

EcoFarming: A Realistic Vision for the Future of Agriculture?

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I. Introduction	1167
II. Ecosystem Services: The Building Blocks of EcoFarming.....	1172
A. The Millennium Ecosystem Assessment.....	1173
B. Ecosystem Services from an EcoFarming Perspective.....	1174
III. Markets and Other Incentive Systems.....	1180
A. Private Commercial Markets	1182
B. Philanthropic Payments.....	1184
C. Consumer Demand for EcoFarming.....	1186
D. Governmental Support.....	1187
IV. EcoFarming Opportunities	1192
A. Renewable Energy.....	1193
B. Reduced Climate Risks	1199
C. Hydrologic Services	1208
D. Biodiversity Habitat	1211
E. Lessons Moving Forward	1213
V. Concerns About EcoFarming.....	1215
A. The Baseline Question	1215
B. Capture.....	1218
VI. Conclusion.....	1219

I. INTRODUCTION

Farms, ranches, and timberlands can provide a variety of valuable goods and services. We can use agricultural land to grow crops or raise animals for food or clothing. We also can use the land to produce timber for shelter or furniture. In recent years, we have begun to use the land to grow crops for energy and as the

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site for renewable energy facilities such as wind farms. Agricultural land, however, also can provide us with a wide range of other environmental goods and services, often with little effort on the part of the landowner other than protecting and maintaining natural features such as wetlands. Farms, ranches, and timberlands can, among other things, sequester carbon (and thus help mitigate the risks of climate change), provide recharge to underground aquifers of water, reduce downstream flood risks, help purify water used by downstream consumers, serve as a source of scenic beauty and inspiration, and furnish habitat for pollinators and imperiled species. Agricultural lands, in short, can be the source of multiple, diverse goods and services of significant value to society.

Yet farmers and other cultivators of these working landscapes have traditionally focused on producing only a small set of these goods and services.¹ Farmers have raised animals and cultivated crops, historically for food and clothing but increasingly for energy too, while too frequently ignoring the other goods and services that their lands can provide. This would not be surprising or troublesome if the other goods and services were relatively valueless to society compared to what farmers do produce, but economic and ecological studies suggest that the unproduced or underproduced goods and services are often of substantial value.² Farmers are managing their lands for only some of the goods and services that the lands can produce and consequently not optimizing the societal value of that land.

Multiple factors explain this failure. First and foremost, society does not pay or otherwise reward farmers to produce many of these goods and services; even where payments are available, they often undervalue the goods and services. Robust global markets reward farmers for growing crops and livestock, but no one historically paid farmers to sequester carbon or provide habitat for imperiled species. Second, farmers often have hesitated to take advantage of those markets and incentives that exist for environmental services because of their instability and high transaction costs. In the United States, the federal government has run a number of programs since 1985 to support farmers who produce various environmental services on their land ranging from habitat to water purification—creating a federal market for the services. For example, the Wildlife Habitat Incentives Program (WHIP) pays farmers to develop and improve wildlife habitat, while the Wetlands Reserve Program (WRP) encourages the restoration of wetlands on farmland through cost-sharing and easements.³ Funding for these

1. In the rest of this Article, I refer to the unitary “farmer.” As many of the examples illustrate, however, the themes, proposals, and discussion of this Article address not only “farmers” in the restricted sense of the term, but also ranchers and silviculturalists.

2. See Taylor H. Ricketts et al., *Economic Value of Tropical Forests to Coffee Production*, 101 PROC. OF THE NAT'L ACAD. SCI. 12579 (2004) (finding that the preservation of small remnant forests as pollinator habitat helped significantly increase the quantity and quality of neighboring coffee production and was more valuable than alternative uses of the land).

3. For a general discussion of current and past programs to encourage farmers to produce

programs, however, has been unstable, because it depends on yearly congressional appropriations that have been notoriously uncertain. Additionally, the costs of learning about and then enrolling in each individual program are often large.⁴ The uncertainty and transaction costs have scared away many farmers who might otherwise have taken advantage of the programs. Finally, because robust markets have not existed, there has been a dearth of organizations able and willing to provide farmers with the technical, financial, and business expertise needed to identify and take advantage of the market opportunities that do exist; governmental technical assistance has also declined in recent years.⁵ This void has again increased the transaction cost to farmers of identifying and participating in market opportunities.

This does not mean that farmers never produce environmental goods and services absent market incentives. In many cases, today's farmers voluntarily improve habitat on their land, protect wetlands on their property, and take other important measures for which the market does not reward them, because of their own personal preferences for environmental amenities.⁶ Such measures, however, are not likely to reflect the full value that society places on the services. Indeed, as discussed below, the overall environmental record of farmers is poor.

This Article examines the opportunity to transform traditional farmers into EcoFarmers through private, philanthropic, and governmental markets. A growing number of ecologists, economists, and legal experts have recognized an emerging opportunity to transform agriculture by stressing the wider range of goods and services that farmers can provide.⁷ This Article takes a realistic look at this

environmental goods and services, see Craig Cox, *U.S. Agriculture Conservation Policy & Programs: History, Trends, and Implications*, in U.S. AGRICULTURAL POLICY AND THE 2007 FARM BILL 113 (Kaush Arha et al. eds., 2006).

4. See, e.g., JEFFREY A. ZINN, CONG. RESEARCH SERV., MANDATORY FUNDING FOR AGRICULTURAL CONSERVATION PROGRAMS 2 (Jan. 9, 2007) (noting importance of continual appropriations); Kaush Arha et al., *Conserving Ecosystem Services Across Agrarian Landscapes*, in U.S. AGRICULTURAL POLICY AND THE 2007 FARM BILL, *supra* note 3, at 207, 221 (noting the problem farmers have understanding the "vast and befuddling array of existing farm conservation programs").

5. See Arha et al., *supra* note 4, at 224 (noting the need for extension help from research institutions); Cox, *supra* note 3, at 134–36 (documenting and criticizing the reduction in governmental technical support).

6. Marc Ribaud et al., *Ecosystem Services from Agriculture: Steps for Expanding Markets*, 69 *ECOLOGICAL ECON.* 2085, 2086 (2010).

7. See, e.g., Wayt Gibbs, *How Should We Set Priorities?*, *SCI. AM.*, Sept. 2005, at 91; Rebecca L. Goldman et al., *Managing for Ecosystem Services on U.S. Agricultural Lands*, in U.S. AGRICULTURAL POLICY AND THE 2007 FARM BILL, *supra* note 3, at 97; J.B. Ruhl, *Agriculture and Ecosystem Services: Strategies for State and Local Government*, 17 *N.Y.U. ENVTL. L.J.* 424, 424 (2008) (urging state and local policies to promote what he labels the "multifunctional capacity of farms"); James Salzman, *A Field of Green? The Past and Future of Ecosystem Services*, 21 *J. LAND USE & ENVTL. L.* 133 (2006); James Salzman et al., *Protecting Ecosystem Services: Science, Economics, and Law*, 20 *STAN. ENVTL. L.J.* 309 (2001) (calling for the creating of markets to encourage the production of ecosystem services). In 2006, the Woods Institute for the Environment at Stanford University held a series of workshops to develop a new vision for federal farm policy, including prominently the production of ecosystem goods and services.

opportunity. Unlike traditional farmers, EcoFarmers would manage their land to maximize the overall benefit to society from the full range of goods and services that their land can produce. Farmers would no longer be just cultivation specialists. Instead, farmers would be multifaceted and holistic land managers, evaluating how to preserve, improve, and utilize their land to produce that mixture of goods and services providing the greatest societal benefit.

The transitioning of farmers to EcoFarmers has immense potential importance to society. As ecologists and economists have emphasized, “[a]griculture is by far the most important of the activities through which humanity interacts with the natural world.”⁸ Farmers are the world’s most significant land managers.⁹ Over a third of the land in the world is in agricultural use; that fraction rises to approximately half if one excludes the least productive lands (desert, boreal lands, rock, and ice).¹⁰ Farmland similarly constitutes almost half of all the land in the forty-eight contiguous states in the United States.¹¹ Thus, failing to maximize the value of the diverse goods and services that can be produced on farmland can have a sizable adverse impact on societal well-being.

If sufficiently profitable, EcoFarming also might help improve the economic health of farms and rural communities—a goal that Congress has long espoused.¹² EcoFarming could expand and diversify the goods and services that farms produce, increasing income streams and reducing the market risks of specializing in the production of one or more economically volatile crops. Farms themselves also depend on the continued flow of supportive ecosystem services such as pollination and climate regulation to grow crops and raise livestock,¹³ so efforts to increase the flow of those services could again be beneficial to the agricultural sector.

If successful and widespread, EcoFarming would reverse the traditional image of farmers as not simply environmentally agnostic but environmentally destructive. Farms in the United States are currently major sources of water

See U.S. AGRICULTURAL POLICY AND THE 2007 FARM BILL, *supra* note 3, at 207. In 2000, the European Community inserted a similar vision in its Common Agricultural Policy. See Thomas L. Dobbs & Jules N. Pretty, *Agri-Environmental Stewardship Schemes and “Multifunctionality,”* 26 REV. AGRIC. ECON. 220 (2004).

8. Geoffrey M. Heal & Arthur A. Small, *Agriculture and Ecosystem Services*, in 2 HANDBOOK OF AGRICULTURAL ECONOMICS 1341, 1343 (Bruce L. Gardner & Gordon C. Rausser eds., 2002).

9. Ribaudo et al., *supra* note 6, at 2086.

10. Virginia H. Dale & Stephen Polasky, *Measures of the Effects of Agricultural Practices on Ecosystem Services*, 64 ECOLOGICAL ECON. 286, 286 (2007).

11. Tim Kroeger & Frank Casey, *An Assessment of Market-Based Approaches to Providing Ecosystem Services on Agricultural Lands*, 64 ECOLOGICAL ECON. 321, 323 (2007).

12. An entire section of the farm bill is devoted to promoting rural development and economic health. See, e.g., Food, Conservation, and Energy Act of 2008, Pub. L. No. 110-246, Title VI—Rural Development, §§ 6001 et seq., 122 Stat. 1651, 1923–73 (2008) (codified as amended in scattered sections of 7 & 42 U.S.C.).

13. Heal & Small, *supra* note 8, at 1348; Kroeger & Casey, *supra* note 11, at 323.

pollution, air pollution, hazardous waste, and habitat destruction.¹⁴ Farmers, moreover, have consistently and often successfully fought efforts to bring their operations under many of the same environmental regulations that other businesses must meet.¹⁵ Although many environmental organizations are pushing for new legislation and regulations that would force farmers to better manage their lands, these efforts are likely to be only marginally successful in the near and intermediate terms. Although agricultural lobbies are less powerful than they once were, they are still powerful enough to kill off legislation they oppose. Most command-and-control regulations, furthermore, require regulated industries to meet specific standards but fail to spur new industry innovations that allow the standards to be surpassed. EcoFarming, by contrast, would create an incentive for innovation in the production of ecosystem services on agricultural land. Agriculture's poor historic environmental record is a vestige of the distorted incentives that current agricultural markets provide. One solution is therefore to design incentive systems that encourage farmers to consider all of the potential goods and services that their lands can provide.

Part II of this Article reviews the concept of ecosystem services that underlies EcoFarming and examines the attributes of services that make them either good or poor products for EcoFarmers. Some services lend themselves to markets or incentive programs more than other services. In particular, services most likely to generate private markets are those that constitute private (rather than public) goods, can be readily valued, are scarce, and cannot be readily replaced by substitutes. Services that are public goods but meet the other criteria are unlikely to support private markets but can still be the subject of efficient and effective governmental incentive programs. Services that meet none of the criteria are unlikely to support EcoFarming.

Part III investigates the various financial incentives that can drive demand for ecosystem services and thus reward landowners for producing these services, paying particular attention to the relative size, applicability, advantages, and disadvantages of each type of incentive. Private commercial markets are one source of demand, but as just mentioned, are unlikely to develop for services that are public goods. In the case of public goods, demand is likely to come from philanthropy (e.g., agricultural or conservation land trusts), ecolabeling (e.g., the United States Department of Agriculture's Organic label), direct governmental payments (e.g., WHIP or WRP), or governmental policies that drive third-party purchases of ecosystem services (e.g., carbon offset programs).

Part IV takes a critical look at the likely financial opportunity from specific

14. For an excellent summary of the environmental harms of current U.S. farming operations, see J.B. Ruhl, *Farms, Their Environmental Harms, and Environmental Law*, 27 *ECOLOGY L.Q.* 263 (2000). See also Heal & Small, *supra* note 8, at 1343 (detailing some of the major environmental harms from agricultural operations).

