Chapter 9
Sustainability Issues in Biomass Feedstock Production: A Policy Perspective

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Abstract Demand for energy biomass has led nongovernmental organizations, industries with interests contrary to biofuels, and even governments to question whether bioenergy policies truly result in environmental and societal improvements befitting of their "bio," "renewable," and "green" labels. Environmental concerns range from potential emissions of greenhouse gas emissions from indirect land-use change, in some cases making the footprint of biofuels worse than petroleum. Environmental groups also fear that forests' fragile ecosystems could be threatened by overharvesting that leads to water pollution and loss of biodiversity and soil productivity. In addition to environmental harms, social advocates predict that biomass production in developing countries could lead to loss of land tenure/rights, and labor and employment abuses. Laws and private standards have evolved in response to these concerns. Challenges remain, however, in implementing biofuels' sustainability standards, such as enabling farmers to practically and economically use practice and measurement tools, reconciling divergent standards among countries, and solving the seemingly intractable "food versus fuel" dilemma. This chapter examines sustainability requirements for biomass-to-bioenergy that have arisen through the convergence of energy, environmental, agricultural, and forestry policies; examines core "sustainability" definitions in United States, European Union, Brazil, and private policies; and asks how international policy can reconcile meanings of sustainability to foster the nascent bioenergy sector.

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9.1 Introduction

Regeneration of plant and forest materials constitutes "renewability" in the strictest sense of the word. The ultimate definition of what a sustainable agricultural system should look like varies. One of the most commonly cited definitions of sustainability is a system that supplies a growing population with resources without destroying the environment within which they are used and provides resources for the present without compromising the ability of future generations to meet their needs [1].

Demand for energy biomass, however, has led nongovernmental organizations (NGOs), industries with interests contrary to biofuels (e.g., food and feed), and even governments to question whether bioenergy policies truly result in environmental and societal improvements befitting of their "bio," "renewable," and "green" labels [2]. In 2008, a vocal cadre of academics struck a blow to sustainability assumptions about biofuels [3]. They argued that greenhouse gas (GHG) emission reductions may be dramatically overestimated because of market-induced indirect land-use change (ILUC), in some cases making the footprint of biofuels worse than petroleum. NGOs jumped on the bandwagon with distress calls about fragile ecosystems threatened by overharvesting, particularly in forests. Other environmental and social concerns were added to the agenda of biofuels' opponents, including water and air pollution, loss of soil productivity, loss of land tenure/rights, and labor and employment.

In response to these concerns, bioenergy laws and private standards have evolved to make biofuels more "sustainable" from both a GHG and "other" sustainability perspective. Generalized environmental and social policies, too, exist to fill in where gaps in bioenergy laws occur. Challenges remain, however, in implementing biofuels' sustainability standards, such as enabling farmers to practically and economically use practice and measurement tools, reconciling divergent standards among countries, and solving the seemingly intractable "food versus fuel" dilemma. This chapter examines sustainability requirements for biomass-to-bioenergy that have emerged through the convergence of energy, environmental, agricultural, and forestry policies, and focuses on core "sustainability" definitions in United States, European Union, Brazil, and private policies. It concludes by examining harmonization and efforts to address perhaps the most formidable sustainability challenge in policy—biomass' competition with food.

9.2 Sustainable Biomass Laws and Policies

The past 10 years have seen a significant proliferation of bioenergy policies, and as they have evolved, more and more focus has been placed on accounting for the potential environmental and social impacts of biomass-based fuels. Initial concern was whether from a lifecycle perspective biofuels deliver true GHG emission reductions. The United States, California, and the EU all have codified some form of GHG measurement for biofuels. Policies increasingly contemplate biomass' other possible effects on air, water, and soil quality, and biodiversity, as well as fair labor practices and property rights in the wake of potential land grabs in undeveloped countries.

9.2.1 The United States

9.2.1.1 Federal Policies

Historically, US biofuels policy has relied primarily on corn as an ethanol feedstock. Although corn ethanol has served as an engine for rural development, the environmental implications of conventional corn production [4] were largely unaddressed in government energy policy until the enactment of the Energy Independence and Security Act of 2007 (EISA) [5]. In order to satisfy the mandatory blending levels of "renewable fuels" into transportation fuels, now, for the first time, all biofuels qualifying for EISA's Renewable Fuel Standard (RFS) had to achieve a certain level of GHG reductions and be derived from certain renewable sources. In addition, the 2008 Farm Bill established the first supply-side incentive for renewable biomass through creation of Biomass Crop Assistance Program (BCAP) [6]. The program conditions payments on whether the biomass was produced under a conservation plan [7]. At the state level, California is in the process of developing biomass sustainability standards to accompany its broader GHG reduction agenda embedded in programs such as the low-carbon fuel standard (LCFS) [8]. The following sections provide, in greater detail, the meaning of these sustainability provisions.

The US Renewable Fuel Standard

EISA increased the mandatory blending of renewable fuels to 36 billion gallons by 2020. Each category of qualifying fuel (renewable fuel, cellulosic ethanol, biomass-based diesel, and advanced biofuels) must meet minimum threshold GHG emissions reductions [5], and obligated parties under RFS must source renewable fuels from "renewable biomass" [5]. "Renewability" in the statute focuses on land conversion prohibitions [5], limits on biomass sourcing from nonfederal forests, and absolute bars against harvests from old-growth or late-succession forests and forests with ecological communities with a certain global or state ranking [5]. The environmental protection agency (EPA) is implementing a plan [9], in response to several instances of Renewable Identification Number (RIN) fraud [10], for quality assurance through independent third parties. EPA notes that the Quality Assurance Program will also verify that feedstocks are from "renewable biomass" and meet land-use restrictions.

EISA requires the US EPA to report triennially on the environmental impacts of the RFS [5]. In February 2011, it issued its first triennial report of the environmental impacts of the RFS [11]. EPA acknowledges in its report studies that confirm commodity crop production in the Mississippi watershed results in harmful nitrogen pollution. It concludes, however, that the effects of biomass cropping are yet to be fully understood due to the dearth of scientific research. Perhaps most significantly, EPA indicates in the triennial report that it will apply lifecycle analysis (LCA) in the next triennial report (2014) to determine the full range of environmental effects within the RFS supply chain. What methodology and data EPA will use, however, remain unclear.

Most significantly, the RFS has been under assault by livestock and grocer interests for raising prices of agricultural feed stocks. Both have lobbied Congress to end the RFS altogether [12] and have unsuccessfully sued EPA for diverting corn to ethanol from livestock feed [13]. Still, EPA has resisted adjusting the mandate down [14]. EPA may, under the RFS statute, adjust the mandate after 2013 if it determines that it negatively affects US food and feed prices [5]. According to a 2013 ruling by a federal court of appeals, EPA must be more accurate in its technology predictions when setting the mandate than it had been in the past [15].

