by bioenergy and the other focusing on environmental implications. In the analysis consequentialist and deontological lines of thought are identified and discussed, with these corresponding to utilitarian and Kantian approaches to the ethics of land use. An analysis of bioenergy and land use policy adopting Kantian ethics would require consideration of both the *intention* behind the policy and the *principles* that underlie this intention (O'Neill 2000). This can be difficult to determine even when one is dealing with the conduct of a single individual; it becomes even more challenging when policies developed in a complex policy-making process are subjected to scrutiny.[4]

Within each of the two main sections of the paper, a brief overview of the debate, as it has evolved, is presented. There follows an analysis of some of the prominent arguments, in the course of which a range of controversial empirical assumptions are highlighted. The purpose of this paper is not to advocate, or promote, a specific ethical position on bioenergy. The aim is to map out the key issues raised by bioenergy and land use and connect these with a prominent distinction in moral philosophy, between consequentialist and deontological ethical positions. It is

[4] Intention may be a simplistic concept when it comes to the investigation of the origins of a policy. Palmer (2010) states that there was an "intricate interplay of variables" involved in the development of the UK's flagship biofuels policy, the Renewable Transport Fuels Obligation, involving "not just scientific evidence and discursive argument but also political interests and institutional factors." The concept is arguably useful, however, for our purposes, as it allows us to subject the rationale for policies to ethical analysis.

intended that this will offer a better understanding of the debate and a more refined appreciation of future policy needs.

Bioenergy and Land-Use Policy

Within the EU bioenergy has been promoted as an essential component of sustainable energy-use. The Union's "Europe 2020" strategy requires 20% of total energy consumption to be based on renewables by the year 2020, a requirement set out in the RED Directive. To reach this goal, binding national targets have been imposed on Member States.[5] Renewables include solid biomass, wind, solar energy, and hydropower, as well as biofuels. Specifically, the RED Directive emphasizes that only biofuels meeting the sustainability requirements of the EU—as evidenced in Sustainable Biofuel Certificates, which confirm the protection of untouched nature and sufficient GHG savings—can contribute to this EU policy target.[6]

Several definitions of the terms "biofuel" and "bioenergy" are currently used. In this paper *bioenergy* refers broadly to renewable energy from biological sources (biomass from wood and agriculture sources) which can be used for heat, electricity, and transportation fuel, and associated co-products (see FAO 2008a, b). And although there is noticeable inconsistency in the use of the terminology, *biofuel* refers here to liquid fuels produced from the biological sources just mentioned. The commercially established and most abundant sources of biofuel today are crops such as soy, palm oil, sugar cane, or corn. These are often referred to as "first-generation" biofuels. "Second-generation" biofuels are produced from lignocellulosic biomass derived from non-food or food crop co-products (such as straw); however, further technological and commercial development is still required in order to make these viable (Connor and Hernandez 2009).

Bioenergy is unique in being the only form of renewable energy that can at the same time be used for heating, electricity, and transport. Looking at transport, it is estimated by the International Energy Agency (IEA 2008) that biofuels should be able to reduce current fossil-fuel related carbon dioxide emissions from cars by 30–50%. Further reductions can be expected when biofuels are used in sea and air transport. In Europe, the area cultivated with non-food rapeseed has grown rapidly over the last decade with increased use of biodiesel. Bioethanol accounts for approximately 20% of all biofuels within the EU, although it should be noted that part of this production is also based on biomass imported from countries such as Brazil.

The main drivers of biofuel production—as reflected in EU biofuel policy aims—are energy security, a commitment to economic development, and the mitigation of climate change. More specifically, the RED Directive and the Fuel Quality Directive (hereafter the "FQD Directive"), which were introduced in 2003 and revised in 2009, set out the following policy objectives: security of supply through reduced

[5] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32009L0028:EN:NOT.

[6] http://ec.europa.eu/energy/renewables/biofuels/sustainability_criteria_en.htm.

dependency on crude oil and transport fuels; security of agricultural productivity and quality of life in rural areas; and a reduction in GHG emissions through the use of sustainably produced biofuels.