15. Ribaldo et al., *supra* note 6, at 2086; Ruhl, *supra* note 14.

services (e.g., energy production). The section examines the current status of markets for key services, as well as the opportunity for future growth in each market and, where future growth is possible, the policy steps needed both to grow the market and to allow a budding EcoFarmer to take advantage of it. As discussed, the most promising services from an economic perspective are the production of renewable energy, reduction or sequestration of greenhouse gases, provision of various hydrologic services (e.g., flood control or water quality), and creation or restoration of habitat for biodiversity.

Part V concludes with a brief but essential consideration of two important policy concerns regarding EcoFarming. The first is the fundamental baseline question of what level of environmental production should be expected or required of farmers as a matter of law rather than rewarded through private markets or other incentive systems. While EcoFarming is likely to improve the environmental condition of farmland, many people argue that farmers have an obligation to do so even without payments. Is EcoFarming unethical, or even worse, does it undermine political support for important regulatory programs? The second concern is that the agricultural sector will capture governmental programs supporting EcoFarming and lobby for payments even where farmers provide no net benefit to society. As discussed in Part V, biofuels are an example of this concern. Agricultural representatives have pushed to subsidize the broadest set of biofuels possible, even though the environmental effects of some are unclear and even potentially negative.

II. ECOSYSTEM SERVICES: THE BUILDING BLOCKS OF ECOFARMING

EcoFarming builds on the concept of ecosystem services—the recognition that ecosystems provide humans with a range of valuable goods and services through ecological functions and processes.¹⁶ Ecosystems can provide a wide range of valuable goods and services ranging from food to flood protection. Ecologists dub these collectively “ecosystem services.”¹⁷ Farms are simply a

16. For overviews of the concept of ecosystem services, see EPA SCI. ADVISORY BD., VALUING THE PROTECTION OF ECOLOGICAL SYSTEMS AND SERVICES (2009); NATURE'S SERVICES: SOCIETAL DEPENDENCE ON NATURAL ECOSYSTEMS (Gretchen C. Daily ed., 1997); Barton H. Thompson, Jr., *Ecosystem Services & Natural Capital: Reconceiving Environmental Management*, 17 N.Y.U. ENVTL. L.J. 460 (2008). Multiple definitions of ecosystem services exist. Thompson, *supra*, at 464 n.15. Among the most common are the “benefits human populations derive, directly or indirectly, from ecosystem functions” and, more simply, the “benefits people obtain from ecosystems.” Brendan Fisher et al., *Defining and Classifying Ecosystem Services for Decision Making*, 68 ECOLOGICAL ECON. 643, 645 (2009).

17. “Ecosystem service” has yet to become an everyday term. See, e.g., Thompson, *supra* note 16, at 468–69 (noting low use in the press). In the belief that part of the problem might be the term itself, some scientists and policy advocates have suggested alternative terms, including “environmental services,” “natural capital,” and “environmental amenities.” For varied name suggestions, see Robert Lalasz, *What Should We Call What Nature Provides Us?*, COOL GREEN SCIENCE: THE CONSERVATION BLOG OF THE NATURE CONSERVANCY (Jan. 22, 2010), <http://blog.nature.org/2010/01/nature>

managed ecosystem and, like natural ecosystems, can furnish a wide variety of ecosystem goods and services of significant value to society.¹⁸ These goods and services include food, fiber, timber, livestock, and energy, as well as water purification, flood protection, and aesthetic beauty.

Despite the significant societal value of most ecosystem services, commercial markets historically have rewarded landowners for producing only a small percentage of services. For example, commercial markets have encouraged farmers to produce food, fiber, timber, livestock, and—to a growing degree in recent years—energy. Private markets historically have not existed for the other services that farmland can produce. While governments sometimes have provided monetary incentives to produce some of these services (e.g., flood protection), the incentives often have been uncertain and limited in scope. Not surprisingly, farmers have focused on providing those services that commercial markets or governmental incentives encourage, to the general neglect of the other services their lands could provide.

This Part examines what other types of ecosystem services might support markets or incentive programs and thus help transform traditional farming into EcoFarming. As explained below, a number of key service characteristics are likely to be determinative. For example, services that are rival and excludable (what economists sometimes label “private goods”) can support markets, while all other services (public goods) typically will not generate markets absent government intervention. Neither private markets nor governments are likely to pay for services unless they are scarce and can be measured and at least roughly valued.

A. *The Millennium Ecosystem Assessment*

Before considering such attributes, however, it is worth looking first in more depth at what constitutes an ecosystem service and how ecosystem services have been faring. The most comprehensive study of ecosystem services was the Millennium Ecosystem Assessment, completed in 2005. With support from the United Nations, over 1,300 scientists spent five years studying the current state of ecosystem services around the world. The Millennium Ecosystem Assessment classified ecosystem services into four categories.¹⁹ *Provisioning services* are the consumptive goods that ecosystems can produce: food, fuel, fiber, genetic resources, biochemicals, and fresh water. *Regulating services* are those services that regulate the environment in which we live and make a healthful and productive life possible. Important regulating services include climate control, flood protection, pollination, and pest control. *Cultural services* are the elements of

ecosystem-services.

18. Kroeger & Casey, *supra* note 11, at 323.

19. MILLENNIUM ECOSYSTEM ASSESSMENT BD., ECOSYSTEMS AND HUMAN WELL-BEING: A FRAMEWORK FOR ASSESSMENT 56–60 (2003); *see also* Thompson, *supra* note 16, at 465–66 (providing an overview of ecosystem services).

ecosystems that contribute to people's cultural, spiritual, and aesthetic well-being, often by providing people with a sense of place. Finally, *supporting services* maintain ecological processes that are necessary to ensure the continued supply of provisioning, regulating, and cultural services. Important examples of these services include soil formation, habitat, biogeochemistry, and primary productivity.

The Millennium Ecosystem Assessment also examined how ecosystem services fared during the last half of the twentieth century.²⁰ The assessment concluded that over sixty percent of ecosystem services declined during this period, including such services as erosion regulation, water purification, and pollination.²¹ Only four ecosystem services increased in amount: crops, livestock, and aquaculture (all of which are readily marketable), as well as carbon sequestration (which is somewhat more surprising given the historic lack of a commercial market for sequestration, but reflects reforestation in significant parts of the northern hemisphere).²²

Farming during the second half of the twentieth century paralleled these trends. Farmers excelled at increasing the amounts of food, fiber, and livestock produced. At the same time, cropland expansion and agricultural intensification reduced water quality, increased downstream flood risks (as farmers filled wetlands and constructed levees and protections for their own lands), and destroyed habitat critical for pollinators and other species. In the latter part of this period, government regulation and a growing set of government payment systems helped reduce the loss of these ecosystem services in the United States and other developed nations, but the overall trend for the period was down.

B. *Ecosystem Services from an EcoFarming Perspective*

The four categories set out in the Millennium Ecosystem Assessment have become the most common categorization scheme for analyzing ecosystem services, although various other schemes have been suggested.²³ Unfortunately, the categories do not help in identifying which services could be of greatest interest to the prospective EcoFarmer or how best to structure public policy to promote EcoFarming. The answer to these questions depends on a better understanding of the ease or difficulty with which each service could become the subject of a market or governmental incentive system. While the four categories

20. MILLENNIUM ECOSYSTEM ASSESSMENT BD., ECOSYSTEMS AND HUMAN WELL-BEING: SYNTHESIS (2005).

21. *Id.* at 6.

22. *Id.* at 7.

23. See, e.g., Fisher et al., *supra* note 16, at 651–52 (calling for classification systems that are clear, relevant to the particular ecosystem under investigation, and keyed to the decision context); Ken J. Wallace, *Classification of Ecosystem Services: Problems and Solutions*, 139 BIOLOGICAL CONSERVATION 235, 240 (2007) (proposing a classification system that permits better assessment of the “consequences for human well-being of manipulating ecosystems”).

indirectly reflect some important economic considerations of relevance to farmers, they also obscure or confuse other considerations.

As economists have observed, for example, the Millennium Ecosystem Assessment mixes and confuses final goods and services, which directly contribute to human well-being and for which people are often willing to pay, with intermediate processes, which are merely a step in the overall production process.²⁴ For example, virtually none of the supporting services (e.g., biogeochemistry or primary productivity) are final goods and services for which people will pay, and they thus are unlikely to support ecosystem service markets. The EcoFarmer may care about the services because they are essential to producing other goods or services that will bring in revenue, but the services typically will not provide an opportunity in themselves to expand farming operations into new revenue streams.

Intermediate services might sometimes support a market. Where the EcoFarmer can offer a service that is a critical intermediate process for another economic producer, that producer might be willing to pay for the service. For example, providing habitat for pollinators is not a final consumer good or service, yet neighboring farmers might pay to support the habitat because of the importance of pollinators to their crops. Where final products are difficult to measure or attribute to the actions of any particular landowner, people or organizations also might be willing to pay for intermediate services that they assume will help ensure the final product that they want. Thus, governments sometimes pay farmers to restore or protect habitat for endangered species, not because the governments value the habitat per se (an intermediate process) but because the habitat helps protect the species (the final product).²⁵

In determining which ecosystem services might support EcoFarming and how governmental policy might promote their production, three characteristics are likely to be particularly important. The first characteristic is whether the good or service can be readily sold in a private commercial market (assuming adequate demand and an appropriate legal structure) or is, instead, a “public good.”²⁶ Most marketable goods are both “rival” (as one person consumes more of the good, there is less for others to consume) and “excludable” (the producer or owner can exclude others from using the good).²⁷ Many ecosystem services, however, are

24. See, e.g., JAMES BOYD & SPENCER BANZHAF, RESOURCES FOR THE FUTURE, WHAT ARE ECOSYSTEM SERVICES? THE NEED FOR STANDARDIZED ENVIRONMENTAL ACCOUNTING UNITS (2006) (criticizing the classification for mixing products, processes, and benefits); Kroeger & Casey, *supra* note 11, at 322 (same); Wallace, *supra* note 23, at 236 (criticizing the Millennium Ecosystem Assessment classification for mixing “processes (means) for achieving services and the services themselves (ends) within the same classification category”).

25. See *infra* note 72 and accompanying text (discussing WHIP).

26. See Kroeger & Casey, *supra* note 11, at 325 (concluding that the “public goods nature of many” ecosystem services is a principal reason for the lack of markets for such services).

27. Fisher et al., *supra* note 16, at 647.

neither rival nor excludable but instead “public goods.”²⁸ For example, if a farmer sequesters carbon on his or her land, the resulting benefit to global climate regulation is neither rival nor excludable. Everyone in the world will enjoy the benefit, and one person’s enjoyment of that benefit will not take away from others’ enjoyment of the benefit. Public goods such as carbon sequestration are unlikely to generate private commercial markets, absent government intervention, because each beneficiary has an incentive to free ride on other beneficiaries’ investments in producing the good, rather than paying for the good himself or herself.

To encourage farmers to produce public goods on their lands, either governments or philanthropies will typically need to step in. As explained in Part III, governments or philanthropies can directly pay farmers to produce such services. Governments also can create markets for public goods through regulatory programs. Carbon-offset programs are an example of a governmentally created market. The government creates a market for carbon sequestration by limiting the carbon emissions of industrial facilities but then agreeing to relax the limitations if a facility pays someone else to sequester carbon and thus offset the difference.

A second distinguishing characteristic among ecosystem services is measurability: the ease of determining how a particular farm-based action is likely to affect the quantity and monetary value of the service—and indeed whether such a determination is possible at all. Services that are difficult to measure and value are unlikely to lead to either markets or efficient incentive programs. Before paying a farmer to restore a wetland as habitat for migrating waterfowl, a conservation land trust will want to know the value of that habitat compared to other options; the government typically will not want to provide carbon offsets for a farmer who engages in conservation tillage to sequester carbon unless it can determine how much carbon will be sequestered.

Unfortunately, it is currently costly and difficult, and in some cases impossible, to (1) measure the change in the flow of specific ecosystem services as a result of particular on-farm activities, and (2) attach a monetary value to that change in flow.²⁹ “Ecological production functions” that link changes in farm management to changes in the flow of ecosystem services are missing or rudimentary for most ecosystem services.³⁰ Even where it is possible to calculate flow changes, such calculations often require careful and expensive investigations

28. See, e.g., Ribaudo et al., *supra* note 6, at 2086 (observing that “nearly” all ecosystem services are public goods).

29. See EPA SCI. ADVISORY BD., *supra* note 16, at 22–23 (noting that both biophysical measurement and monetary valuation are needed); Kroeger & Casey, *supra* note 11, at 325, 328 (same); Heal & Small, *supra* note 8, at 1366 (observing that variables must be measurable “at low cost, and without undue risk of tampering or fraud”).