The Biomass Crop Assistance Program

The BCAP is the United States' first federal subsidy for biomass-to-bioenergy feedstocks, which pays farmers over 5- to 10-year period for the establishment and production of "renewable biomass," which has two basic meanings under the statute and regulations [16]. First, crops eligible for the subsidy cannot be cropped on lands with native vegetation not previously tilled at the time the 2008 Farm Bill became law, or on land that receives conservation, wetland, or grassland reserve payments [16]. Second, food crops are not eligible for payment [17]. Thus, only second-generation crops, like perennial grasses, and short-rotation woody biomass, like poplar, are eligible.

Just like for a condition for any type of federal farm subsidy (whether direct and countercyclical payments or other conservation grant funding such as the Environmental Quality Incentives Program or Wildlife Habitat Incentive Program), BCAP producers must implement some form of USDA Natural Resource and Conservation Service (NRCS) conservation planning [18]. In addition, BCAP farmers must comply with some general environmental laws that protect fragile habitats such as the Endangered Species Act, Farm Bill proscriptions against wetland and native grassland conversion, and controls on pest control application in the Federal Insecticide, Fungicide, and Rodenticide Act. Otherwise, Congress has largely exempted agriculture from air and water pollution control requirements [19]. Federal labor and employment laws also contain certain exemptions for agriculture from overtime pay and minimum wage requirements.

BCAP's requirement that all subsidy recipients complete conservation plans highlights the need for farmer education on sustainability practices. Research, education, outreach, and support are critical building blocks of agricultural knowledge [20]. Farmer assistance in the United States is primarily funded through the USDA's National Institute of Food and Agriculture (NIFA) at state land-grant universities [21]. Much of the services' and research funding focus, however, has been on traditional commodity crop production systems with less emphasis on sustainability [22]. Land-grant universities that sponsor extension services have been criticized for "neglecting important segments of the population," including small and family farmers, and have instead "allied themselves with the corporate interests that are at odds with promotion of rural life" [23, 24]. In light of new markets created by sustainable biomass mandates, extension services can counter these criticisms by refocusing their mission toward smaller, less corporatized farmers who want to

improve the sustainability of their practices through biomass cropping. Although this transition may already be occurring, the research side of sustainable practices has much catching up to do [25]. New research must also be incorporated into NRCS practice standards, which inform farmers' conservation planning. Although somewhat analogous NRCS cover cropping and riparian buffer practice standards are in place, no standards exist that would guide producer's decision for energy cropping. It is believed that the Farm Services Administration and NRCS have worked together in devising practice standards for BCAP to prevent the spread of invasive species for individual participants, but these have not been published publically.

The Clean Air Act "Tailoring Rule" for Biomass-Based Emissions from Stationary Sources

In addition to bioenergy-specific statutes such as the RFS and BCAP that contain sustainability provisions for biomass, federal efforts to reduce GHGs from electricity generation also contemplate the sustainability of biomass. EPA is implementing stationary [26] GHG rules under the federal Clean Air Act (CAA) in response to the US Supreme Court's holding in 2007 that EPA must determine whether GHGs cause or contribute to air pollution (GHGs) that may be reasonably anticipated to endanger public health (which it did in 2010). For certain stationary sources such as electricity generators that combust biomass that EPA must permit under its "Tailoring Rule," EPA controversially ruled in July 2011 that it will treat biomass as "carbon neutral" while it studies the issue for 3 years [27]. Put another way, EPA deferred permitting of facilities that combust forest and agricultural biomass until studies can be completed on its carbon neutrality. EPA's Science Advisory Board (SAB) has conducted hearings to evaluate EPA's proposed "Accounting Framework for Biogenic CO_2 Emissions From Stationary Sources" and proposed to EPA that not all biogenic carbon is carbon neutral [28]. In July 2013, a federal appeals court struck down EPA's deferral. Citation: Center for Biological Diversity v. EPA, No 11–1101 (D.C. Cir. July 12, 2013). Despite a call for information related to other sustainability issues (particularly impacts on forests) in July 2010, EPA did not indicate in its neutrality rule any reference to what, if anything, it will do moving forward with regard to environmental issues other than GHG emissions [29].

Procurement Market-Pull for Sustainable Biomass: USDA, EPA, Department of Defense

In addition to compliance-based incentives to increase biomass sustainability, the primary potential market-pull in the United States for sustainable biomass likely will come from federal procurement standards. All executive agencies (e.g., the Department of Homeland Security) follow the Federal Acquisition Regulation (FAR) to make "sustainable acquisitions" (i.e., purchases) [30]. Ninety-five percent of new contract actions must require that the product is, among other qualities, water-efficient, biobased, and environmentally preferable. Each federal agency

must establish affirmative procurement programs (APPs) (otherwise known as green purchasing plans [GPPs]) for biobased products. Products qualifying under the FAR include those covered by the EPA's Environmentally Preferable Purchasing (EPP) guidelines and USDA's biobased program, both of which delineate what products may qualify under their programs. The Farm Security and Rural Investment Act of 2002 (FSRIA) established USDA as the lead agency for the federal procurement of biobased products, including developing categories of qualifying "biobased" products.

EPA's Final Guidance on EPP is based on the goal of pollution prevention and consideration of multiple attributes from a lifecycle perspective. The guidance states that there is "no hierarchy that ranks which attributes or environmental impacts are the most important," but recovery time and geographic scale, differences between competing products, and human health are factors that agencies consider [31]. Although certification is not required, it is one way in which federal officials can evaluate a product for qualification. The guidance also maintains an annex with a list of "environmental attributes" including ecosystem impacts and water consumption and pollution.

USDA's Guidelines for Designating Biobased Products for Federal Procurement, issued as part of the biobased program referenced above, on the other hand, forbid a procuring agency from requesting more information from vendors of biobased products than required of other vendors generally but "encourages" them to provide information on environmental and public health benefits based on "industry accepted analytical approaches such as ASTM D7075 and ISO 14040" [32]. Biobased products do not include electricity or motor fuels or any other product for which there is a mature market. Two congressmen recently introduced the Forest Products Fairness Act of 2012, which would open up the program to forest-based products, regardless of market maturity, including pellets.

Congress required the Department of Defense (DOD) in 2009 to study ways in which alternative fuels could be procured and used to reduce GHG emissions. DOD's final study concluded that it remains uncertain whether alternative fuels can be produced sustainably. Its recent request for proposals required a reference to sustainability certification, which indicates that while DOD is interested in procuring biofuels (including those made from forest biomass), it must be assured at some level of their true sustainability.