However, it has recently been pointed out that, while global biofuel production offers opportunities, it also presents something of a food, energy, and the environment trilemma (Tilman et al. 2009). Certainly, an increasing number of studies are pointing to the potentially negative effects of land conversion for biofuels. The role of biofuel production in slowing global warming has also been questioned, with doubts being expressed about the ability of biofuels to deliver lower GHG emissions (e.g., Searchinger et al. 2008; Fargione et al. 2008). It has been claimed that, to the extent that the production of crop-based biofuels involves deforestation or other types of land degradation, any carbon saving benefits will be compromised. Hence, the issue of land use for biofuels—and more particularly changes the production of those fuels necessitates—is becoming increasingly controversial.

Bioenergy-related land-use change (LUC) can transform the forests and other types of natural vegetation, and indeed organic soil matter, all of which are, in effect, carbon stocks. Such change can take the form of deforestation and conversion to arable land, or the replacement of grassland by arable land. Change brought about by the annexation of land for crops (in this case, biofuel crops) in these ways is *direct* LUC. When it occurs the existing stocks of carbon, embodied in forest or grassland, are released, which then in turn alters the GHG emission accounting value. When land that could otherwise be used for food or fodder crops is used to grow biofuel crops, and the existing agricultural production shifts to new land, creating a knock-on conversion of forest, grasslands, or other forms of natural vegetation, *indirect* LUC takes place—the change being indirect in the sense that it does not necessarily occur where the biofuel feedstock is produced, though of course biofuel production is still the driver of the LUC. This can be mediated through a pricing mechanism, with demand for biofuels impacting on food prices, which in turn can create additional pressure to convert land. For example, if farmers in the US switch production from soy to maize crops, soy imports may increase, and this may in turn lead to “virgin” land being used to produce soy in Brazil. Hence, indirect LUC and the displacement of food crops may result in higher food prices in both regions. Of course, those rising prices might well impair food access, increase food poverty, visit insecurity on rural and urban communities, and distort markets, as well as affecting GHG emissions and biodiversity (Bouët et al. 2010; Cushion et al. 2010).

From a policy perspective it is important to determine the wide range of risks associated with the EU biofuel policy, by which we mean the potentially adverse results of direct and indirect LUC: increased competition for land, raised food and feed supply and prices, and environmental costs (Croezen et al. 2010). However, it is no easy task to determine these risks, and the boundaries of any assessment. Both the data to be included and the framing of the assessment have been disputed (Palmer 2010), and no official resolution of this matter (e.g., in terms of how EU envisages the calculation in its member states) has emerged to date (European Commission 2010).[7] A key area of dispute is whether, and to what extent, indirect LUC should be included in biofuel assessment. Moreover, there is disagreement over the way in which the impact of EU biofuel policy depends on the mix of biofuels (how much is based on conventional food and feed crops and how much is based on so-called residues, or non-edible crops). Nor have so-called "flanking policies"—i.e., trade policies, such as agreements between EU and non-EU states on subsidies for fallow land or stimulation of growing feedstocks on marginal or degraded land—been settled (European Commission 2010).

The connection between direct LUC and biofuel production is often readily traceable. However, indirect changes are much harder to associate with a specific practice, particularly as many other factors can come into play. Even where there is general acknowledgement that a case of LUC is indirectly associated with biofuels, considerable scientific controversy over how to calculate the associated GHG emissions remains—and that is so even if we put the complexity associated with the wider impact assessment to one side (Croezen et al. 2010). The implications of LUC for carbon neutrality have not been fully considered by the EU; this much is clear from a recent report which discusses possible policy changes (European Commission 2010).

At a time when the land-use issue is being disputed and policy development is being discussed, the framing of the debate—in particular, its social aspects (e.g., concerns about food prices and food scarcity) and environmental aspects (concerns about GHG emissions and biodiversity)—will undoubtedly play a notable role in shaping the EU stance on biofuel. It is therefore important to look at the framing, in its social and environmental aspects, in more detail.