30. See Dale & Polasky, *supra* note 10, at 287 (discussing the problem of measuring changes in the flow of services as a result of management efforts); Thompson, *supra* note 16, at 471–72 (same).

of local parameters, because ecosystems and ecosystem services are highly heterogeneous.³¹ For example, restoration of one wetland might significantly increase recreational value, but not restoration of another. Where commercial markets do not exist for particular goods or services, calculating an accurate market value for a change in the service flow also can be difficult, assuming that it is possible at all, because reliable commercial data for establishing a price is lacking.³² Values for many services are again highly localized, adding to the expense of determining an appropriate price.³³ The value of recreational opportunities, for example, might differ significantly between Northern California and North Dakota.

Determining the flow and market value of an ecosystem service is likely to grow easier over time. Both scientists and economists are working to find simpler and more accurate methods for determining the monetary values of ecosystem services produced by land-use management. Just as market demand helped to drive the monetization techniques and institutions that underlie today's market economy in commodified goods and services,³⁴ increased interest in ecosystem services is helping to drive improved techniques for measuring the value of these services as well. A cottage industry of researchers is currently working to develop new model-based systems for measuring the flow of ecosystem services from farms and other lands.³⁵ An example is the Natural Capital Project, which has developed a tool known as InVEST to model and map the delivery, distribution, and economic value of a suite of ecosystem services.³⁶ Nonetheless, even with significant measurement advances, some ecosystem services will remain more difficult to measure monetarily than others. For example, changes in hydrologic services such as the provision or purification of freshwater tend to be very site specific and therefore more difficult to predict or measure than changes in other ecosystem services such as carbon sequestration. Ecosystem services that consumers do not physically use, which includes virtually all cultural services, also tend to be more difficult to value monetarily.

Where accurate and precise valuation is impossible or more expensive to determine than a service is worth, private markets are very unlikely to arise.³⁷ Few

31. See EPA SCI. ADVISORY BD., *supra* note 16, at 33 (noting the problem of having to parameterize models to local conditions); Heal & Small, *supra* note 8, at 1366 (commenting on the heterogeneity of agriculture and the services that it can provide); Thompson, *supra* note 16, at 472 (noting the difficult task of parameterization).

32. See Thompson, *supra* note 16, at 472 (noting that economists use a variety of techniques for placing values on ecosystem services, some of which are more difficult to apply than others).

33. See Kroeger & Casey, *supra* note 11, at 324.

34. See Dale & Polasky, *supra* note 10, at 287.

35. See Kroeger & Casey, *supra* note 11, at 328.

36. See PETER KAREIVA ET AL., NATURAL CAPITAL: THEORY AND PRACTICE OF MAPPING ECOSYSTEM SERVICES (2011); Natural Capital Project—InVEST: Integrated Valuation of Ecosystem Services and Tradeoffs, <http://www.naturalcapitalproject.org/invest.html> (last visited Sept. 18, 2010).

37. See Kroeger & Casey, *supra* note 11, at 328.

private entities are likely to pay for a service if the value of that service is uncertain. Governments may still be willing to create incentive programs if they believe they have a sufficient sense of the value of the service, no matter how rough; governmental incentive programs generally do not demand high levels of accuracy. But even governmental incentive programs demand some ability to determine the value of the activity being encouraged. Measurement inaccuracies, moreover, make it more likely that government incentives will not accurately reflect the true value of the ecosystem service and thus either understimulate or overstimulate production of that service.

The final important difference among ecosystem services is the relative scarcity of and demand for each service. Viable markets for ecosystem services will arise only when the services become sufficiently scarce. Historically, the natural flow of many ecosystem goods and services was sufficiently ample that no one needed to pay landowners to support or produce them.³⁸ Even where ecosystem goods and services are scarce, their value will depend on the availability of substitutes. If substitutes are less expensive than the cost of maintaining and producing the services, no market will develop for the service. For example, pollination might be a valuable service, but farmers will not pay neighboring landowners to protect the habitat of pollinators if they judge that there are already sufficient pollinators in the area (i.e., the service is not in scarce supply) or if it is less expensive to hire a beekeeper to provide the service (i.e., a good substitute is available). The government is also unlikely to provide financial incentives in such situations.

38. *See id.* at 325.

Table 1
Ecosystem Goods & Services of Potential Interest to EcoFarming

Service	Is the Service a Public Good?	Ease of Valuing the Service	Likely Scarcity Value of the Service
Food	No	High	High
Fiber	No	High	High
Livestock	No	High	High
Timber	No	High	High
Energy	No	High	High
Carbon Sequestration	Yes	Medium	High
Water Purification	Yes	Low	Can be regionally high
Water Supply	No	Low	Can be regionally high
Flood Protection	Yes	High	Can be regionally high
Wildlife Habitat	Yes	Low	Can be regionally high
Erosion Protection	Yes	Medium	Can be regionally high
Pollination	Yes	Medium	Can be regionally moderate
Recreation (including hunting & fishing)	No	Medium	Generally low
Aesthetics	Yes	Low	Can be regionally moderate

Table 1 lists the major ecosystem goods and services for which a prospective EcoFarmer might receive compensation either through private compensation or governmental incentive programs, along with their defining characteristics. The table lists the goods and services in the approximate order of their likely income

value to the EcoFarmer. By evaluating each service for the characteristics described above, Table 1 also provides a rough sense of the likelihood that effective markets or other incentives will develop for each service. These characteristics help determine (1) whether a private market is possible in the service, and (2) how difficult it is likely to be to create any type of efficient incentive program, whether governmental or philanthropic. As discussed above, public goods are unlikely to support private markets absent the creation of new forms of exclusionary property rights in the service. Public goods will generally require governmental or philanthropic incentives to enable production by the EcoFarmer. Difficulty in measuring the flow or value of an ecosystem service will make it difficult to develop markets or optimal incentive programs, although governments or philanthropies may create an incentive program in any case. Not knowing the full value of carbon sequestration on farmland does not preclude the government from establishing a market that provides for some level of sequestration, but government incentives are less likely and, if they exist, less likely to be efficient. Finally, where scarcity is low or substitutes are inexpensive, neither markets nor incentive programs are likely to arise—nor would they benefit overall societal well-being.

III. MARKETS AND OTHER INCENTIVE SYSTEMS

In examining the prospects for EcoFarming and determining policies needed to support the transformation, it is also important to consider how farmers might be rewarded for producing a broader range of valuable goods and services. Purely private commercial markets will provide incentives for an important but limited segment of environmental services—increased energy production, and perhaps in some regions the provision of freshwater. Philanthropic organizations, such as The Nature Conservancy, may also support the production of some services, such as habitat preservation and management, where it aligns with the organization's mission, but that support is likely to be marginal and socially inadequate. Consumer demand for environmentally sustainable products may also encourage farmers, as a sidelight of their cultivation of crops and raising of livestock, to preserve and promote ecosystem services that are salient to the public and rewarded by certification or market programs. Government will have to develop markets for most of the new ecosystem services producible on farmland by creating mitigation markets, mandating purchases of the services, directly paying farmers to produce the services, or using tax policy to encourage private investments in the production of ecosystem services. Table 2 lists the potential categories of support for EcoFarming, along with examples of markets or programs in each category.

Table 2
Potential Sources of Demand for Agricultural
Production of Ecosystem Services

Source of Demand for Ecosystem Services	Examples
Private Commercial Markets	<ul style="list-style-type: none"> • Markets for biofuels and other renewable energy • Markets for hunting and fishing privileges on private land
Environmental Philanthropy	<ul style="list-style-type: none"> • Agricultural easements • Conservation easements
Ecolabels	<ul style="list-style-type: none"> • USDA Organic
Governmental Payments	<ul style="list-style-type: none"> • Conservation Security Program • Conservation Reserve Program (CRP) • Wildlife Habitat Incentive Program (WHIP) • Wetland Reserve Program (WRP) • National and state subsidies for biofuels
Tax Leverage	<ul style="list-style-type: none"> • Tax deductions for contributions of conservation or agricultural easements • Tax deductions for monetary contributions to land trusts or agricultural trusts
Governmental Mandates	<ul style="list-style-type: none"> • Surface Water Treatment Rule under the U.S. Safe Drinking Water Act • State Renewable Portfolio Standards
Governmental Mitigation or “Offset” Programs	<ul style="list-style-type: none"> • Wetlands mitigation and banking under the U.S. Clean Water Act § 404 • Water quality trading under the U.S. Clean Water Act • Habitat Conservation Plans under the U.S. Endangered Species Act • Agricultural offset programs under carbon cap-and-trade program

A. Private Commercial Markets

Many scientists and policy makers have hoped that increased understanding of ecosystem services would produce private commercial markets in which beneficiaries of services would voluntarily pay landowners to produce the services out of enlightened self-interest.³⁹ For example, cities might pay upstream landowners to protect and construct wetlands for water quality and flood protection; farmers might pay neighboring landowners to maintain habitat for pollinators; bird watchers might pay property owners to provide habitat for migrating bird species and for permission to come onto their land to see the birds. To help promote this vision of private ecosystem-service markets, the 2008 United States Farm Bill instructed the Secretary of Agriculture to “facilitate the participation of farmers, ranchers, and forest landowners in emerging environmental services markets” and created an Office of Environmental Markets in the Department of Agriculture; the Washington State government similarly passed a bill providing for a study of how ecosystem-service markets might promote increased conservation practices on agricultural land.⁴⁰

Private markets are likely to play an important role in supporting EcoFarming. An increasing number of farmers are taking advantage of markets for biofuels, wind production, and other renewable energy to increase and diversify their incomes.⁴¹ Cities and large water users have occasionally paid farmers and other landowners to produce hydrologic services of importance to the cities and water users (e.g., protection of water quality and reduction of downstream flood risks). Perrier-Vittel, for example, paid French farmers to manage their farmlands to protect water quality; Macquarie River Food & Fibre has paid Australian farmers to reforest their lands to mitigate salinity concerns; Napa Valley in California has paid land owners to restore wetlands to reduce flood risks; Quito, Ecuador has paid upstream farmers to protect the city’s water supply by improving land management; and hydropower companies have paid upstream landowners to reduce sediment loadings.⁴²

Private markets, however, also will play an inherently limited role. Significant commercial markets for potential EcoFarm products remain limited to those

39. Thompson, *supra* note 16, at 474–75.

40. Food, Conservation, and Energy Act of 2008 § 2709; Farm and Forest Land Preservation and Restoration Act, 2008 Wash. Sess. Laws 687; *USDA Office of Environmental Markets*, U.S. DEPT OF AGRIC., <http://www.fs.fed.us/ecosystemservices/oem/index.shtml/index.shtml> (last visited Sept. 19, 2010).

41. See, e.g., Ribaud et al., *supra* note 6, at 2085 (noting that markets for energy are well established).

42. RODNEY J. KEENAN, CTR. FOR APPLIED ECON. RESEARCH, UNIV. OF NEW SOUTH WALES, APPROACHES TO PROVIDING FOR MULTIPLE VALUES AND FUNCTIONS FROM FORESTS IN AUSTRALIA (2005); *Are You Being Served?*, *ECONOMIST*, Apr. 23, 2005, at 91; Kroeger & Casey, *supra* note 11, at 325 n.4; Sandra L. Postel & Barton H. Thompson, Jr., *Watershed Protection: Capturing the Benefits of Nature’s Water Supply Services*, 29 NAT. RES. F. 98, 101–05 (2005).

products for which private commercial markets have long existed: food, fiber, timber, livestock, and energy. Private water transactions have been local and isolated. None of the water transactions listed in the previous paragraph occurred as part of established commodity markets, which do not exist for water quality or flood protection. Instead, all of the transactions were local one-off agreements, in which interested parties negotiated specific terms responsive to local concerns and conditions. Such one-off agreements generally involve high transaction costs that limit their duplication elsewhere.