9.2.1.2 State Programs: California's Multifaceted Assembly Bill (AB) 32 GHG Reduction Policies

In addition to federal bioenergy, environmental, and procurement laws, California leads the way among states in development of policies to combat GHGs through policies such as a LCFS, cap and trade, renewable electricity, vehicle emissions, and green subsidies. The LCFS requires each fuel supplier in California to reduce the overall carbon intensity of fuel sales each year, for an overall reduction by 2020 of 10 % relative to the 2005 baseline [33]. The California Air Resources Board (ARB)

is in the process of developing concurrent practice-based sustainability standards to accompany the LCFS' carbon foot printing. ARB has developed a set of draft metrics (e.g., water, soil, biodiversity, and labor/employment) in consultation with a sustainability workgroup of stakeholders and other experts [34]. Similar forestry sustainability standards began through the Interagency Forestry Working Group but appeared to be stalled [35].[1]

Plaintiffs have challenged the constitutionality of the LCFS' carbon footprinting through LCA [36]. Specifically, a group of farmers and ethanol interests from the US Midwest claim that the Dormant Commerce Clause of the US Constitution prohibits California from imposing rules that substantially affect interstate commerce. These include the GHG penalties that Midwestern corn ethanol receive because of transportation emissions associated with logistics of shipping ethanol from the Midwest to California, and the use of high GHG intensity coal-fired electricity that is prevalent in the Midwest. While triumphant at the district court level, the Ninth Circuit Court of Appeals held the regulation valid in September 2013. Citation: Rocky Mountain Farmer's Union v. Corey, No. 12–15131 (Sept. 18, 2013).

In addition to ARB's LCFS efforts, the California Energy Commission (CEC) applies sustainability criteria to make green subsidies for alternative and renewable fuels and technologies [37]. For purpose-grown energy crops, these include "development and implementation of a sustainability best management practices plan developed by institutions such as the University of California at Davis," land use that does not disrupt food cropping, and crop selection that fits climate, water, and natural resource constraints [38]. On the other hand, renewable energy credits (RECs) generated through its Renewable Electricity Standard (RES) lack concrete definitions of "renewability" except as broadly defined through statute by source (e.g., biomass) and that which does not "cause or contribute to any violation of a California environmental quality standard or requirement" [39]. While it remains unclear how CEC will verify environmental compliance, presumably Cap-and-Trade regulations would cross-apply. CEC did recently issue a study of the lifecycle effects of certain energy systems [40]. Controversy surrounding the definition of "renewability" of RES feedstocks has emerged in other states such as North Carolina, where environmentalists have appealed the NC Utilities Commission's order, allowing whole trees to be combusted for electricity generation [41].

California's Cap-and-Trade regulation exempts biomass-based fuels from carbon accounting, but entities must still report GHG emissions from biomass under the mandatory reporting regulation [42]. In December 2011, ARB finalized additional reporting requirement that forest-derived biomass demonstrate compliance with environmental and forestry laws [33]. For international sourcing, California continues to work, through the Governors' Climate and Forests Task Force (GCF), on the integration of sustainability mechanisms such as Reducing Emissions from Deforestation and Forest Degradation (REDD) into the Cap-and-Trade program [43].

[1] *CAT Forest Group/Inter-Agency Forest Working Group*, CAL. CLIMATE CHANGE PORTAL, http://www.climatechange.ca.gov/forestry/index.html (last modified Jan. 12, 2010).

9.2.1.3 Sustainability and the Forest Sector in the United States

While the aforementioned policies reach both agricultural and forest biomass, sustainability regulation within forests is more developed than in agricultural landscapes due to the historical exemption of farming activities from environmental regulation. Jurisdiction over forestry sustainability management depends on whether the land is publically or privately held. The US Department of Agriculture's Forest Service (USDA-FS) and the US Department of Interior administer sustainable forestry laws and rules on federal lands. These include the Organic Act leading to the modern-day establishment of the USDA-FS, the Sustained Yield Act of 1944, the Multi-Use and Sustained Yield Act of 1960 (MUSYA), and the National Forest Management Act of 1976 (NFMA). Since its inception, USDA-FS has come under criticism by forest-protection advocates that its interpretation of "sustained yield" and "multiple use" contained in these statutes favors harvest levels to the detriment of sustained ecological function of the forest. In addition to NFMA, however, federal forest actions also are subject to other general laws such as the National Environmental Policy Act, the Clean Water Act (CWA), and the Endangered Species Act. The USDA-FS' interpretation of these laws still is ever-evolving, however, as evidenced by the US Supreme Court's recent decision deferring EPA's decision not to apply CWA point source permitting to road building in federal forests [44]. How these laws are interpreted will affect the ability to harvest forest biomass on federal lands for bioenergy. The following sections detail the potential relationship between the applications of various federal forest policies for biomass energy.

The National Forest Management Act of 1976

Although NFMA does not allow environmental values to completely trump economic uses of federal forests, NFMA does require the USFS to prepare management plans that provide for "sustainable" yields and regulations that consider plant, animal, and tree diversity. The Forest Service Manual and other guidance (e.g., best management practices for water quality) play primary roles in implementation of forest plans. Until 2012, federal planning rules have been based on a 1982 rule. The Clinton administration proposed a revised rule in 2000, but the George W. Bush administration refused to implement the rule. Instead, it proposed its own rules twice that essentially eliminated environmental review and scientific assessment. Courts on both occasions struck down the rules, opening an opportunity for the Obama administration to finalize a new forest management rule [45, 46].

Whether or not the current rule will be similarly overturned is uncertain, but undoubtedly it has already caused controversy. The Center for Biological Diversity, the organization behind the two other successful suits, has criticized the rule for weakening longstanding biodiversity protections by eliminating the requirement that the Forest Service maintain viable populations of species in favor of deference to localized decisions. The rule instead focuses on ecosystem integrity and

biodiversity that is dependent on the regional forester's discretion as to what species are of concern and whether the Forest Service has the authority and capability to maintain a viable population. That does not mean the Forest Service can choose to ignore species conservation; it must in its plans under the new rule "maintain or restore ecological conditions within the plan area to contribute to maintaining a viable population of the species within its range." Conservationists would argue that the rule's focus on species of concern lessens protections for all native species, and its diffusion of decision-making authority to lower levels risks capture by local economic interests. The Forest Service currently maintains technical guidelines for species monitoring, but it is unclear how those might change in light of the new rule.