Bioenergy Ethical Debate

Increasingly, biofuels are being subjected to forms of ethical analysis that focus directly or indirectly on the land-use issue. A number of commentators have highlighted important issues here. For example, Thompson (2008) places biofuels in a broader agricultural ethics perspective; Mudge (2008) asks how we are to assess whether biofuels are environmentally or ethically sound; Gamborg et al. (2009) consider the acceptability of the use of food crops for energy; Gomiero et al. (2009) discuss biofuels in relation to the appropriation of ecosystem services; Landeweerd et al. (2009) reflect on the distribution of responsibilities; Mol (2010) focuses on the role of environmental authorities; Sodano (2009) examines the human rights and gender aspects of biofuels; and the Nuffield Council on Bioethics (2011) examine whether there is a duty to produce biofuels if this can be done in an environmentally and socially benign way through sustainability benchmarking.

Building on this literature, this paper will present an analysis of the ethical issues that focuses on land use and draws a distinction between the social and

[7] This point is also evident in the consultation undertaken by the Nuffield Council on Bioethics (2011:92). In this consultation questions about land use changes, and how or whether to include them in any assessment, elicited very polarized replies.

environmental aspects of land use. It should be noted that the term “aspect” instead of “impact” is used here, as the latter may imply an exclusively consequentialist approach to the issues, whereas in fact, non-consequentialist arguments will be examined as well. The social aspects of the discussion are essentially “people and community” issues: here we examine questions about livelihood and access to food, about who benefits, who may bear the cost in relation to choice of technology, and so forth. The principal environmental aspects to be considered are: reduction of GHG emissions, biodiversity degradation, and loss of natural habitat.

Social Aspects

The arguments to be considered in this section focus on the way biofuel production may compete with, or displace, food crops, and lead to food scarcity. These arguments tend to concentrate on the commercial establishment of first-generation biofuels— i.e., fuels derived from basic feedstock (such as seed or grain) that could in theory enter the animal or human food chain. It has been alleged that biofuel production of this sort is unwise, and some have claimed outright that it is morally unacceptable: “10 years from now the rapid expansion of biofuel production may look foolish, or worse—unethical, if it leads to environmental degradation, high food prices, and increases the number of undernourished people” (Cassman and Liska 2007: 22).

An argument of this kind can be found in the 2007 address made by Jean Zeigler, the UN Special Rapporteur on the Right to Food (2000-2008): “It is a crime against humanity to divert arable land to the production of crops which are then burned for fuel.”[8] In a similar vein, referring to liquid biofuels, it has been argued that if “you start to fuel cars with crops… you are instantly putting the world’s one billion starving people in competition with the world’s one billion motorists.”[9]

Runge and Senauer (2007) conducted a food and fuel balance calculation; they state that “filling the 25-gallon tank of an SUV with pure ethanol requires over 450 pounds of corn—which contains enough calories to feed one person for a year.” Statements and calculations such as these (cf. Rice 2010) have sparked fierce debate, and the points made by Zeigler and others have been countered. Matthews (2008: 99), for example, points to the need for economic development in many countries, arguing that “the real crime against humanity is to block Africa’s potential, by blocking its exports and stunting its growth.” In essence it is claimed that developing countries should be given the economic opportunity to “grow not only food but also cash crops, and that the cash crop in greatest demand right now is biofuels” (Matthews 2008: 99). However, according to the FAO (2008), it is exactly this driver that has contributed to higher food prices, posing an immediate threat to food security via a dramatic impact on the prices poorer food consumers have to pay in urban and rural areas. This issue is complex, as exemplified by the studies from the World Bank (Cushion et al. 2010) and The International Food Policy Research

[8] http://news.bbc.co.uk/2/hi/americas/7065061.stm) accessed 20 March 2010.

[9] Quoting Ed Matthew, Friends of the Earth. http://news.bbc.co.uk/2/hi/business/7026105.stm) accessed 20 March 2010.