Governmental policies, moreover, have often driven the energy markets and water transactions that have arisen to date. As discussed later, governmental subsidies and renewable portfolio standards have undergirded and promoted the markets for renewable energy, including biofuels. Governmental policies also have encouraged United States cities to pay farmers near the sources of their water supplies to manage their lands to improve water quality. Many articles and books have pointed to New York City's efforts to protect two of its watersheds (the Delaware and Catskills) as an example of the type of voluntary market that could arise for hydrologic services.⁴³ Rather than pay six billion dollars in capital costs to filter its water supply, New York City instead invested one-and-a-half billion dollars to restore and protect its watershed, including paying farmers to improve their land management.⁴⁴ Yet New York City did not act voluntarily. The national Safe Drinking Water Act and EPA's "Surface Water Treatment Rule" required the city to choose between protecting its watershed and filtering its water.⁴⁵ Confronted by this choice, New York City naturally chose the least expensive option. Although some other major cities subject to the EPA rule have followed suit and protected their watersheds, very few cities in the United States are subject to the Surface Water Treatment Rule because they already filter their water, and few cities have voluntarily chosen to pay for upstream water quality services absent any governmental mandate.⁴⁶

Given the obstacles to private ecosystem-service markets discussed in Part II, the existence of *any* voluntary markets for ecosystem services other than for crops, livestock, and energy is more surprising than their relative dearth. As Table 1 shows, crops, livestock, and energy are the only ecosystem goods or services that meet the three principal requirements for robust markets—private goods, readily measurable value, and scarcity. As discussed earlier, most other ecosystem services, including water quality and flood control, are public goods. In some cases, dominant users of a particular service (e.g., the only major city in a

43. See, e.g., GRETCHEN C. DAILY & KATHERINE ELLISON, *THE NEW ECONOMY OF NATURE: THE QUEST TO MAKE CONSERVATION PROFITABLE* 61–86 (2002).

44. Postel & Thompson, *supra* note 42, at 104–05.

45. Thompson, *supra* note 16, at 480.

46. See *id.* at 477 (describing two separate studies of water suppliers in the western United States).

watershed with deteriorating water quality) might be willing to invest in protecting and promoting that service because they will receive virtually all the benefit of their investment (so free riding on others is not an option, and free riding by others is less of a concern). Even in these cases, however, the difficulty of estimating the value of the service may prove an insurmountable obstacle.⁴⁷

The lack of voluntary private markets for many important ecosystem services does not mean that EcoFarming is financially unsupportable. The difficulty of establishing voluntary markets instead highlights the importance of governmental policies in creating markets (as in the case of EPA's Surface Water Treatment Rule) or providing substitute incentives. Many noncommercial services are sufficiently valuable in specific regions that, if the government can help drive and support markets, those markets could be a valuable source of EcoFarming income. As in so many areas involving public goods, governmental support can be both useful and essential.

B. *Philanthropic Payments*

Two sets of philanthropic groups could provide a significant source of funding to the EcoFarmer. The first is agricultural land trusts. Beginning with the formation of the Marin Agricultural Land Trust in 1980, a growing number of agricultural land trusts across the nation have acquired agricultural easements on millions of acres of farmland and ranchland.⁴⁸ These easements provide farmers with funding that is sometimes critical to remaining in business, in return for which the farmer agrees not to develop the land for nonagricultural purposes. Currently, at least fifteen states both authorize agricultural easements and support such programs through bond funding, tax policy, or other mechanisms.⁴⁹

The value of existing agricultural easements in promoting ecosystem goods and services, however, is open to question. To date, the typical agricultural easement requires only that the land remain in agricultural operation; most do not require or encourage farmers to provide ecosystem services beyond traditional crops and livestock. Moreover, in choosing which lands to protect, agricultural land trusts have looked primarily at the quality of the land for traditional

47. Postel & Thompson, *supra* note 42, at 106–07 (describing the problems that the City of Santa Cruz had in placing an economic value on watershed protection); Thompson, *supra* note 16, at 477–78 (noting that water suppliers in California often cannot determine the value of investments in watershed protection).

48. See A NATIONAL VIEW OF AGRICULTURAL EASEMENT PROGRAMS: PROFILES AND MAPS—REPORT 1, at 8 (Alvin D. Sokolow & Anita Zurbrugg eds., 2003) [hereinafter AGRICULTURAL EASEMENT REPORT 1] (estimating that agricultural land trusts had preserved approximately 1.8 million acres as of the date of the study). For information regarding the Marin Agricultural Land Trust, see MARIN AGRIC. LAND TRUST, <http://www.malt.org/> (last visited Sept. 26, 2010); see also *A National View of Agricultural Easement Programs*, AMERICAN FARMLAND TRUST, <http://www.farmland.org/resources/national-view/default.asp> (last visited Sept. 26, 2010) (providing general information on agricultural easements).

49. AGRICULTURAL EASEMENT REPORT 1, *supra* note 48, at 8, 17–18.

agricultural productivity (e.g., soil quality); only a few have looked at the conservation or environmental value of the land—and then only as secondary factors.⁵⁰ For this reason, studies of agricultural-easement programs find that the programs have been very successful in keeping land in farming and redirecting urban growth, but have not reported any gains in ecosystem-service production.⁵¹ At least a few agricultural preservation groups, such as the American Farmland Trust, are growing increasingly interested in the opportunity for EcoFarming,⁵² but it is not clear whether that interest will translate into broader goals and mandates for agricultural easements.

A second set of more traditional conservation land trusts, such as The Nature Conservancy, Trust for Public Lands, Ducks Unlimited, and the Rocky Mountain Elk Foundation, have long used private and public funding to acquire conservation easements and fee interests to preserve natural landscapes and the ecosystem services that they provide.⁵³ Recognizing the limits of a conservation strategy focused exclusively on natural landscapes, such groups are increasingly paying farmers and other landowners to improve the conservation value of working landscapes.⁵⁴ Some conservation groups have even helped create and support for-profit companies that look for ways of raising cash crops, such as timber, while promoting environmental services such as biodiversity habitat. For example, Conservation Forestry, which works frequently with The Nature Conservancy, raises investment funds to engage in sustainable forestry practices while ensuring an attractive rate of return for its investors.⁵⁵

50. *Id.* at 19. According to a study of agricultural easements by the American Farmland Trust and University of California, the principal factors used in selecting easements in most programs were the agricultural quality of the land, followed by contiguity of the acreage to previously conserved land; other programs focused more on location or geography. A NATIONAL VIEW OF AGRICULTURAL EASEMENT PROGRAMS: HOW PROGRAMS SELECT FARMLAND TO FUND—REPORT 2, at 3 (Anita Zurbugg & Alvin D. Sokolow eds., 2006).

51. *See, e.g.*, ALVIN D. SOKOLOW, A NATIONAL VIEW OF AGRICULTURAL EASEMENT PROGRAMS: MEASURING SUCCESS IN PROTECTING FARMLAND—REPORT 4, at 3 (2006) (reporting on the successes of agricultural easements).

52. *See, e.g.*, *American Farmland Trust, Agriculture & Environment: Improving the Environment by Protecting Clean Air and Clean Water*, AMERICAN FARMLAND TRUST, <http://www.farmland.org/programs/environment/default.asp> (last visited Sept. 26, 2010) (discussing programs to promote environmental services on farmland).

53. *See* Barton H. Thompson, Jr., *Conservation Options: Toward a Greater Private Role*, 21 VA. ENVTL. L.J. 245, 254–55 (2002-2003) [hereinafter Thompson, *Conservation Options*] (describing philanthropic conservation); Barton H. Thompson, Jr., *Providing Biodiversity Through Policy Diversity*, 38 IDAHO L. REV. 355, 373 (2001-2002) [hereinafter Thompson, *Policy Diversity*] (same).

54. *See* Adina R. Rissman et al., *Conservation Easements: Biodiversity Protection and Private Use*, 21 CONSERVATION BIOLOGY 709 (2007) (noting that nearly half of the easements sampled in the authors' study were for working landscapes involving farming, ranching, or forestry).

55. *See, e.g.*, Press Release, The Nature Conservancy, Conservation Deal Promotes Sustainable Forestry, Recreation, and Private Ownership (April 9, 2009), available at <http://www.nature.org/our/initiatives/regions/northamerica/unitedstates/pennsylvania/newsroom/conservation-deal-promotes-sustainable-forestry-recreation-and-private.xml> (describing joint project of The Nature Conservancy and Conservation Forestry to provide for sustainable timber operations in Pennsylvania).

Even if conservation groups and agricultural land trusts increasingly support EcoFarming, however, such philanthropic support will inherently be of only marginal importance to the vast majority of farmers. Philanthropy depends on the selfless donations of private citizens, the beneficence of corporations hoping for good publicity, and governmental support. Private contributions will inherently fail to reflect the full value of the resulting ecosystem services to the donors, for at least two reasons. First, many citizens are simply unaware of the ecosystem services that benefit them; second, those that are aware will be tempted to free ride on others' contributions.⁵⁶ Business support will reflect the marketing value of the contributions, rather than the actual value of ecosystem services to society, and historically such contributions have constituted only a small fraction of the support received by land trusts in the United States.⁵⁷ Governmental support for land trusts has become increasingly important in recent years, but must deal with the same limitations in public budgets as other programs currently do.

Even if available funding were greater, the structure of philanthropy is not well suited to promoting EcoFarming. Successful EcoFarming requires continued innovation in maximizing socially valuable ecosystem services on farmland. However, the traditional tool of land trusts—the conservation easement—is better at preventing unwanted behavior such as development than at encouraging dynamic production of ecosystem services. Conservation easements historically have provided farmers with a single upfront payment, leading to a principal-agent problem in which the landowner has an incentive to cheat and the easement holder must engage in constant monitoring.⁵⁸ Although land trusts could switch to periodic contractual payments to encourage the continual provision of ecosystem services, farmers are unlikely to invest in the production of new ecosystem services unless they are assured a continued stream of payments over a sufficient length of time to amortize the necessary investments. Because of their heavy reliance on yearly donations and other funding, land trusts may not be able to generate the degree of funding reliability that the EcoFarmer will demand.

C. Consumer Demand for EcoFarming

In recent years, a number of efforts at ecolabeling have tried to use consumer preference for environmental sustainability to encourage more sustainable business practices.⁵⁹ The Marine Stewardship Council, for example,

56. Thompson, *Conservation Options*, *supra* note 53, at 255.

57. For example, in 2010, corporations provided only seven percent of the donations to The Nature Conservancy; by contrast, individuals and foundations provided thirty-four and thirty-three percent, respectively. See NATURE CONSERVANCY, 2010 ANNUAL REPORT 42 (2011), available at www.nature.org/media/annualreport/annualreport2010.pdf.

58. Dominic P. Parker, *Land Trusts and the Choice to Conserve Land with Full Ownership or Conservation Easements*, 44 NAT. RESOURCES J. 483, 498–99, 503–04 (2004).

59. Jay S. Golden et al., *Sustainable Product Indexing: Navigating the Challenge of Ecolabeling*, 15(3) ECOLOGY & SOC. 8 (2010); A. Banerjee & B.D. Solomon, *Eco-Labeling for Energy Efficiency and*

certifies seafood that has been caught sustainably; the Forestry Stewardship Council warrants the sustainable production of wood products; EPA's Energy Star program highlights electronic products that minimize energy use.⁶⁰ Consumers repeatedly report that they would prefer to purchase products that have been produced in an environmentally sustainable fashion, although the actual impact of ecolabeling on consumer and business behavior is still not clear.⁶¹ Ecolabeling of agricultural products could provide a mechanism for encouraging farmers to produce a broader and more balanced array of ecosystem services. An "EcoFarm" label could reward the joint production of traditional food crops with other ecosystem services.

One of the best known ecolabels in the United States today is the "USDA Organic Seal," which is a national label controlled by the U.S. Department of Agriculture.⁶² Because organic farming promotes the production of several important ecosystem services such as wildlife protection and improved water quality, the USDA Organic label could serve as a precursor for a broader EcoFarm label. However, despite gains in organic farming, only a very small percentage of agricultural land in the United States—half a percent in 2005—is certified organic.⁶³ Without evidence that consumers would pay significantly more for a broader EcoFarm label, ecolabeling is unlikely to encourage farmers to invest the additional sums needed to be true EcoFarmers.⁶⁴

D. Governmental Support

Given the inherent limitations of voluntary markets, philanthropy, and ecolabels in promoting EcoFarming, governmental support will be essential in creating adequate economic incentives. This is not surprising. Nor does it mean that EcoFarming is economically inefficient, producing less in economic benefits to society than it costs. As discussed in Part II, most ecosystem goods and services are public goods for which purely private markets will not work. And both philanthropy and labeling, as just described, generally fail to generate financial support equivalent to the social gains.

Sustainability: A Meta-Evaluation of U.S. Programs, 31 ENERGY POL'Y 109 (2003).

60. Golden et al., *supra* note 59, at 8–9.

61. *Id.* at 8 (reporting that ninety-five percent of surveyed U.S. consumers report that they would buy "green"); Katharina Sammer & Rolf Wüstenhagen, *The Influence of Eco-Labeling on Consumer Behaviour: Results of a Discrete Choice Analysis for Washing Machines*, 15 BUS. STRATEGY & ENVT. 185 (2006) (reporting on the results of a study of Swiss consumers).