USDA-FS states in the final rule that it "recognizes…that development of renewable and non-renewable energy resources are among the potential uses in a plan area. However, the final rule does not dictate the activities that may occur or not occur on administrative units of the NFS" [45]. Assessments for planning purposes must account for energy resources. The extent to which those resources are accessible depends on other sustainability factors incorporated into planning such as biodiversity and water-quality conditions. New Section 219.8 contains the core sustainability provisions for forest planning, spanning ecosystem integrity, air quality, soils, and water quality. Persistent violation of state water-quality standards led to an added requirement in the final rule that the Forest Service Chief promulgate national-level best-management practices to maintain and restore water quality and a system of ensuring that lessees implement them.

The Healthy Forests Restoration Act of 2003

While environmentalists were successful in blocking George W. Bush's changes to the NFMA forest planning rule that would have exempted leasing decisions from environmental review, he was successful in getting the Healthy Forests Restoration Act of 2003 (HFRA) passed [47]. HFRA contains similar exemptions from environmental review, such as (1) categorical exclusion from environmental review for logging projects up to 1,000 acres in size when the projects are intended to combat forest-damaging insects; (2) exemption of hazardous fuel reduction projects from the administrative appeal process, allowing the Forest Service to establish a "predecisional administrative review process"; and (3) limiting plaintiffs to specific written issues raised during this administrative review process unless a court determines the process is futile or inadequate with respect to the specific client or claim [48].

While these provisions can serve to facilitate the process of biofuel harvesting by limiting time-consuming public review and litigation that could hinder or completely halt harvesting, forest-protection advocates claim that destructive overharvesting and accompanying ecological degradation could occur and have pursued legal challenges against Forest Service HFRA decisions. The Forest Service and Department of Interior's Bureau of Land Management have issued an interim field guide for HFRA implementation, but substantive changes made by HFRA to the

environmental assessment process governed by NEPA have been made through Council on Environmental Quality (CEQ) guidance. Other changes to the appeals process are found in general Forest Service regulations.

Despite the continuing controversy, HFRA plays a large role in the utilization of biomass for bioenergy. The Departments of Agriculture, Interior, and Energy signed a memorandum of understanding in 2003 setting "Policy principles for Woody Biomass Utilization for Restoration and Fuel Treatments on Forests, Woodlands, and Rangelands" [49]. The principles include mapping of potential biomass resources and encouraging sustainable development as sustainability "measures." In 2008 the Forest Service issued its "Woody Biomass Utilization Strategy," which recognizes the need to develop management practices for sustainability that presumably would apply to restoration and fuel treatments [50].[2] Part of USDA-FS's national strategy, too, includes the "Woody Biomass Utilization Desk Guide," which recognizes the environmental implications of increased harvest but does not recommend specific practices [51]. USDA-FS also contributed funding to a National Association of Conservation District's "Woody Biomass Desk Guide and Toolkit" that recognizes specifically the environmental disadvantages of woody biomass-to-energy activities [52].

Private Certification on Federal Forest Lands

In 2007, the USFS commissioned a study gauging the effectiveness of its existing forest management practices when compared with certain third-party certification standards [53]. While auditors commended the thoroughness of planning, comprehensive use of scientific data, and stakeholder engagements, shortcomings in USDA-FS policy were found in relation to practices that related to forest sustainability. Delayed silvicultural treatments and unachieved ecological, social, and economic management goals were the primary lapses cited. The report cites increased pest and disease infestation, increased potential for "stand-replacing" wildfire, and the inability to achieve desired forest structure and composition (e.g., bird habitat) as some of the ramifications of the failure to manage forests for sustainability. Lack of financial resources and lack of capacity have led to these delays. Forest officials further admitted their inability to adequately enforce rules meant to reduce the detrimental environmental impacts of off-road vehicle use. Some inadequacies related to scale and access also were found with management of late-succession and old-growth forests.

The 2007 study reveals that public laws, standing alone, are in some cases not enough to ensure the sustainability of forest harvests. Assuming that federal forests will be opened to harvests for energy biomass, to combat the threat of overharvesting for energy biomass, future general federal forest laws could require regular

[2] USDA, Woody Biomass Utilization Strategy (Feb. 2008), http://www.fs.fed.us/woodybiomass/strategy/documents/FS_WoodyBiomassStrategy.pdf.

audits of Forest Service policies to third-party certification principles, criteria, and indicators, or private leases in federal forests could be subject to actual third-party certification. A combination of both public and private requirements would ensure that both whole forest and site-level sustainability are better achieved.

The Lacey Act and Imports of Forest Biomass from Illegal Logging

The Congress passed the Lacey Act in 1900 as a way to prevent illegal fish and wildlife trafficking. The 2008 Farm Bill expanded Lacey Act prohibitions to the interstate or international trade in illegally harvested timber either under the United States or any foreign law covering theft, taking from protected or officially designated areas, taking without prior authorization, or taxes. All imports must file a declaration with USDA's Animal and Plant Health Inspection Service (APHIS) stating the scientific name of the tree, the quantity and value of the shipment, and the country from which the tree is taken.

While the declaration does not require importers to maintain a chain of custody regarding sustainability, it does carry stiff criminal penalties if the importer knowingly sources illegally harvested timber, including woody biomass for energy such as pellets. If the importer does not knowingly import such products, but fails to exercise "due care," the importer is subject to lesser misdemeanor charges and civil penalties. The US Department of Justice has stated that "due care means that degree of care which a reasonably prudent person would exercise under the same or similar circumstances" and that it "is applied differently to different categories of persons with varying degrees of knowledge and responsibility" [54]. The ambiguous nature of the "due care" standard has lead industry groups to issue their own guidance that includes a written company policy, standard operating procedures and checklists, asking suppliers to explain the due diligence they exercised in sourcing wood products, and knowing where the biomass is harvested from through third-party certifications.

State Sustainable Forest Biomass-to-Energy Initiatives

While federal policies can and do, in some instances, play a significant role in sustainable forest management (SFM) in relation to bioenergy, the lack of a coordinated federal-level bioenergy policy has left a vacuum for states to fill. States can set rules for activities within their jurisdiction. States can reach activities outside their borders, but only if the substantial state interest in regulating does not overburden interstate commerce. The Massachusetts Department of Energy Resources (DOER) finalized in 2012 a rulemaking specifically addressing the sustainability of forest biomass feedstocks qualifying for the state's renewable portfolio standard (RPS). The rules are based in part on the groundbreaking Manomet study, which assessed the possible impacts resulting from the state's proposed transition from traditional fossil fuels to a bioenergy model. The study analyzed three core energy and

environmental questions: (1) the GHG implications of shifting energy production from fossil fuel sources to forest biomass; (2) the amount of available forest wood necessary to support the state's energy goals; and (3) the potential ecological impacts of increased biomass harvests in state forests and the policies necessary to ensure the continued sustainability of the harvests [55].