Institute IFPRI (Bouët et al. 2010). Thus there is notable disagreement about the exact reasons for steep increases in worldwide food prices, *such* as that seen in the food price spike between autumn 2007 and summer 2008, where a number of commentators identified the use of corn for bioethanol (Bach 2009) as a causal, and perhaps significant, contributory factor.

So in terms of food security, biofuels have been framed both as contributing directly to worldwide hunger and as a mechanism to alleviate poverty through rural economic empowerment, thereby reducing hunger.

From a consequentialist perspective, the questions we need to ask about the relationship between food and fuel production, and whether this is developing in distinctively new ways, are these: How much land is available? If land is not used to grow fuels, will it be used to grow food? The main critical argument seems to rely on assumptions that are all highly controversial: that the most important limiting factor in efforts to address global malnutrition—which according to the World Health Organization is the biggest contributor to child deaths, representing one third of all child deaths (UNICEF et al. 2010)—is the availability of agricultural land; that abstaining from growing bioenergy crops will ensure land is available for increased food production; and that this in turn will lead to the alleviation of food poverty (Pimentel et al. 2009).

The conversion of land to biofuel production within Europe and North America may, as an indirect LUC, provide markets within which farmers outside Europe can produce staple crops at better prices on the global market. It has been argued that in the short term rising food prices threaten the food security of many people in developing countries. However, over the medium to long-term, if farmers are given the resources to respond, a reversal of the long-term trend of depressed agricultural prices could allow them to increase production and revitalize many countries' agriculture sectors (FAO 2008b). Similarly, the cultivation of biofuels as cash crops in these countries may lead to increased investment in infrastructure that is needed to support thriving or emergent agricultural markets (FAO 2008b). This observation stems from the paradox that land for crop production is both considered a scarce global resource and often under-utilized. For example, land is left fallow within the EU because of CAP set-aside policies; outside the EU it is left fallow because it is not economically viable. In a number of developing countries the quality of the land or a lack of agricultural investment are significant limiting factors. However, with greater resources and more investment in infrastructure, soil quality could be improved, after which yields would increase. The criticism of biofuels illustrated by the remarks of Zeigler (*op cit*) also seems to under-estimate the complexity of food poverty. It is also, in effect, a criticism of most cash crops, not just first-generation biofuels. A more comprehensive characterization of LUC is therefore needed if this kind of criticism is to be substantiated.

Moreover, when it comes to second-generation biofuels that are not yet commercially established the consequences for global food security are by no means clear-cut. These biofuels may not present a simple and transparent solution to the complex issues raised by first-generation biofuels. It was once claimed that there would be no competition between second-generation fuels and food crops (Antizar-Ladislao and Turrion-Gomez 2008). Again, Doornsbosch and Steenblik (2007: 4) have argued that "second-generation technologies could, in theory, make it possible to avoid competing land-use claims by growing biomass feedstocks on marginal and degraded land and using residual biomass materials." However the social implications of using marginal land (e.g., associated with willow production) or agricultural co-products (e.g., straw) to produce second-generation biofuels have been questioned. Franco et al. (2010) observe that individuals and communities often depend on land categorized (but not by them) as "marginal." Such land might be relied upon in various ways: it can be used in subsistence agriculture or as a source of community fuel (e.g., firewood). Some have also questioned, in principle, the economic viability of an agricultural commodity that is produced on marginal land when it is competing against a similar commodity produced on prime land (Levidow and Paul 2008).

Much food produced on marginal land within the EU cannot compete with food produced on prime land outside the EU, unless subsidized. The suspicion that the same competitive advantage will apply to biofuels seems reasonable. It has been shown that Jatropha planted on marginal land produces uneconomic, marginal yield (Nuffield Council on Bioethics 2011). This raises important questions about the production of second-generation biofuels on marginal land in Europe. One is whether this production system will be unable to compete with cheaper biofuels produced on prime land outside the EU. Another is: If marginal land is to be used economically to produce biofuels, will this only be feasible, and acceptable, if a policy stipulating that *only* marginal land can be used is in place? Such a policy would seem unworkable in the current global commodity market. In addition, how would policy-makers formally define "marginal" land? Would the adoption of a strict definition affect other important uses of the supposedly "marginal" sites?