62. See U.S. DEP'T OF AGRIC., AGRIC. MARKETING DIVISION, NATIONAL ORGANIC PROGRAM, <http://www.ams.usda.gov/AMSv1.0/getfile?dDocName=STELDEV3004446> (last visited Sept. 26, 2010) (describing the USDA organic label).

63. Ribaudo et al., *supra* note 6, at 2087.

64. The development of an effective ecolabel, moreover, can be complex and create perverse, unintended consequences if not carefully executed. See Golden et al., *supra* note 59, at 9–12 (describing the problems, including loss of biodiversity, created through the promotion of "shade coffee").

Government support can take multiple forms. As discussed below, the principal forms of support include direct payments, the use of tax deductions or credits to leverage philanthropic support for ecosystem services, and regulatory policies that create and stimulate markets for ecosystem services. The choice among these alternative governmental policies depends primarily on the political decision of who should ultimately pay for ecosystem goods and services. General taxpayers, for example, ultimately pay for direct support; most governmental policies that create markets place the burden on the shoulders of a regulated community; under tax deductions, taxpayers, and philanthropists share the cost. Different policies also can have differential appeal to farmers. For example, farmers may prefer to work with private groups rather than the government, in which case tax leverage of private donations to conservation groups may be preferable to direct government payments.⁶⁵

1. *Direct Governmental Payments*

Beginning with the 1985 Farm Bill, the United States has created a number of programs to compensate farmers for various actions that produce ecosystem services of value to society.⁶⁶ Early programs emphasized taking land out of production and managing the land instead for environmental benefits.⁶⁷ The Conservation Reserve Program (CRP), established under the 1985 Farm Bill, reduces sediment discharge into streams by providing farmers with an annual rental payment if, under ten-to-fifteen-year contracts with the U.S. Department of Agriculture, they take sensitive land out of production and establish permanent vegetative cover on the land.⁶⁸ Another program established under the 1985 bill, the Wetland Reserve Program (WRP), pays farmers to restore and protect wetlands on their property either for thirty years or in perpetuity.⁶⁹

While CRP and WRP focus on changing long-term land use, programs created under the 2002 Farm Bill encourage farmers to improve and actively

65. See Thompson, *Conservation Options*, *supra* note 53, at 306 (noting that private property owners often feel more comfortable working with nongovernmental organizations than with government).

66. See Arha et al., *supra* note 4, at 209–18 (summarizing major conservation programs of the U.S. Department of Agriculture); Thompson, *Policy Diversity*, *supra* note 53, at 366–67; Thompson, *Conservation Options*, *supra* note 53, at 271–72. “The 1985 Farm Bill accelerated the introduction of environmental concerns into agricultural policy and marked the beginning of what has become the most important development in agricultural conservation policy and programs since the New Deal—the transition from a focus on productivity-enhancing, agricultural-resource conservation with large ‘on-farm’ benefits to environmental management and improvement with large ‘off-farm’ benefits.” Cox, *supra* note 3, at 115.

67. Arha et al., *supra* note 4, at 208.

68. *Id.* at 213; Cox, *supra* note 3, at 117, 143; Mary Jane Angelo, *Corn, Carbon, and Conservation: Rethinking U.S. Agricultural Policy in a Changing Global Environment*, 17 GEORGE MASON L. REV. 593, 629–30 (2010).

69. Arha et al., *supra* note 4, at 213; Cox, *supra* note 3, at 145; Angelo, *supra* note 68, at 630.

manage their lands to promote environmental benefits.⁷⁰ The Environmental Quality Incentives Program (EQIP), for example, provides financial and technical assistance to farmers who wish to implement conservation practices on their land to enhance soil conditions, water quality, wetlands, and wildlife habitat, although the payments only offset costs and thus do not constitute an affirmative incentive.⁷¹ The Wildlife Habitat Incentives Program (WHIP) similarly offers financial cost-sharing and technical assistance, but no affirmative incentives, to farmers wishing to promote wildlife habitat on their land.⁷² The Conservation Security Program (CSP) goes a step further than these first two programs and pays farmers for ongoing stewardship of soil conservation and water quality.⁷³

The federal farm bill is not the only source of direct governmental payments for ecosystem services. Both the federal and state governments directly subsidize the production of some ecosystem services. For example, the federal government offers a number of subsidies to encourage the production of biofuels on agricultural land.⁷⁴ States often subsidize farm-based production of other forms of renewable energy, such as wind production or biomethane.⁷⁵

The United States also is not alone in paying farmers to produce ecosystem services. Australia, for example, has experimented with a “bush tender” program that rewards farmers for producing a broad array of ecosystem services on their land—in contrast to United States programs that often focus on single services.⁷⁶ Europe also pays farmers for the production of ecosystem services on their land.⁷⁷

70. Arha et al., *supra* note 4, at 208–09. The 2002 Farm Bill also marked a milestone in explicitly recognizing that the purposes of the new agricultural assistance programs were environmental. Cox, *supra* note 3, at 119.

71. Arha et al., *supra* note 4, at 213; Cox, *supra* note 3, at 119, 122, 142; Angelo, *supra* note 68, at 630–32.

72. Arha et al., *supra* note 4, at 213; Cox, *supra* note 3, at 122; Angelo, *supra* note 68, at 631–32.

73. Arha et al., *supra* note 4, at 213; Cox, *supra* note 3, at 122, 144. Other important federal programs that promote environmental management of agricultural land include the Agricultural Water Enhancement Program (which pays farmers to conserve water and improve water quality), the Conservation Stewardship Program (which pays for the adoption and maintenance of conservation activities), and the Agricultural Management Assistance Program (which provides both cost sharing and affirmative payments for farming measures that promote water management, water quality, and erosion control). See Angelo, *supra* note 68, at 631–32 (describing these and other programs).

74. See, e.g., PAUL FRISMAN, CONN. OFFICE OF LEGAL RESEARCH, BIODIESEL PRODUCTION SUBSIDIES (2005), available at <http://www.cga.ct.gov/2005/rpt/2005-R-0904.htm>.

75. See, e.g., OFFICE OF THE TEXAS COMPTROLLER, GOVERNMENT FINANCIAL SUBSIDIES, WINDOW ON STATE GOVERNMENT (2008), available at <http://www.window.state.tx.us/specialrpt/energy/subsidies/> (discussing Texas subsidies).

76. For information on Australia’s bush tender program, see *Bush Tender 2007*, QUEENSLAND MURRAY-DARLING COMMITTEE, <http://www.qmdc.org.au/projects/bush-tender-2007.html> (last visited Nov. 28, 2010).

77. See, e.g., Michael Hammel, *Environmental Integration into Agricultural Policy in the European Union*, in U.S. AGRICULTURAL POLICY AND THE 2007 FARM BILL, *supra* note 3, at 147 (describing agricultural programs in the European Union).

2. *Leveraging Private Payments Through Tax Policy*

Governments also use tax policy to both directly subsidize the production of ecosystem services and drive philanthropic markets for ecosystem services. As described earlier, agricultural and conservation land trusts encourage the production of ecosystem services through the acquisition of easements that prohibit development and, in some cases, require particular land-use practices. In some cases, the government effectively subsidizes the acquisition of such easements by giving tax deductions to farmers who donate easements to land trusts.⁷⁸

In other cases, however, governmental support leverages private funding of conservation easements and other land-use practices designed to protect and promote ecosystems. As noted earlier, the private funding that land trusts receive to buy easements and encourage land uses that promote ecosystem services is less than the easements' or actions' social value because of free-rider problems. Governments use their tax policies to help encourage larger private gifts to land trusts by giving tax deductions for such gifts.⁷⁹ In this situation, the government is not directly paying for the easements or land-use practices, but instead using its funds to encourage private individuals to increase their investments or gifts. Studies suggest that tax deductions are likely to increase gifts by more than the lost tax revenue, allowing governments to leverage the use of their limited financial resources to protect or promote ecosystem services.⁸⁰

3. *Governmentally Driven Markets*

Governmental policies also can create markets for ecosystem services.⁸¹ As discussed earlier, the national Safe Drinking Water Act, combined with EPA's Surface Water Treatment Rule, have driven the investments of New York City and other municipalities in protecting their watersheds. Climate policies, either existing or anticipated, are driving some utilities and other companies to invest in carbon sequestration on agricultural lands.

Two types of governmental policies can create ecosystem service markets. First, the government can mandate that particular entities invest in ecosystem services. EPA's Surface Water Treatment Rule, discussed earlier, is an example. Under that rule, EPA requires water suppliers that are not filtering water to invest in protecting their watersheds so that land in the watershed continues to produce

78. See Thompson, *Conservation Options*, *supra* note 53, at 274; Thompson, *Policy Diversity*, *supra* note 53, at 373–74.

79. See Thompson, *Conservation Options*, *supra* note 53, at 273–74; Thompson, *Policy Diversity*, *supra* note 53, at 373–74.

80. See Thompson, *Conservation Options*, *supra* note 53, at 274–75 (citing studies); Thompson, *Policy Diversity*, *supra* note 53, at 376.

81. See Thompson, *supra* note 16, at 479–85 (discussing the important role that government and law play in creating and promoting markets for ecosystem services).

high quality drinking water.⁸² State renewable-energy portfolio standards, which require electricity suppliers in a state to supply a set percentage of their power through renewable-energy sources, is another example of a governmental mandate driving a significant market for an environmental service.⁸³ Without renewable portfolio standards, the market for siting wind power and other sources of renewable energy on agricultural lands would be substantially smaller.

Governments also create markets for ecosystem services through mitigation or offset policies, in which regulated entities are permitted to engage in activities harmful to the environment in return for the entities' investment in other activities that offset the harm in full or part. Greenhouse gas offset programs are a prominent example. Under proposed global policies for "Reducing Emissions from Deforestation and Forest Degradation" (REDD), nations or companies obligated to reduce their greenhouse gas emissions by a set amount could partially meet their obligation by paying to protect forests that sequester carbon.⁸⁴ The principal climate bills that Congress considered in 2009 and 2010 would have permitted regulated entities to partially meet their carbon-reduction requirements by paying farmers to sequester carbon through no-till farming and similar actions.⁸⁵

Several existing mitigation programs already drive markets for the production of ecosystem services on agricultural lands. For example, wetland mitigation measures under section 404 of the Clean Water Act permit landowners, in limited situations, to modify wetlands on their own property in return for restoring or constructing wetland elsewhere.⁸⁶ Emerging water quality trading under the Clean Water Act allows some "point" sources of pollution such as factories to relax their emission discharge limitations by paying "non-point" sources to reduce their emissions instead.⁸⁷ Finally, the Endangered Species Act permits landowners to modify the habitat of endangered species, which otherwise would violate the Act's "taking" proscriptions, in return for individual or regional habitat conservation plans (HCPs) that take other actions to protect the species; these actions frequently include protection and enhancement of other habitat, including agricultural lands.⁸⁸ Endangered species laws also have generated local

82. 40 C.F.R. § 141.70-75 (2010).

83. See JAMES SALZMAN & BARTON H. THOMPSON, JR., ENVIRONMENTAL LAW AND POLICY 311-12 (3d ed. 2010) (summarizing the renewable portfolio standards existing in thirty of the fifty states).

84. See *id.* at 134 (providing a brief overview of REDD); MOVING AHEAD WITH REDD: ISSUES, OPTIONS, AND IMPLICATIONS (Arlid Angelsen ed., 2008).

85. SALZMAN & THOMPSON, *supra* note 83, at 170-71.

86. *Id.* at 278. See also J.B. Ruhl & R. Juge Gregg, *Integrating Ecosystem Services into Environmental Law: A Case Study of Wetlands Mitigation Banking*, 20 STAN. ENVTL. L.J. 365, 365-66 (2001) (providing an overview of wetland banking programs).

87. SALZMAN & THOMPSON, *supra* note 83, at 170-71.

88. Barton H. Thompson, Jr., *Managing the Working Landscape*, in 1 THE ENDANGERED SPECIES ACT AT THIRTY: RENEWING THE CONSERVATION PROMISE 101 (Dale D. Goble et al. eds., 2005).

markets for habitat through so-called “conservation banks.”⁸⁹

IV. ECOFARMING OPPORTUNITIES

EcoFarming in theory could involve the production of any ecosystem good or service. In practice, a small number of ecosystem goods and services are likely to provide the greatest financial opportunity and thus attract the most attention from EcoFarmers. These include (in addition to traditional crops and livestock) energy production, carbon sequestration, various hydrological services (with the greatest opportunity probably coming from water quality and flood protection), and biodiversity habitat. This Part examines the opportunities that each of these services or goods is likely to offer in the near future, as well as obstacles to developing effective markets for these services and goods, and potential policy steps to address them.