The new RPS rule defines eligible woody biomass as (1) forest-derived residues (i.e., tops and other portions of trees produced as a byproduct of the normal harvesting process, other woody vegetation that interferes with regeneration of natural growth but limited to locally invasive native species and nonnative invasive woody vegetation); (2) forest-derived thinnings (including whole trees that are weak or of low vigor and trees removed during thinning operations for the purpose of reducing stand density and enhancing growth and volume of the stand); (3) forest salvage (i.e., damaged, dying, or dead trees due to weather events or disease and trees removed to reduce fire hazard, but not those trees removed due to competition between plantings); and (4) non-forest-derived residues (including trees removed for nonagricultural and agricultural land-use change) [56].

Each year, the unit using eligible biomass woody fuel must document total tonnage through "biomass fuel certificates." The certificate also verifies the source of forest-derived residues and thinnings by citing either a Massachusetts Department of Conservation and Recreation (DCR) "cutting plan" or other equivalent state plan prepared by a licensed forester, or obtaining the signature of a professional forester [56]. The DOER has created a set of certificate guidelines on an Excel spreadsheet that place additional restrictions on biomass removal [57]. For forest-derived residues, the report must provide information detailing the residues' precise derivation—whether the residues are harvest by-products or the result of damage caused by invasive species. This is required to prevent prohibited material or materials in prohibited amounts from entering the supply chain, including material from old-growth forest stands, naturally down woody material, forest litter, forest floor roots and stumps, live cavity trees, den trees, and live but decaying trees and snags. In addition, the amounts of biomass eligible to be taken away from a harvest site are tied to the overall tonnage of biomass harvested and to the quality of the soil at the harvest site.

For areas deemed to be of poor soil quality, 100 % of the tops and branches from the forest material must remain on site in order to prevent erosion and to supplement soil conditions and quality. In cases where soil quality is "good," 25 % of the tops and branches from the harvest must remain on site. A soil designation of "good" or "poor" is determined by set criteria established by DOER and the NRCS. In all cases, 30 % of material eligible for thinning must remain. Beyond regulation and guidance specific to the RPS, any forest harvesting activity in the state above a certain volume must be conducted with an approved cutting plan pursuant to the Forest Cutting Practices Act (FCPA), including compliance with the Best Management Practices Manual [58]. Like most states, Massachusetts maintains its own Endangered Species Act that also applies to any forestry activities, including those conducted to qualify for the state's RPS.

9.2.2 The European Union

Unlike in the United States, which has only the RFS at the federal level as its bioenergy policy, and California, with its multifaceted A.B. 32, the EU Renewable Energy Directive (RED) and Fuel Quality Directive (FQD) combine both a mandate and LCFS. Both directives became final in April 2009. The RED requires that energy from renewable sources, such as biomass, makes up 20 % of the total EU energy supply by 2020 [59]. Ten percent of the total energy used for transportation must be from renewables, which would be counted toward the 20 % overall mandate. Member states bear responsibility for fulfilling these commitments through national action plans, including implementing schemes to guarantee that feedstocks for biofuels meet sustainability criteria enumerated in Article 17 of the directive. These criteria include meeting increasingly more stringent GHG minimum thresholds (concurrent amendments made to the FQD require all transportation fuels to reduce their emissions by 10 % by 2020 [60], like the California LCFS), land-based sourcing prohibitions (lands with high biodiversity or carbon values), and cross-compliance [61] with existing agro-environmental laws. "Economic operators" are required to seek independent audits to verify that these criteria are met and must report as part of verification "appropriate and relevant information on measures taken for soil, water and air protection, the restoration of degraded land, the avoidance of excessive water consumption in areas where water is scarce and appropriate and relevant information concerning measures taken" [59].

Cross-compliance measures required in Article 17(6) of the EU RED are contained in the Common Agricultural Policy (CAP) [59]. This requirement for bioenergy recognizes that since the early 1990s, the EU has shifted toward a policy of "multifunctionality" of agriculture—that agriculture should produce environmental and societal goods and services in addition to food, feed, fiber, and energy [62]. Beginning in 2003, the EU implemented changes to the farm subsidy program contained in the CAP in order to create better balance and consistency between rural development and sustainability objectives [63].

Whether a producer receives a direct payment for income support, or support under the EU rural development policy, the CAP requires producers to observe "cross-compliance" with environmental, food safety, plant and animal health, public health, animal welfare, and environmental condition rules [61, 64, 65]. Cross-compliance contains two elements. "Statutory management requirements," or SMRs, include 19 different pieces of EU legislation, including directives on wild birds, sewage sludge, wastes, nitrates, release of dangerous substances into aquatic environments, habitats, ground water, and plant protection products [61]. Second, all producers who receive subsidies must maintain lands in good agricultural and environmental condition (GAEC) [61]. The CAP establishes a minimum standards framework for GAEC relating to soil protection, organic matter and structure, avoiding deterioration of habitats, and water protection and management. Beyond cross-compliance and GAEC, producers can voluntarily adopt agri-environmental measures (AEMs) in return for payments under the EU rural development policy

[64]. The EU further has provided subsidies since 1975 for production on "less favored areas" (LFAs) (now under the Rural Development Policy) to both ensure income in low-productivity areas vulnerable to abandonment and maintain environmental values dependent on agricultural production.

Member states are responsible for implementing cross-compliance, GAEC, AEMs, and LFAs through national legislation and rules that define standards known as "good farming practices" (GFPs) or "good agricultural practices" (GAPs) [66]. GFPs vary widely between member states, due in part to variation in both ecosystems and types of farming operations throughout Europe [66]. For example, cross-compliance with the Nitrates Directive requires a determination of when application of fertilizer is appropriate (e.g., sloped or wet areas) and mitigation practices such as cover crops and good record keeping [67]. From an implementation perspective, some member states require farmers to practice nutrient accounting and keep records, while other member states take different approaches to reducing nutrient runoff [68].[3] This is not unlike the United States, where the federal NRCS develops Field Office Technical Guidance (FOTG) down to the individual county level to address site-specific and area resource concerns [69].

The EU places primary responsibility on member states to provide advisory services to producers related to agri-environmental programs. The CAP requires that member states operate a Farm Advisory System (FAS) to help farmers, on a voluntary basis, in complying with SMRs and GAECs [70]. Member states vary in how they deliver FAS services in terms of whether the service is provided by private, public, or hybrid entities, whether the service is free of charge, what type of service is offered, and to whom it is offered [71]. In some member states, responsibility is devolved to individual states (e.g., Germany) that differ in types of services provided. The majority of assistance consists of going through checklists one-on-one or with small groups. FAS advice also extends to occupational health and safety issues. One report has concluded that "experience of European farmers with energy crop plantations is very limited, and transition to lignocellulosic feedstock systems requires tailor-made agricultural extension services assisting farmers on the various aspects of production from planting to harvesting" [72].