It has also been claimed that second-generation biofuels could provide more energy output per unit of land than their first-generation predecessors, so that the former involve a more efficient use of land (whether marginal or prime). This implies that significant social advantages will arise from these biofuels in terms of the energy security benefits; however, this needs further investigation. The FAO (2008: 34) states that if second-generation fuel production were to use 25% of agricultural land it would be able to replace 14% of transport fuels. Discussions of second-generation biofuels often assume implicitly that such fuels will be able to overcome the problems faced by first-generation biofuels if they are more energy-efficient and "sustainable." However, the utilization of 25% of currently available agricultural land appears to be a very high price to pay for 14% of our current transport fuel needs. Given that biofuel production will undoubtedly incur costs connected with competition for resources and environmental damage, irrespective of the technology used, a key question might be: What are the comparative benefits of biofuel production in terms of economic development and energy security? The consequences of second-generation biofuels, both positive and negative, need to be evaluated not only in comparison with first-generation equivalents, but in relation to other land uses across the board.

From a deontological perspective, the first claim—that biofuels compete with food crops—could require an assessment of whether biofuels in fact constitute the most appropriate or right use of land. This requires us to explore further questions: What is land for? What principles should we apply when seeking to determine the levels of food energy produced on land and transport energy and electricity? Estimations of efficiency of this kind are likely to depend on the outcome of a full Life Cycle Assessment, and this assessment should be complemented by some form of social impact assessment. Holistic assessment of this sort may reveal that other forms of bioenergy are more efficient than biofuels, whether first-generation or second-generation. For example, the cultivation of crops such as Miscanthus or willow in short rotation coppice for non-liquid fuel production may turn out to be a good use of the land. Such cultivation can be efficient—at least, as long as the crops are used effectively in stationary facilities such as combined heat and power plants (sometimes referred to as "CHPs") rather than used to produce biofuels (see Yuan et al. 2008). Miscanthus and willow, which are regarded as high-yielding, yet low-input, perennial crops with low, or zero, fertilizer requirements may deliver a number of additional environmental benefits (Campbell et al. 2009; Rawlings 2007). Given this alternative approach, it could be argued that it is ethically problematic to use land to produce biofuels for transport if we have a global scarcity of viable land, particularly if the fundamental targeted purpose of biofuel production is to increase energy supply.

One cannot properly address the question whether biofuels lead to food scarcity or displacement without considering possible inefficiencies and inequalities of current food production systems. Livestock production is widely felt to be a very inefficient way to produce food because it uses grains as animal feed that can be directly consumed by humans (Steinfield et al. 2006). Hence depending on how we value land across several land use options—i.e., for meat production, staple food production, or energy production—it might well be suggested lower levels of animal production are a better option than reducing, or altogether avoiding, the cultivation of crops for first-generation biofuel production. In other words, it is important to place the bioenergy debate in a wider agricultural context. Our reasons for valuing food energy (and other forms of energy) need to be made explicit if we are to structure land use priorities around specific values. Indeed it is helpful to differentiate two kinds of arguments: those supporting the use of land for bioenergy with the primary *intention* of providing benefits to communities in developing countries, on the one hand, and those supporting policies that do not have this explicit intention, but that point to this as an additional beneficial consequence, on the other.

The main aim of developing bioenergy could be to provide a greater volume of safe, reliable energy to communities in developing countries (UNEP 2009). European biofuels policy could have the beneficial, secondary consequence of strengthening agricultural sectors in developing countries, as claimed above. Although raised prices might stimulate supply, significant challenges to equitable market access may remain for farmers in developing regions wanting to produce food and/or biofuel crops. Again, bioenergy production needs to be assessed in terms of market opportunities, specifically to determine whether the farmers involved will obtain fair returns, or whether, instead, they will face unique challenges when attempting to access an equitable market.