EcoFarmers will also manage their lands for other services or goods. Many farmers in the United States, for example, have long opened their lands to commercial hunting, fishing, camping, or other forms of recreation, and a small percentage charge a fee for such use.⁹⁰ In many cases, paid recreational use has enabled farmers to remain in business despite downturns in crop or livestock prices.⁹¹ Hunting, fishing, and other forms of direct recreational use meet the criteria for private goods (rival and excludable) and are thus well-suited to market payments. States, moreover, have sometimes supplemented private recreational revenue by paying farmers for public access rights across their lands for hunting, fishing, or other purposes.⁹² Payments for recreational use of agricultural land, however, are likely to remain small compared to the revenue that farmers might earn from the ecosystem services or goods discussed in the remainder of this section.⁹³

89. Jessica Fox et al., *Conservation Banking, in 2 THE ENDANGERED SPECIES ACT AT THIRTY: CONSERVING BIODIVERSITY IN HUMAN-DOMINATED LANDSCAPES* 228 (Dale D. Goble, J. Michael Scott & Frank W. Davis eds., 2006) (providing an overview of conservation banking programs).

90. See JOHN D. COPELAND, *RECREATIONAL ACCESS TO PRIVATE LANDS: LIABILITY PROBLEMS AND SOLUTIONS* (2d ed. 1998), available at http://www.nationalaglawcenter.org/assets/articles/copeland_recreationalaccess.pdf; Ribaudo et al., *supra* note 6, at 2087 (citing a 1993 study finding that seventy-seven percent of farmers permit hunting but only five percent charge for the opportunity, and citing a 2007 study finding that only one to two percent of farmers receive income from recreational activity).

91. COPELAND, *supra* note 90, at 10.

92. See, e.g., Doug Huddle, *Outdoors: Record Revenue Leads to More Hunting Access*, BELLINGHAM HERALD, Aug. 12, 2010 (describing Washington State program to dedicate \$400,000 toward access agreements between the state and private landowners for hunting).

93. See, e.g., W. Aaron Jenkins et al., *Valuing Ecosystem Services from Wetlands Restoration in the Mississippi Alluvial Valley*, 69 *ECOLOGICAL ECON.* 1051, 1057 (2010) (concluding that, of a potential total of \$1035 per hectare that farmers in the Mississippi alluvial valley could raise from the ecosystem services created by restored wetlands, only fifteen dollars would come from recreational fees).

A. Renewable Energy

Renewable energy presents a substantial opportunity for agriculture. Like crops and livestock, energy is a private (rather than public) good and can be readily valued in the marketplace (see Table 1). Indeed, biofuels are merely a crop grown for energy rather than for food or fiber. Renewable energy also promises sizable revenue in the long run, although most forms of renewable energy are not currently cost competitive and thus require public subsidies or other incentive programs for short-term viability.⁹⁴ In the last decade, renewable energy was one of the fastest growing sectors in the United States economy.⁹⁵ As Table 3 illustrates, the states with the largest amounts of farmland are also often the states that today produce the greatest amount of renewable energy—suggesting significant overlap between local support and demand for renewable energy and the size of a state’s agricultural sector. Of the sixteen states with over twenty-five million acres in cultivation, twelve of them rank in the top third of states for current renewable-energy generation. Given the potential opportunities, many farmers and ranchers are already taking advantage of federal and state subsidies and incentives to produce renewable energy.

94. See SALZMAN & THOMPSON, *supra* note 83, at 309 (noting that renewable energy currently costs significantly more than fossil fuel).

95. See 25x’25, MEETING THE GOAL: A PROGRESS REPORT 3 (2010), *available at* <http://www.infrastructureusa.org/wp-content/uploads/2010/07/25x25progressreport1.pdf> (noting that U.S. renewable energy grew by almost twenty-five percent from 2004 through 2009 and now surpasses the nuclear power sector in total energy produced).

Table 3
States with Over 25 Million Acres of Farmland in 2007

State	Farmland Ranking ⁹⁶	Ranking by Current Renewable Generation ⁹⁷	Ranking by Wind Energy Potential ⁹⁸
Arizona	15	14	24
California	16	2	18
Colorado	9	19	12
Illinois	14	29	14
Iowa	10	10	7
Kansas	3	33	2
Minnesota	13	12	10
Missouri	12	36	13
Montana	2	9	5
Nebraska	4	47	3
New Mexico	6	40	11
North Dakota	7	22	6
Oklahoma	8	15	9
South Dakota	5	20	4
Texas	1	5	1
Wyoming	11	31	8

Farms and ranches can profit from the production of a wide variety of renewable energy sources, including crop-based biofuels (ranging from the current generation of corn-based ethanol to future cellulosic fuels), biopower from the burning of biomass or from biodigestors, geothermal, hydroelectric, solar (including photovoltaic, solar-thermal heating, and large-scale solar), and wind.⁹⁹ Of these sources, biofuels, biopower, and wind currently offer the greatest potential to farmers. Neither geothermal nor hydroelectric production is growing

96. Rank in total acres devoted to farming operations. Table shows only those states with more than twenty-five million acres in farms in 2007. Source: U.S. DEPT OF AGRIC., NAT'L AGRIC. STATISTICS SERV., 2007 CENSUS OF AGRICULTURE, VOL. 1, CH. 2, TABLE 8.

97. Rank by total renewable net generation. States with grey shading are those states in the top third of all U.S. states for current renewable net generation. Source: U.S. DEPT OF ENERGY, ENERGY INFO. ADMIN., STATE RENEWABLE ELECTRICITY PROFILES (2009), *available at* http://www.eia.doe.gov/cneaf/solar.renewables/page/state_profiles/r_profiles_sum.html.

98. Rank by annual generation capacity of wind within each state. States with grey shading are those states in the top third of all U.S. states for wind generation capacity. Source: NAT'L RENEWABLE ENERGY LAB., ESTIMATES OF WINDY LAND AREA AND WIND ENERGY POTENTIAL BY STATE FOR AREAS >= 30% CAPACITY FACTOR AT 80M (2010), *available at* http://www.windpoweringamerica.gov/pdfs/wind_maps/wind_potential_80m_30percent.pdf.

99. STEPHEN HERBERT ET AL., UNIV. OF MASS. EXTENSION, RENEWABLE ENERGY PRODUCTION ON FARMS (n.d.), *available at* <http://www.umass.edu/cdl/BMPs/RenewableEnergyProd.onFarms09-54.pdf> (last visited Nov. 14, 2010).

rapidly, and both depend on highly localized sources of energy.¹⁰⁰ The solar sector is growing more rapidly than any other energy sector except wind,¹⁰¹ but the footprint for large-scale solar is sizable and could require farmers to dedicate significant amounts of agricultural land to solar facilities and away from crops.¹⁰² The remainder of this section therefore focuses on biofuels, biopower, and wind energy.

1. *Biofuels and Biopower*

The Union of Concerned Scientists estimates that a tripling in use of biomass in the United States could bring twenty billion dollars in additional income to farmers and rural communities, while significantly reducing emissions of greenhouse gases.¹⁰³ Of the various biomass options, ethanol has received the greatest attention in recent years, in part because ethanol is currently the only competitive option to petroleum in powering motor vehicles.¹⁰⁴ The federal government has strongly pushed ethanol production over the last decade. The federal government has directly subsidized the production of ethanol through tax credits.¹⁰⁵ The United States also has adopted renewable fuel standards requiring increased use of ethanol.¹⁰⁶ States have used tax policy and renewable fuel standards to promote the local use and production of ethanol.¹⁰⁷ As a result, production of corn-based ethanol tripled from 2004 to 2009—served by approximately 200 biorefineries and blended into about eighty percent of the nation's gasoline.¹⁰⁸

100. For discussions of geothermal and hydroelectric outlooks, see 25x'25, *supra* note 95, at 16–18.

101. *See id.* at 7, 14 (solar grew forty-one percent from 2004 to 2009).

102. For a discussion of the potential for solar production on farms, see UNION OF CONCERNED SCIENTISTS, FACT SHEET: UP WITH THE SUN: SOLAR ENERGY AND AGRICULTURE (n.d.), available at http://www.ucsusa.org/assets/documents/clean_energy/agfs_solar_2003.pdf (last visited Nov. 14, 2010). Some companies are now examining whether solar panels might potentially aid agriculture by shading crops that favor less sunlight. *See, e.g.*, Susan DeFreitas, *Solar Panels to Shade Organic Crops*, EARTH TECHLING (Sept. 26, 2011), <http://www.earthtechling.com/2011/09/solar-panels-to-shade-organic-crops>.

103. UNION OF CONCERNED SCIENTISTS, FACT SHEET: GROWING ENERGY ON THE FARM: BIOMASS ENERGY AND AGRICULTURE (n.d.), available at http://www.ucsusa.org/assets/documents/clean_energy/agfs_biomass_2003.pdf (last visited last Nov. 14, 2010).

104. *See* SALZMAN & THOMPSON, *supra* note 83, at 309 (noting that biofuels can be used in internal combustion engines and thus do not require major transformations in automobiles).

105. OFFICE OF SEN. MARIA CANTWELL, COMPREHENSIVE GUIDE TO FEDERAL BIOFUEL INCENTIVES (2006), available at http://cantwell.senate.gov/services/biofuels/comprehensive_guide_to_federal%20biofuel_incentives.pdf.

106. Renewable fuel standards under the Energy Independence & Security Act of 2007 require the annual production of thirty-six billion gallons of renewable fuels by 2022. Daniel de la Torre Ugarte et al., ANALYSIS OF THE IMPLICATIONS OF CLIMATE CHANGE AND ENERGY LEGISLATION TO THE AGRICULTURAL SECTOR 1 (2009), available at http://beag.ag.utk.edu/pp/ut_climate_energy%20report_25x%2725Nov30.pdf. *See also* AMERICAN COUNCIL ON RENEWABLE ENERGY, AN OVERVIEW OF THE U.S. RENEWABLE ENERGY FIELD IN 2009 8 (2009).

107. *See, e.g.*, FRISMAN, *supra* note 74; SALZMAN & THOMPSON, *supra* note 83, at 312–13.

108. 25x'25, *supra* note 95, at 9.

Corn-based ethanol, which is the principal form of ethanol currently produced in the United States, has attracted significant criticism. Scientific and economic studies have questioned whether the use of corn-based ethanol in place of petroleum reduces greenhouse gases, while attacking corn-based ethanol for its actual and potential impacts on world food prices, conservation, local air pollution, and water resources.¹⁰⁹

Research is underway, however, on new generations of ethanol that scientists believe will reduce greenhouse gas emissions and carry fewer negative environmental and social side effects than corn-based ethanol. Cellulosic ethanol, produced from fast-growing switch grass or crop residuals, holds the greatest promise, both for reducing greenhouse gas emissions and for providing a significant source of additional income for farmers.¹¹⁰ The Oak Ridge National Laboratory estimates that ethanol produced from switch grass could increase net farm income across the United States by almost six billion dollars, while cellulosic ethanol produced from leftover corn stover and wheat straw could add an additional two billion dollars.¹¹¹ The Union of Concerned Scientists believes that farmers could also harvest energy crops for cellulosic ethanol on land managed for other environmental benefits under federal conservation programs such as the Conservation Reserve Program—thus providing multiple ecosystem services simultaneously.¹¹² Cellulosic ethanol, however, is still in an early research phase and thus currently costs substantially more than either corn-based ethanol or petroleum.¹¹³

Ethanol is not the only biofuel of potential interest to farmers. Biodiesel, for example, also holds promise as an area of potential agricultural income growth. Spurred by a focused federal tax credit, the biodiesel industry enjoyed exponential growth for part of the last decade, but collapsed when the tax credit expired.¹¹⁴ Biomethane similarly offers a substitute for methane that can be used either to generate electricity or as vehicle fuel. Manure from dairy farms or other

109. See KRISTINA E. PHIPPS ET AL., THE OPPORTUNITIES AND RISKS OF LARGE-SCALE PRODUCTION OF BIOFUELS (2007), available at [http://woods.stanford.edu/docs/biofuels/Biofuels Commentary.pdf](http://woods.stanford.edu/docs/biofuels/Biofuels%20Commentary.pdf) (discussing the challenges posed by corn-based ethanol). A collection of papers regarding the potential problems of corn-based ethanol can be found at *Biofuels Workshop*, WOODS INST. FOR THE ENV'T, <http://woods.stanford.edu/ideas/biofuels/results.html> (last visited Nov. 14, 2010); see also Rosamond L. Naylor et al., *The Ripple Effect: Biofuels, Food Security, and the Environment*, 49 ENV'T 30 (2007) (discussing the potential impacts of biofuels on food prices).