Thus, what existing tools are available for biomass growers to certify their sustainability depends on the EU member state policy and practices in relation to the environmental principle in question [73]. Member states also vary between and within in the way they deliver advisory services to farmers. In the United States, on the other hand, despite the fact that AEMs apply much less than to farms in Europe, and the identification of ecosystem-level resource concerns is in its nascency, the federal NRCS does provide one central, consistent source for advice on designing agri-environmental planning and practices. However, with the US federal budget crisis severely curtailing agency funding, it is uncertain what level of service NRCS

[3] European Commission, Report from the Commission, Implementation of Council Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources, Synthesis from year 2000 Member States Reports, COM (2002) 407 final, at 17–22.

will be able to provide in the future, particularly for biomass where capacity is almost nonexistent. Moreover, unlike the EU FAS, NRCS services are limited to environmental issues, so producers must seek out occupational health and safety information separately through CREES and the federal Department of Labor's Occupational Health and Safety Administration (OSHA).

The RED does not impose sustainability criteria on renewable sources used for electricity, heating, and cooling. Instead, it required the Commission to report on a similar scheme for these uses [59]. In its report issued in February 2011, the Commission recommends member states introduce sustainability schemes [74], although concurrently the Commission initiated a consultation based on "new developments" in the industry and policies to determine whether a need exists for additional measures at the EU level [75]. In its July 2011 findings, the Commission notes that 72 % of respondents "believed that additional measures at [the] EU level are needed to ensure the sustainability of biomass used in electricity and heating/cooling sectors" [76]. The respondents' reasoning was based on (1) increasing EU demand, (2) inadequate existing sustainability policy frameworks in the EU, (3) the need for a consistent approach, and (4) the lack of a binding EU sustainability scheme. The EU is currently considering existing forest sustainability laws and whether amendments to the RED are necessary.

9.2.3 Brazil

Brazil's federal requirement for mandatory blending of sugar cane ethanol, Proalcool program [77], does not contain practice-specific sustainability requirements. However, in response to international pressure to prevent deforestation resulting from energy biomass cropping, Brazil has codified an agroecological zoning plan for the expansion of its sugar cane-to-ethanol industry (ZAE-CANA) [78]. The multiagency federal effort used soil, climate, hydrological, biological, socioeconomic, and regulatory criteria to designate where cropping can occur. It automatically excluded areas of native vegetation and areas of high biodiversity, such as the Amazon and Pantanal, and focused on ensuring that land designation would support sustainability and protection of biodiversity and would reduce competition with food cropping. States must incorporate these land-use designations into their legal regimes permitting expansion of sugar cane cropping [79].

The Forest Code is the second key law related to constraining land-use change [80]. The Forest Code divides land categories into those for agricultural production and conservation. Conservation is further subdivided into "permanent preservation areas" (APPs) and "legal reservation areas" (RL). APPs must be established in areas next to drinking water sources and rivers and sloped lands. The RL requires between 20 and 80 % of land owned to be maintained in forest or native vegetation, depending on the location of the farm. These conservation provisions are controversial among private landowners. The Brazilian federal Congress approved a new version of the Forest Code in 2011, which kept the RL and APPs in place but at a reduced

rate and with amnesty for some rural producers who did not comply with the Forest Code restriction prior to 2008. The World Bank contends that one side effect of the RL and APPs is that if productive land must be otherwise "reserved," agricultural land use could move to more sensitive areas such as the Amazon [81]. Future discussion, therefore, could revolve around how to make reserves more economically meaningful to producers (thus relieving the incentive to deforest elsewhere) and the application of ZAE-CANA zoning restrictions. One way to do this would be through certified biomass production.

From a cross-compliance perspective, environmental licensing is required for "high impact agricultural activities, including sugar cane ethanol facilities" [82]. Environmental licensing includes pre-project environmental review for compliance with other environmental laws [83, 84]. It remains unclear, however, whether responsible authorities (states) require compliance beyond the biorefinery to the field level. Pursuant to the "Green Protocol," financial institutions have agreed with the federal environmental agency to condition lending on obtaining environmental licensing [85].

The State of São Paulo has taken steps to phase out the burning of sugar cane prior to harvest by 2021 under pressure to reduce air pollution and lifecycle GHG emissions attributable to sugar cane ethanol [86]. In 2007, UNICA (the main Brazilian sugar cane industry group) voluntarily agreed with the State of São Paulo to reduce burning in all areas in anticipation of a 2013 deadline as well as no burning in new areas [87]. One significant societal side effect of burning bans, however, has been the elimination of hand labor in favor of mechanization. The UNICA Agreement also involves other areas of improved sustainability. Its "technical directives" provide that sugar cane growers will observe a variety of sustainable practices, including (1) assessing areas that could contribute to environmental protection, including biodiversity; (2) protecting water sources in rural areas; (3) implementing soil conservation and watercourse protection plans; (4) properly disposing pesticide containers and applicator training; and (5) adopting best practices to minimize air pollution from industrial practices. In return, the State agrees to fund research, install logistical infrastructure for exports, issue a "certificate of agro-environmental conformity" as contained in the technical directives, and consider small holders in designing anti-burning measures. The agreement establishes an executive committee of three technicians from the government and industry to establish criteria for the certificate. "According to the State Environment Secretary, 145 out of 177 plants in São Paulo have adhered to the Protocol" [88].

The 2007 National Plan on Climate Change recommends ways in which agricultural and forestry practices can reduce GHG emissions, such as the adoption of no-till techniques, strategies to deal with degraded pasture, integrated crop-livestock operations, reduction in the use of nitrogen fertilizers, and organic "enrichment" of cattle pastures to reduce nitrogen emissions [89]. The emphasis on improving pasture in Brazil, particularly if it involves intensification of cattle, has been activity forwarded as one way to reduce ILUC penalties placed on biofuels. The drive toward livestock intensification may result in trading one environmental problem, such as the ILUC, for another, because while biofuel sustainability standards may

take into account GHG emissions from ILUC, they do not take into account the negative, indirect environmental effects of ILUC avoidance through livestock intensification that have been the subject of much environmental dispute in the United States [90, 91].