A study by German et al. (2011) focusing on biofuel production in six developing countries found that the potential environmental and rural-development benefits have largely not materialized. This study can be used to support the idea that the beneficial outcomes of bioenergy production depend not just on the form of land use, but also on the policies that affect trade and equitable market access. Hence the market values implicit within the prevailing economic "arrangements" must be addressed in tandem with those applied through bioenergy policy. If the stimulation of agricultural markets is not the intended consequence of bioenergy policy, and if it is claimed merely that this *may* come about despite certain obstacles, the skepticism of some commentators about the likelihood of an equitable market emerging is understandable. It could therefore be argued, in deontological terms, that bioenergy policy should not be justified on the basis of this possible, secondary positive consequence.

These observations serve to highlight the fact that there is a genuine ethical debate to be had about the relationship between the production of bioenergy and global food security. In taking a position on this issue, one needs to be aware of a number of its controversial empirical aspects: principally, the consequences for food security in the short-term and the long-term, and the land-use effects of different forms of bioenergy. In addition there are various ways of characterizing the ethical concerns involved—regarding both the balancing of effects on different communities over time and the nature of the intentions connected with different bioenergy policies.

Environmental Aspects

We turn now to environmental aspects of biofuels and land use. It is often assumed that when biofuels are based on co-products (sometimes referred to as "waste products"), or are produced through the cultivation of marginal land, no, or very few, detrimental land-use practices are involved and negative environmental impacts are reduced. Thus it is often argued that these forms of bioenergy—whose prospects have been contemplated for more than 30 years (Pimentel et al. 1981)—would require minimal resources in terms of water and land, reduce GHG emissions, and avoid degradation of habitats and biodiversity (Nuffield Council on Bioethics 2011). Lignocellulosic biofuels, i.e.,. second-generation biofuels that use indigestible co-products from food or fodder crops or other biomass sources such as Miscanthus, have been promoted as environment-friendly, and hence ethically attractive, bioenergy solutions.

This assumption, or set of assumptions, has been challenged, however. Some observers allege that the production of biomass for second-generation biofuels in fact presents a number of threats to environmental conservation and biodiversity, and therefore is not sustainable. Specifically, it is claimed that the use of biomass from crop and forest residues could disrupt local carbon cycles and the fertility of agricultural soil; and that applications of artificial fertilizer to compensate for the disruption may well result in eutrophication and the loss, in effect, of any potential savings in GHG emissions (Doornsbosch and Steenblik 2008).

Assessments of the benefits of second-generation biofuels must take into account the impacts of indirect LUC. Yet, as stated above, this aspect of assessment is controversial (Searchinger et al. 2008). It would be possible in principle, presumably, to manage the sequelae of indirect LUC by ensuring that imported biomass is not sourced from converted areas that were previously forest, or naturally carbon-rich in some other way, or such as to support high levels of biodiversity. If feedstocks could be sourced from abandoned or underutilized arable land (Croezen et al. 2010), and if yields could be increased in way which does not require high levels of fertilizer input (with associated emissions), the EU's current sustainability criteria could be met.

Thus although second-generation biofuel production is claimed to deliver greater savings in GHG emissions than first-generation biofuel production (Delshad et al. 2010), these savings could be absorbed, or lost, in an indirect LUC, if production of the necessary biomass simply results in the displacement of cropland on to land that presently acts as a carbon sink, such as forest and pasture (Melillo et al. 2009).

It is no easy matter evaluating the empirical evidence used to determine the sustainability credentials of second-generation biofuels, and establishing both the direct and indirect environmental impacts over a longer time horizon is particularly difficult. The currently dominant Life Cycle Assessment approach to the development of policy instruments like environmental certification and labeling may adequately address only the vertical dimension of environmental impact: that is, the direct effects of production of a particular product (UNEP 2009). It has been claimed that current approaches are less able to cope with the horizontal dimension: indirect and cumulative environmental impacts such as eutrophication and GHG emissions from indirect land-use change (UNEP 2009).

From the consequentialist perspective, the two questions introduced earlier become pertinent once again in connection with environmental aspects: What is "marginal" (or, as it is sometimes stated, "abandoned" land)? What are "by-products" or "waste" material?