110. 25x'25, *supra* note 95, at 10; SARAH BRECHBILL & WALLACE E. TYNER, PURDUE EXTENSION, THE ECONOMICS OF RENEWABLE ENERGY: CORN STOVER AND SWITCHGRASS (2008), available at <http://www.extension.purdue.edu/extmedia/ID/ID-404.pdf>.

111. UNION OF CONCERNED SCIENTISTS, *supra* note 103 (describing the study by Oak Ridge National Laboratory, based on price of less than \$40 per dry ton delivered of either switch grass or corn stover/wheat straw).

112. *Id.* (noting that a co-op in Iowa is currently using CRP land to grow switch grass for a local power plant).

113. Naylor et al., *supra* note 109, at 34.

114. 25x'25, *supra* note 95, at 10.

agricultural operations can be used to generate biomethane-producing power as well as reducing emissions of methane (a potent greenhouse gas) and improving local water quality.¹¹⁵ Both the U.S. Department of Agriculture and local governments have actively promoted biomethane, although the current level of production remains low.¹¹⁶

The major obstacle to the growth of biofuel production is cost. No biomass-based fuel is currently cost competitive with fossil fuels. Given current technology and processes, for example, ethanol is not competitive with petroleum unless the price of oil rises substantially.¹¹⁷ Part of the reason is the significant subsidy the federal government currently provides to fossil fuels.¹¹⁸ More importantly, biofuels are still in their infancy; like all renewable fuels, costs are still quite high compared to theoretical cost levels and almost certainly will decline over time.¹¹⁹

At least three policies can help speed the growth of the biofuel market. First, the federal government can help ensure that biofuels are not at an unwarranted cost disadvantage by reducing the current subsidy advantage given to fossil fuels, ensuring that fossil fuel prices reflect pollution costs, and helping to defray the costs of new infrastructure needed to produce, distribute, and use biofuels. Second, to promote use in early stages of development, the federal and state government can mandate increased use of biofuels through renewable fuel standards.¹²⁰ Finally, the government can subsidize or otherwise help finance basic research and development for new biofuels, recognizing that research is generally underfunded in the private market.¹²¹ The government has taken steps along all three of these lines,¹²² although the government's policies have shifted over time, creating uncertainty about long-term governmental support and thereby undermining longer-term investments.

115. See John Addison, *Biomethane for Energy and Fuel*, CLEANTECH BLOG (June 25, 2009), <http://www.cleantechblog.com/2009/06/biomethane-for-energy-and-fuel.html> (describing the potential benefits of biomethane).

116. *Id.*

117. YANG JUN ET AL., GLOBAL IMPACT PATHWAYS OF BIOFUELS AND (ON) THE POOR (n.d.), available at <http://www.berkeleybioeconomy.com/wp-content/uploads//2011/04/Rozelle.pdf> (last visited Oct. 13, 2011).

118. See SALZMAN & THOMPSON, *supra* note 83, at 310 (noting that the subsidies provided to fossil fuels are approximately two-and-one-half times those provided to the renewable sector).

119. See, e.g., Naylor et al., *supra* note 109, at 34 (discussing the current cost disadvantages of cellulosic ethanol).

120. See SALZMAN & THOMPSON, *supra* note 83, at 312 (describing California's adoption of a low-carbon fuel standard, and noting the increasing interest among other states in adopting a similar standard). Renewable fuel standards, however, require careful design in order to avoid perverse effects. *Id.* at 313.

121. See, e.g., *id.* at 311 (noting that private markets do not provide an optimum level of energy research).

122. See, e.g., News Release, U.S. Dept. of Agric., Agriculture Secretary Vilsack Showcases New Energy Opportunities for Rural America, Visits Pennsylvania Biofuels Producer (May 7, 2010), available at <http://www.usda.gov/wps/portal/usda/usdahome?contentidonly=true&contentid=2010/05/0236.xml> (listing key energy provisions of the federal Farm Bill making funds available to support biofuel production).

2. *Wind Energy*

The production of wind energy also promises significant revenue in broad regions of the United States. Wind energy is the fastest expanding of the renewable energy sectors, growing 1000% during the 2000s.¹²³ Wind constituted over a third of new power installations in 2009.¹²⁴ Wind energy, moreover, could ultimately provide a high percentage of the total electricity used in the United States.¹²⁵

Wind production is likely to be a particularly attractive source of revenue for many farmers. As Table 3 shows, there is an exceptionally high correlation between states with sizable agricultural economies and states with large wind potential. The same flat terrain that characterizes much of the best farmland in the United States also provides favorable conditions for wind production. Of the sixteen states with over twenty-five million acres of farmland, fourteen of them are among the third of the states with the greatest potential for wind-energy production. Conversely, the twelve states with the greatest wind potential all have sizable amounts of farmland. Wind energy also requires a relatively small footprint,¹²⁶ making it compatible with growing crops or raising livestock and allowing farmers to bring in additional income with little if any sacrifice to their traditional business.

Wind developers offer a variety of types of revenue to farmers willing to locate turbines on their land, including up-front payments, fixed annual lease payments, and a share in wind revenue.¹²⁷ Studies have found that the income from wind production can provide a significant source of farm income and outweigh any losses in farming income from the land lost to production.¹²⁸ Yearly royalties for wind production currently range from two thousand to ten thousand dollars per turbine.¹²⁹

Like biofuels, wind is still more expensive than alternative fossil-fuel options, although the cost of wind has fallen rapidly and is expected to continue to decline.¹³⁰ So long as wind remains at a cost disadvantage to fossil fuels,

123. SALZMAN & THOMPSON, *supra* note 83, at 308; *see also* UNION OF CONCERNED SCIENTISTS, FACT SHEET: FARMING THE WIND: WIND POWER AND AGRICULTURE (n.d.), available at http://www.ucsusa.org/assets/documents/clean_energy/agfs_wind_2003.pdf (last visited Nov. 14, 2010) (noting that wind power is the fastest-growing energy source in the world).

124. *See* 25x'25, *supra* note 95, at 12 (thirty-nine percent of new power installations in 2009 were wind facilities).

125. *See, e.g.*, Mark Z. Jacobson & Mark A. Delucchi, *A Path to Sustainable Energy by 2030*, SCI. AM., Nov. 2009, at 58 (describing the potential for wind energy); UNION OF CONCERNED SCIENTISTS, *supra* note 103 (noting that wind could produce five times more electricity than the United States currently uses).

126. *See* UNION OF CONCERNED SCIENTISTS, *supra* note 103 ("Large wind turbines typically use less than half an acre of land, including access roads, so farmers can continue to plant crops and graze livestock right up to the base of the turbine.").

127. *Id.*

128. 25x'25, *supra* note 95, at 11.

129. PATRICK MAZZA, COMMUNITY WIND 101: A PRIMER FOR POLICYMAKERS 4 (2008), available at http://www.ef.org/docs/CommWind_web.pdf.

130. *See* UNION OF CONCERNED SCIENTISTS, *supra* note 103 (noting that the cost of

government assistance and mandates will remain necessary to promote greater development of wind power in rural areas. The government already has funded a variety of programs, including the federal Department of Energy's Wind Powering America initiative.¹³¹ The Union of Concerned Scientists estimate that this initiative alone could bring sixty billion dollars in capital investment to rural America and over one billion dollars in new income to farmers and other rural landowners.¹³²

Wind farms also face a variety of other obstacles. First, with some exceptions, major wind areas are far from major population centers,¹³³ and most lack high-voltage transmission lines connecting them to cities and other major centers of demand.¹³⁴ To recognize the full potential of wind energy, new transmission lines will therefore be needed. Second and equally problematic, wind energy is intermittent, reducing its current value as an energy source.¹³⁵ Until large-scale energy storage becomes possible, wind power will remain in a purely supportive role. Finally, wind energy faces various environmental concerns, including potential harm to birds and aesthetics.¹³⁶

Community wind programs, in which groups of rural landowners develop collaborative projects to furnish local energy, provide an alternative means of promoting wind energy in those regions that are distant from major cities.¹³⁷ One study by the National Renewable Energy Laboratory found that local economic benefits from a community wind program can be several times larger than the benefits from standard corporate wind projects.¹³⁸ Unfortunately, community wind programs also can suffer from diseconomies of scale, and federal and state programs designed to promote wind energy are designed with large-scale commercial programs in mind, so that community wind programs often do not qualify.¹³⁹

B. *Reduced Climate Risks*

Another major business opportunity in the future for EcoFarming may be in sequestering carbon or reducing emissions of major greenhouse gases such as methane and nitrous oxide.¹⁴⁰ The current opportunity for profiting from climate-

producing wind power has dropped 90% since 1980).

131. *See Wind Powering America*, U.S. DEPT. OF ENERGY, www.windpoweringamerica.gov.

132. UNION OF CONCERNED SCIENTISTS, *supra* note 103.

133. SALZMAN & THOMPSON, *supra* note 83, at 308.

134. 25x'25, *supra* note 95, at 4, 14.

135. SALZMAN & THOMPSON, *supra* note 83, at 308.

136. *Id.*

137. *See* MAZZA, *supra* note 129 (describing community wind programs).

138. *Id.* at 4.

139. *See id.* at 5 (describing the difficulties in using existing governmental incentive programs for community wind programs).

140. *See, e.g.*, Benjamin M. Gramig, *Greenhouse Gas Emissions Offsets from Agriculture: Opportunities and Challenges*, in ADAPTING AGRICULTURE TO CLIMATE CHANGE 179, 181, available at <http://nabc>

mitigation practices is limited, largely because of Congress's failure through 2011 to pass major climate legislation that would drive a market for agricultural actions. However, the market is likely to grow over time as states and regions adopt climate mitigation programs and, if the United States ultimately adopts a strict regulatory program that permits agriculture to play a major role in reducing and sequestering greenhouse gas emissions, the financial opportunity could be substantial.

Offset programs will be the principal source of opportunity. Most climate-mitigation regulation, both actual and proposed and both domestic and overseas, requires various entities, such as power plants or factories, to reduce their emissions of carbon dioxide and other greenhouse gases, but typically exempts agriculture from direct regulation. However, most climate mitigation programs generally allow regulated entities to meet their reduction requirements by paying nonregulated entities such as farmers either to reduce their emissions or sequester greenhouse gases. The regulated entities can then offset their own reduction requirements by the amounts that the nonregulated entities have either reduced or sequestered the relevant gases. Most regulatory programs, in short, create offset markets for greenhouse gas reductions and sequestration.¹⁴¹

The American Clean Energy and Security Act (ACES) (also known as the Waxman-Markey bill), which the House of Representatives passed in June 2009, illustrates the opportunity.¹⁴² ACES would not have regulated agricultural emissions of greenhouse gases, but provided for offsets from a variety of activities including agricultural practices. The bill specifically listed tillage, crop covers, fertilizer reductions, and the capture and combustion of biogas as potential sources of offsets.

All climate programs require that offsets meet at least three requirements: verifiability, additionality, and enforceability.¹⁴³ Offsets are "verifiable" if scientific techniques exist to quantify the amount of carbon equivalents that are offset by a particular action.¹⁴⁴ Offsets are "additional" if farmers would not have engaged in the specific activity if it had not been for the offset program; some mitigation programs go a step further and require that there be no other incentive to engage

.cals.cornell.edu/pubs/nabc_21/nabc21_module4_gramig.pdf (proceedings of a conference at Univ. of Saskatchewan, June 24-26, 2009) (noting that agriculture, along with forestry, is one of the "most commonly considered sources of offsets").

141. See SALZMAN & THOMPSON, *supra* note 83, at 141-43 (describing proposed U.S. cap-and-trade programs, including the role of offsets).

142. See JULIA OLMSTEAD, INSTITUTE FOR AGRICULTURE AND TRADE POLICY, U.S. CLIMATE POLICY AND AGRICULTURE 2 (2009) (summarizing the ACES offset program).

143. Gramig, *supra* note 140, at 183. Verifiability is sometimes broken into two separate requirements: (1) the ability to quantify the offset, and (2) the ability to verify it.

144. See, e.g., OR. DEPT OF AGRIC., OREGON AG CARBON WORKING GROUP REPORT 3 (2009), available at http://www.oregon.gov/oda/docs/pdf/agcarbonrpt12_09.pdf?ga=t. The goal is to ensure that the offsets are as "real and measurable" as the emissions that they offset. *Id.*

in the practice other than the existence of the offset.¹⁴⁵ Offsets are “enforceable” if legal contracts exist that require compliance and that can be enforced in court.