The sugar cane sector in Brazil has been subject to much criticism for its labor practices involving poor, uneducated workers, both internally and from international human rights groups. Although Brazilian authorities have pursued action under labor laws against poor working conditions, the conditions for laborers have only until recently began to improve [82]. Under pressure from critics and threat of further enforcement, UNICA signed a voluntary agreement with five Brazilian federal ministries to improve labor practices in sugar cane production in 2009 [82]. The industry has promised to provide work contracts, improved conditions for migrant workers, transparency in how workers are paid by unit of production, better health and safety mechanisms, improved transportation conditions, the provision of meals, the possibility of unionization, and reporting of practices.

Brazil does maintain the "Social Seal" program for biodiesel, which, in addition to mandating 5 % blending after 2013, forces biodiesel producers to buy at least 50 % of feedstocks from family farmers in order to qualify for the government's price premium and other incentives [88, 92]. Criteria have been developed to monitor whether the Social Seal program requirements are met, and companies must submit quarterly data to the Ministry of Agriculture. These include reporting on technical assistance provided to farmers, maintaining food security, respect for cultural practices, sustainability systems that emphasize indigenous, local practice knowledge, appropriate management of soil and water resources, consideration of women and children in income generation, and measures to reduce poverty in rural areas.

9.2.4 Private Sustainability Standards

Thus far, the EU RED has recognized several voluntary schemes to verify sustainability criteria [93], including the International Sustainability and Carbon Certification (ISCC), Bonsucro EU, the Roundtable on Responsible Soy (RTRS) EU, the Roundtable for Sustainable Biofuels (RSB) EU RED, Biomass Biofuels voluntary scheme (2BSvs), Abengoa RED Bioenergy Sustainability Assurance (RBSA), Greenergy Brazilian Bioethanol verification program, ENSUS, Red Tractor, SQC, Red Cert, and NTA 8000 [94]. US-based stakeholders similarly have come together to form the Council for Sustainable Biomass Production (CSBP) and have issued a final standard and guidance in anticipation of verification requirements in the United States [95]. Standards share common principles of soil, water, and air pollution avoidance, biodiversity protection, GHG accounting, legality, and social (e.g., labor, land rights, food security) considerations.

Although neither the federal or state governments in the United States require sustainability certification at this time for transportation fuels or electricity, in 2013, California's ARB will begin benchmarking its draft principles and criteria for its

LCFS to California and federal laws that already apply to agriculture in order to determine synergies and gaps, and in an effort to ensure that its sustainability provisions are as implementable as possible for farmers [34]. It will benchmark these results to the CSBP and RSB standards to determine also the standards' feasibility for farmers and the efficacy of third-party verification at the federal level. Third-party sustainability certification also could assist obligated parties in meeting EPA Quality Assurance Requirements.

9.3 International Standards and Harmonization

Without some level of public-level, international harmonization of sustainability standards, international trade could come to a standstill. The stage is being set. The American Soybean Association (ASA) formally complained to the Office of the US Trade Representative and USDA in early 2011 regarding the EU's application of its GHG calculations to disqualify soy biodiesel as a renewable source under the RED [96]. Argentina similarly is seeking consultation with in the WTO regarding what it sees as arbitrary, trade-distorting GHG thresholds [97]. Developing countries warned the EU in the early stages of RED development that if it implemented "unjustifiably complex" a third-party certification program, they might pursue a complaint under world trade agreements [98]. Some assert that only a binding international minimum standard can truly ensure all market players achieve a level of sustainability [99]. The notion ignores symptoms of the world's broader failures to reach consensus on how to address climate change, fair and equitable agricultural trade, and labor standards that protect vulnerable people against exploitation [100]. Parties to any harmonization of biofuels sustainability standards would have to agree on how to account for direct and indirect GHG emissions, and as post-Kyoto negotiations on carbon accounting demonstrate, this is highly unlikely, even as GHG emissions dangerously escalate even beyond previous estimates [101]. As for the "other" aspects of biofuels sustainability, such as soil, water, and biodiversity protection, the Marrakesh agricultural trade negotiations prove the difficulties in reaching consensus. They have yielded nothing, for example, in response to Brazil's request that biofuels be classified as an "environmental" good versus an agricultural good [102].

Regardless, any signatory to the World Trade Organization Agreement on Technical Barriers to Trade (TBT) treaty must give positive consideration to the exporting country's technical regulations in conducting conformity assessments, but where an international standard exists, such as the ISO standard being developed, this must be applied [103]. When the ISO process is complete for sustainability criteria for bioenergy [104], a country will be required under the TBT to apply ISO methodology for ILUC and food security calculations, if they are indeed included [103].

Perhaps in a somewhat duplicative way, the G8 countries "+5" (Brazil, India, China, Mexico, and South Africa) formed the Global Bioenergy Partnership (GBEP) in 2005 through The Gleneagles Plan of Action to increase the world supply of

biofuels and biomass [105]. While fruitful in fostering dialogue, the GBEPs progress toward building biofuels sustainability standards, and its ultimate effectiveness, should not be exaggerated. Its framework to guide country-specific regulation consists of indicators that are vague and noncommittal, which reflects carry-over of these more general failures to agree internationally on GHG or agricultural sustainability metrics [106]. Its GHG accounting framework expressly refuses to promote or endorse "one methodology or approach over another" with regard to LCA "due to differences in national circumstances or legitimate differences of opinion regarding what should be included in LCA" [107]. This begs the question of how to resolve those differences when international trade occurs. While its social indicators emphasize food security through "assessment" and "allocation" of land resources, the GBEP has not explained how countries such as the United States, with well-developed private property rights regimes, would "allocate" lands for food and energy biomass production. Again, although the GBEP food security indicator may be intended only to apply in underdeveloped countries with food insecurity problems, arguably developed countries should be under the same requirement as major actors in a fully globalized market economy for food commodities.

Although science is increasingly recognizing that the most effective solutions to sustainability involve outcomes at the system level, the GBEP relies on actions within and between jurisdictional boundaries that typically do not coincide with ecological or social systems. Countries are only beginning to recognize that their regulation and other policies should take into account the complex interactions that occur environmentally within ecosystems or "sheds." The US EPA's recent efforts to reduce agricultural pollution loading in the Chesapeake Bay demonstrate aptly the challenges that countries face in tackling agriculture's environmental problems from a systems perspective. EPA has relied on modeling to establish maximum pollution loading for each state, but it has proved no panacea, however, as plaintiffs are now challenging in court the agency's use of modeled results that they argue are too uncertain and thus are unlawfully arbitrary in application [108]. If the United States lacks the scientific and legal infrastructure to design system-level solutions to sustainability, the GBEP must consider how producers in less-developed countries could comply with standards that seek system-level outcomes. The GBEP has great potential to serve as a global research network to test sustainability principles across ecoregions and to disseminate knowledge gained.