On the first of these questions, even from an agrarian perspective, of course there is always *an* alternative use for a piece of land. Moreover, if the land in question is converted to production, the net carbon sequestering through natural re-growth and the wider impacts on biodiversity will need to be calculated. And, as has been pointed out by Bindraban et al. (2009), the exploitation of this land will often require high inputs of nutrients and water, which in turn has a production cost and impacts upon GHG savings.

On the second question, though second-generation biofuels use co-products that are sometimes accurately characterized as surplus to current agricultural need, rather than referred to as waste, indirect LUC may be problematic if, for example, it is not included in emissions accounting. According to Howarth and Bringezu (2008: 68) "indirect land use will be responsible for substantially more carbon loss (up to twice as much) than direct land use; however, because of predicted increases in fertilizer use, nitrous oxide emissions will be more important than carbon losses themselves in terms of warming potential." If this view is substantiated by empirical evidence, it will be hard to resist the conclusion that second-generation biofuels could lead to higher GHG emissions than their fossil fuel counterparts and as such result in substantially greater carbon loss (up to twice as much) than direct land use.

In addition, the availability of some "co-products," like straw and other co-products of crop production, may not be as unlimited as originally hoped. Use of residual co-produced material such as straw as a feedstock on a large scale may, in practice, be unfeasible. Assumed to be an "available resource," such co-products may turn out to be very limited feedstocks: it is important to acknowledge that straw is still part of the crop, and that therefore there is a natural limit to how much is available. The quantity of a co-product like straw available depends on factors such as crop rotation, field management practice, and climate (Pahkala and Kontturi 2009). More importantly, straw is useful as a farm resource in number of ways—for example, it is used as bedding for livestock, and it can be used (when dug back) to improve soil fertility, control erosion, and maintain soil carbon (Gomiero et al. 2009). In short, the casual description of some co-products as "waste material" conceals various "uses," greater exploration of value is needed.

It can be seen, then, that the specific "details" of production, and the differences between different kinds of production, affect assessments of bioenergy and land use. In turn, if we apply a consequentialist approach, this affects the assessment of acceptability. For example, diverting land currently used to produce the animal feed used in highly (energy) inefficient meat production systems to first-generation biofuel production may be a more acceptable and sustainable practice (under the assumption of a drop in the consumption of the relevant kinds of meat).

From a deontological perspective, a key task in the discussion of the potential environmental benefits of producing biofuels from co-products, is that of reframing the (predominantly consequentialist) argument. Questions to be addressed here include: Are the co-products used to mitigate climate change or for other reasons? Is land being treated merely as a means or as an end itself?

Clearly, one of the most important goals of biofuel and bioenergy policy is to mitigate climate change: the *intention* behind the policies is to limit global warming. One of the reasons that biofuels have faced such harsh criticism from environmental NGOs is the view that there is a gross mismatch between intention and reality in this respect. At first glance, it may seem inappropriate to examine the environmental dimension of land use in Kantian terms, since at the micro-level the relevant decisions are made, not so much with the intention of bringing about, or avoiding, particular environmental outcomes, but rather with market conditions and resource constraints in mind: that is, people do not intend to release carbon dioxide into the atmosphere, or to destroy ecosystems, when they cut down a forest to grow palm oil for biodiesel, but they do so because it is profitable and/or is deemed to support development. Indirect LUC is also very problematic because it is by definition an unintended consequence of biofuel production. As in the case of the social dimensions of biofuels production, this raises questions about the prioritization of the intention to mitigate climate change by using biofuels and shows that a realistic appraisal of the work needed to align intention and reality is required.

It is possible to examine the market conditions and resource constraints under which biofuels are produced and traded within a Kantian framework. One might conclude that, in the biofuels commodity market, land is viewed as private property, and that this is tantamount to treating land merely as a means and not as an end in itself (O'Neill 2000).