Even if scientific capabilities were in place, countries may not yet fundamentally share a common "web of norms" to form the foundation for agreement on biofuels' place within a sustainable system [109]. Although the GBEP involves the participation of over 45 countries and 24 international organizations and institutions constituting "the majority of bioenergy produced in the world," [110] developing countries have accused similar international processes as excluding their viewpoints [111]. While networks of association are important in coordinating globalized economies [112], "the legitimacy of decision making becomes more strained as the sense of community thins and the distance between those exercising authority and the public grows" [113]. The GBEP must be very careful, therefore, to observe tenets of legitimacy in standard settings, such as transparency, notice and comment, and stakeholder inclusion.

Another step toward public international harmonization of sustainability standards has been the success achieved by the United Nation's collaborative program for the Reduction of Emissions from Deforestation and Degradation (REDD+). For example, REDD+ may provide one "way out" of calculating ILUC—arguably the controversial aspect of biofuels' carbon accounting. That is, if REDD+ is successful in directly curtailing deforestation, then either ILUC would not have to be calculated at all or future emissions in ILUC models could be adjusted based on a predicted effect of REDD+ programs on deforestation. The UN REDD+ Programme has issued a guiding framework of environmental and social principles [114], but it remains to be seen whether REDD generally will receive enough support from the developing world to be effective.

Lastly, in anticipation of European requirements that the US aviation sector participate in its Emissions Trading System (ETS), the aviation sector has formed groups to discuss sustainability metrics for biomass-based aviation fuels such as the Sustainable Aviation Fuels Users Group [115] and the Midwestern Aviation Sustainable Biofuels Initiative (MASBI) [116]. The discussions mirror those that have occurred with private sustainability standards groups, with the exception that aviation is focusing on feedstocks that can be made into aviation fuels. The EU announced in November 2012 that it was suspending the requirement for 1 year, while the UN International Civil Aviation Organization attempts to develop a "global market-based measure" and a "policy framework to guide general application" of the measures to the aviation sector [117].

9.4 Food Security: The Biggest Policy Challenge Ahead for Biomass-Based Energy

The nascent biomass-to-bioenergy sector faces formidable challenges to its successful adoption as part of a balanced energy portfolio. Arguably, the greatest obstacle to second-generation transportation fuels is technology development to overcome cellulosic materials' recalcitrance to the degradation required to make ethanol [118]. EPA is trying to force accelerated technology development by refusing to waive RFS mandates despite claims that the program is causing food price inflation [119]. Despite these efforts, one of the potentially largest market players recently announced it would withdraw for the most part from developing cellulosic fuels in the United States [120].

Arguably the second greatest challenge for cellulosic biofuels, whether blended as ethanol or "dropped in" [121] as diesel, undeniably is how the sector will answer accusations that its indirect effects stemming from land-use changes for bioenergy crops create food insecurity and copious GHG emissions. One solution put forth in policy discussions has been movement of bioenergy cropping to marginal, idle, degraded, and abandoned (MIDA) lands. Because bioenergy statutes have fallen short of providing concrete definitions, the RSB has attempted to fill in gaps by developing (but not finalizing) an "indirect impacts" module in anticipation of EU measures to combat food insecurity and ILUC-induced GHG emissions [122].

The GBEP, too, has developed international guidance for land management to avoid competition between food and energy biomass cropping. Its indicators include assessment of several potential LUC impacts, including the extension of agriculture onto currently unused land [123]. Significantly, the GBEP recommends countries consider environmental, social, and economic impacts when evaluating land uses (including how to exploit unused lands such as degraded or contaminated land), and the particular benefit when this is done as part of a national assessment on the suitability of land for biomass cropping such as that conducted by the Brazilian ZAE-CANA [123]. The GBEP recognizes that such an assessment is most effective when coupled with a comparison to the land-use effects of other energy options such as coal and oil [123].

Assuming this policy course, significant obstacles remain to implementation. Preference for MIDA lands cropping in policy discussions to address the food and GHG dilemmas has not transformed into definitions in bioenergy statutes. One likely reason is that MIDA lands definitions are difficult to design. Economic models do use defined marginal land assumptions to determine carbon footprinting, but "economic marginality" for purposes of modeling does not translate easily into enforceable legal land definitions and ignores other environmental and social characteristics of marginal lands. Some methods do exist for balancing environmental and socioeconomic characteristics of land within countries' subsidy and taxation policies, but questions remain regarding both their methods of measuring the complexity of interactions and the absence of biomass-to-bioenergy cropping systems in factor analysis. This is particularly acute when ecosystems span various landscapes and where ecosystem services must be accurately assessed and valued. These methods, too, lack tools for farmers to make valid marginality or degraded assessments.

9.5 Summary

Few have questioned whether it is reasonable for policymakers to expect bioenergy statutes to shoulder balancing of food, energy, and environmental needs that are mediated through an international market system. As demonstrated in this chapter, bioenergy policies, to varying degrees, incorporate concrete sustainability expectations for biomass feedstocks. In the United States, California's LCFS is the furthest along in developing environmental and social metrics. Federal procurement in the near feature likely, too, will apply sustainability metrics to biobased fuels and products. Sustainability regimes have not been applied on a widespread basis to agricultural landscapes in the United States, however; thus, challenges lie ahead in developing tools and practices for farmers to deploy. The decisions made in this regard will most certainly impact all the feedstock production tasks previously discussed in this book and may make one or the other approaches described here more or less sustainable. While sustainability has been much more of a focus in forests, the prospect of increased demand for forest biomass for energy because of various government mandates most certainly will be much more highly controversial because of the ecosystem values inherent in forests. The EU has had sustainability

requirements for fuels in place since 2010, and several private standards have emerged in response. In response to the "food versus fuel" argument that has predominated biofuels sustainability policy debates, the EU in late 2012 proposed limiting food-based feedstocks to 5 % of the mandate, decreasing to zero by 2020 [124]. Cellulosics also receive preference through double counting toward the mandate, although the EU has not added any additional land-based preferences beyond GHG bonuses for cropping on highly contaminated and degraded lands.

While the effort to develop sustainability metrics for biomass-to-bioenergy applications will continue to go forward—particularly in sectors like defense and aviation that cannot rely on electrification or natural gas—focus will increasingly be on technology advancements for economically feasible "drop-in" fuels. Concurrently, advancements continue to be made in the ability to assess, both in the field and through models, the environmental, social, and economic effects of biofuels. In the interim, policies must innovate to incorporate as many ways possible for biomass producers to feasibly reach sustainability expectations.

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