Some take a rather different view of land and land use. Jasanoff (2010) states that greater awareness of current environmental problems is leading to deeper reflection on questions about who and what has standing in our ethical reasoning. She points out that India and Ecuador have included "rights of the environment" within their constitutions. Similarly, it was recently reported that Bolivia has granted nature equal rights to those of humans in a Law of Mother Earth.[10] Does this constitute treating land as an end, not a means? Certainly, it raises questions about the interpretation of nature's "ends": nature is not one homogeneous entity and it cannot be said to have plans or guiding principles.

The argument under consideration here also raises questions about the way we deal with situations where people's rights conflict with notions of the ethical standing of nature. Debate in environmental ethics has often returned to the contentious issue of whether the environment should be valued for its own sake or instrumentally, because of the pleasure or benefits it provides for us (Jamieson 2008). In the case of carbon sequestration, this could be seen as something of a false dichotomy, as the existence of trees benefits us. It shows that our relationship with the land is not always a one-way relationship of exploitation: humans actively use passive land as a resource, and depend on its activities. If the rights of nature are interpreted as the right to exist without interference from humans, one might be tempted to discern here a moral and legal imperative to bring to a halt the deforestation caused by biofuels, though this in turn may cause many problems of interpretation and conflict-management.

Other win–win outcomes for people and the environment have been predicted for biofuels: as well as being useful to us, they are "natural" products that sequester carbon as they grow. However, industrial agricultural methods and land grabbing have created disillusionment with this claim, as discussed above. This suggests that when we treat natural resources like land as means to our own ends, as we are obliged to do in producing biofuels, we must investigate the conditions in which these means are used. How should we change our model of resource use when we switch from fossil fuels (regarded by many as essentially a "free" gift from nature) to biofuels (a costly technology to produce involving many difficult resource trade-offs)? Would this involve changing the end use of the resource or the nature of the markets through which it is sold?

Moreover, when we address the question of how to value trade-offs between the non-environmental benefits of bioenergy production (income and energy) and environmental benefits from the same piece of land, we need according to the line of moral thinking in play here to consider the relative prioritization of the intentions behind bioenergy policy when they conflict, as many maintain they do. We must ask: What does a given policy implicitly assume to be the most important use of land?

[10] *Guardian*, 10 April 2011 (http://www.guardian.co.uk/environment/2011/apr/10/bolivia-enshrines-natural-worlds-rights).

Conclusions

The biofuel debate has moved beyond discussion of energy security, less reliance on fossil fuels and the production of more environmentally responsible energy sources. It is now a much broader debate, and within that debate the central questions are about what is deemed to be responsible land use.

An important observation is that talk about *a* debate is misleading, because the assessment of bioenergy compresses many debates—debates that are highly complex and challenging to unpack in a structured and accessible way. Secondly, it is important to understand that these debates are not only about empirical uncertainties but also involve the clarification and relative weighting of potentially conflicting values. These values are very much up for discussion.

One of the most important issues in the bioenergy debate turns on questions about land-use: What direct and indirect consequences are at stake here? What is the right, or the best, use of land? How should utilization priorities be set? This paper has explored the conceptualization, or framing, of biofuel production in light of these questions in order to throw a more nuanced light on the basis of judgments about the acceptability of bioenergy, and specifically biofuels.

The burden of the paper has been to bring a range of questions to the foreground: What underlying assumptions or perspectives are being applied (who matters, where)? What impacts or effects are being considered? Should things other than impacts matter in judgments of acceptability? How are the risks being framed? What kinds of benefit are being taken into account? How should different concerns be balanced?

Attempts to analyze this complex ethical issue will rely, more or less implicitly, on a conceptualization that involves various assumptions. Some of these assumptions will concern the data to be included in each level of assessment (e.g., social or environmental assessments), and which aspects are to be emphasized or prioritized. Others, perhaps less obviously, will be evidence of a broadly consequentialist or deontological ethical perspective. And of course the various framings will result in actors, including policy-makers, potentially taking different positions on the ethical acceptability of bioenergy and biofuels in terms of the land-use issue. One practical message of the analysis presented in this paper is, we suggest, that deeper ethical engagement in the debate about the future role of bioenergy is needed. Such engagement can only complement and fruitfully extend the current technical and economic approaches.

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