The first two requirements can currently pose significant obstacles for many types of agricultural offsets.¹⁴⁶ Of foremost importance, there is often insufficient data and information to measure the quantity of carbon sequestered through potentially important agricultural practices, including soil sequestration projects.¹⁴⁷ University scientists and governmental agencies such as the U.S. Department of Agriculture are developing new tools to help in measuring agricultural offset programs, but more work is needed.¹⁴⁸ In many cases, there are also factors beyond offset credits driving those farming practices that yield offset opportunities, raising questions about the additionality of the offsets.

Ideally, offsets are also “permanent” (i.e., any carbon sequestered is removed permanently from the ambient environment and cannot be later released), and a number of climate programs currently require permanence of offsets.¹⁴⁹ This again can pose a problem for some agricultural offsets, including soil sequestration. Some programs may decide to recognize nonpermanent offsets if the offset will last for a long enough period of time to have a meaningful impact on climate and serve as an effective bridge to later permanent reductions from other sources.¹⁵⁰ In such cases, however, climate programs are likely to discount the value of the offset to reflect its limited life.

1. Options

Studies suggest that farmers may be able to produce significant offsets through a variety of changes in farming practices, including no-till or conservation tillage, the use of winter cover crops, and reduced fertilizer use. Ranchers can increase soil sequestration of carbon by improving their grazing management.¹⁵¹ Ranchers and dairies can reduce methane emissions by changing their feeding and

145. *Id.* at 3–4.

146. *See* OLMSTEAD, *supra* note 142, at 3 (noting that agricultural offset programs are “notoriously difficult to measure and verify” and also frequently run into additionality problems).

147. OR. DEP’T OF AGRIC., *supra* note 144, at 1, 5.

148. *Id.* at 7 (describing the development by the U.S. Department of Agriculture and Colorado State University of a “Voluntary Reporting of Greenhouse Gases-Carbon Management Evaluation Tool”); Ribaudo et al., *supra* note 6, at 2088–89.

149. Gramig, *supra* note 140, at 183; DANIEL A. SUMNER, UNIV. OF CAL. AGRIC. ISSUES CTR., AB 32 AND AGRICULTURE (2010), *available at* <http://giannini.ucop.edu/AB32/ab32sumner2.pdf> (describing the requirement under California’s climate legislation that offsets be permanent and not reversible); ENVIRONMENT-NORTHEAST, OFFSETS SUMMARY: THE REGIONAL GREENHOUSE GAS INITIATIVE (2008), *available at* http://www.env-ne.org/public/resources/pdf/ene_rggi_offset-design.pdf (offsets under RGGI must be permanent).

150. Gramig, *supra* note 140, at 185.

151. For a complete list of options, see ALISON J. EAGLE ET AL., NICHOLS INSTITUTE FOR ENVTL. POLICY SOLUTIONS, GREENHOUSE GAS MITIGATION POTENTIAL OF AGRICULTURAL LAND MANAGEMENT ACTIVITIES IN THE UNITED STATES: A SYNTHESIS OF THE LITERATURE (2010).

manure-management practices.¹⁵² Shifts in land use are also a potential source of offsets. Farmers can sequester carbon by shifting the use of some or all of their land from traditional crops to either forestry (afforestation) or short-rotation woody crops, combining crops with trees and shrubs in close proximity in a practice known as agroforestry, and converting cropland back to natural landscape or unharvested vegetation.¹⁵³

The viability of particular offsets will depend on the price paid for the offsets (which in turn will depend on the stringency of the regulatory system and the potential supply of offsets), the cost of the offsets, and the ability to meet the requirements set out earlier (including verifiability, additionality, and permanence). Some forms of offsets will not be cost effective even at high carbon prices. While agriculture technically may be able to mitigate up to 6,000 metric tons of carbon equivalents each year by 2030, economically profitable offsets are likely to range from about 1,500 metric tons at a price of twenty dollars per metric ton to approximately 4,300 metric tons at one hundred dollars.¹⁵⁴ As these figures show, however, the potential opportunity is still large even at low prices.

a. Carbon Sequestration Through Tillage Practices

Greatest attention has focused on increasing the sequestration of carbon in agriculture soils either by not plowing the soil (no-till) or reducing tillage (conservation tillage).¹⁵⁵ Soil already sequesters substantial amounts of carbon, holding twice as much carbon as the atmosphere and surface vegetation combined.¹⁵⁶ Studies estimate that no-till and conservation tillage could sequester anywhere from approximately thirty metric tons of carbon-dioxide equivalents per year to over 170 metric tons.¹⁵⁷ Improved tillage practices also carry a variety of potential advantages to agriculture beyond carbon sequestration, including reduced soil erosion, enhanced soil quality, and reduced fertilizer needs, promising cobenefits but potentially raising questions about additionality.¹⁵⁸

The use of winter cover crops also can increase soil sequestration of carbon,

152. Gramig, *supra* note 140, at 181.

153. See, e.g., F. Montagnini & P.K.R. Nair, *Carbon Sequestration: An Underexploited Environmental Benefit of Agroforestry Systems*, 61 *AGROFORESTRY SYSTEMS* 281 (2004); Sten Nilsson & Wolfgang Schopphauser, *The Carbon-Sequestration Potential of a Global Afforestation Program*, 30 *CLIMATE CHANGE* 267 (1995).

154. Gramig, *supra* note 137, at 182.

155. EAGLE ET AL., *supra* note 151, at 3; Gramig, *supra* note 140, at 181; SUSTAINABLE CONSERVATION, U.S. DEPT. OF AGRIC. & NATURAL RES. CONSERVATION SERV., CALIFORNIA AGRICULTURE AND CLIMATE CHANGE: CHALLENGES AND OPPORTUNITIES FOR PROFITABILITY 7 (n.d.), available at <http://www.suscon.org/cowpower/pdfs/CaliforniaAgricultureandClimateChange.pdf> (last visited Nov. 26, 2010).

156. SUSTAINABLE CONSERVATION ET AL., *supra* note 155, at 7.

157. EAGLE ET AL., *supra* note 151, at 5.

158. *Id.* at 3 n.4.

as well as reduce nitrous oxide emissions.¹⁵⁹ Studies estimate that use of winter cover crops can reduce carbon-equivalent emissions by anywhere from approximately thirty-five to eighty-five metric tons per year.¹⁶⁰ Cover crops also provide a variety of other potential agricultural benefits, including weed suppression, insect reduction, and nitrogen fixing for some crops.¹⁶¹

b. Reducing Nitrous Oxides Through Fertilizer and Manure Practices

Because both nitrogen fertilizer and manure can produce nitrous oxide emissions, farmers can also reduce climate risks by (1) matching fertilizer applications more closely to crop needs, (2) reducing soil saturation through irrigation practices, (3) better managing manure through dry handling or composting, and (4) installing and using methane digesters.¹⁶² Nitrous oxide is a particularly potent greenhouse gas, with a global warming potential 280 times that of carbon dioxide, making these practices a particularly valuable means of addressing climate change.¹⁶³

c. Reducing Methane Emissions Through Livestock Practices

Livestock operations currently emit significant amounts of methane through “enteric fermentation,” the process by which livestock digest their food.¹⁶⁴ Like nitrous oxide, methane is a potent greenhouse gas, with a global warming potential fifty-six times greater than carbon dioxide.¹⁶⁵ Farmers have a variety of means through which they can reduce methane emissions, including changes in the diet that they feed their livestock.¹⁶⁶

d. Biological Sequestration of Carbon

In many projections, the principal means by which offsets will be generated is through biological sequestration of carbon.¹⁶⁷ In the agricultural sector, most

159. SUSTAINABLE CONSERVATION ET AL., *supra* note 155, at 8; EAGLE ET AL., *supra* note 151, at 11.

160. EAGLE ET AL., *supra* note 151, at 12.

161. See PRESTON SULLIVAN, NAT'L CTR. FOR APPROPRIATE TECH., APPROPRIATE TECH. TRANSFER FOR RURAL AREAS, OVERVIEW OF COVER CROPS AND GREEN MANURES (2003), available at <http://attra.ncat.org/attra-pub/covercrop.html>.

162. EAGLE ET AL., *supra* note 151, at 28–35; Gramig, *supra* note 140, at 181; OR. DEP'T OF AGRIC., *supra* note 144, at 8, 10–11. See also SUMNER, *supra* note 149 (noting the potential value to farmers of methane digesters).

163. SALZMAN & THOMPSON, *supra* note 83, at 126.

164. OR. DEP'T OF AGRIC., *supra* note 144, at 10.

165. SALZMAN & THOMPSON, *supra* note 83, at 126.

166. OR. DEP'T OF AGRIC., *supra* note 144, at 11.

167. See, e.g., 25x25 CARBON WORK GROUP, RECOMMENDATIONS TO ENHANCE THE BIOLOGICAL SEQUESTRATION PROVISIONS OF THE AMERICAN CLEAN ENERGY AND SECURITY ACT OF 2009 (2009), available at http://www.25x25.org/storage/25x25/documents/carbon_subcommittee/25x25%20cwg%20hr%202454%20bio-seq%20recommendations%209_03_09.pdf.

attention has focused on afforestation, in which farmers replace their traditional crops with forests. At relatively high prices for carbon, farmers may find that replacing crop and pasture lands with forests is economically profitable because of the offsets earned.¹⁶⁸

A second option for biological sequestration of carbon that is more compatible with traditional farming is agroforestry, in which farmers integrate crops with trees and shrubs. Principal agroforestry practices include the use of windbreaks, alley cropping, silvopasture, riparian buffers, and forest farming.¹⁶⁹ Alleycropping, silvopasture, and forest farming have particular promise for carbon sequestration because of their more intensive use of trees.¹⁷⁰

2. *Potential Benefits to Agriculture*

Offset programs could bring significant new revenues to farmers who are willing to manage their land to reduce greenhouse gas emissions and sequester carbon, with the amount of revenue depending both on the stringency of the climate regulation and the percent of commitments that the regulatory system permits to be met through offsets. For example, the Nicholas Institute for the Environment at Duke University estimates that payments for offsets could reach one-and-a-half billion dollars annually if carbon is priced at thirty dollars per metric ton of carbon dioxide equivalents (which is within the range of predicted prices from most national climate legislation).¹⁷¹ Financial benefits from offsets would be relatively widespread throughout the U.S. agricultural sector.¹⁷²

Projections of potential revenue to individual sectors have also been large. Inform Economics, for example, has estimated that no-till practices could bring in over thirty dollars per acre to corn farmers.¹⁷³ A 2009 study by the University of Tennessee found that, over a fifteen-year period, a broad offset program would provide returns of \$91 million for wheat, \$131 million for corn, and \$196 million for soybeans.¹⁷⁴ The sale of offsets from methane capture could bring in \$328 million more.¹⁷⁵

One frequently expressed concern has been that carbon offset programs

168. See, e.g., Gramig, *supra* note 140, at 182 (suggesting that crop and pasture lands will be converted at carbon equivalent prices of thirty dollars or more per ton).

169. EAGLE ET AL., *supra* note 151, at 18–20.

170. *Id.* at 19. See also *id.* at 20 Table 9 (showing the national potential for sequestration by alleycropping ranging from 67.7 to 270.8 metric tons of carbon-dioxide equivalents).

171. JESSICA SHIPLEY ET AL., PEW CTR. ON GLOBAL CLIMATE CHANGE, U.S. AGRICULTURE & CLIMATE CHANGE LEGISLATION: MARKETS, MYTHS & OPPORTUNITIES 9 (2010), available at <http://www.pewclimate.org/docuploads/us-agriculture-climate-change-legislation-markets-myths-opportunities.pdf>.

172. Ugarte, *supra* note 106, at 17.

173. SHIPLEY ET AL., *supra* note 171, at 9 (based on a projected adoption rate of sixty-three percent of total acreage).

174. Ugarte, *supra* note 106, at 10.

175. *Id.* at 12.

could lead to the conversion of substantial amounts of farmland into forests, driving up food prices and devastating rural communities dependent on agricultural revenue.¹⁷⁶ The projections that have led to this concern, however, have not accounted for alternative forms of offsets that farmers might find more attractive.¹⁷⁷ The amount of afforestation that will actually occur will depend on the price of carbon offsets. The 2009 University of Tennessee study mentioned above projects that little afforestation would occur at carbon dioxide prices of twenty-seven dollars per metric ton (which is again in the general range of prices expected under climate bills that have been considered by Congress), because traditional crops outcompete the income from offsets.¹⁷⁸ Significant conversion does not occur under the Tennessee model until prices reach about eighty dollars per metric ton, which is substantially higher than currently predicted carbon dioxide prices but within the realm of possibility with strict regulatory standards.¹⁷⁹ Other studies have found that offsets would have relatively minimal impact on food production and thus food prices.¹⁸⁰

3. *The Prospect for Offset Programs*

Pending a federal climate bill, there are three potential sources of funding for farmers wishing to sequester carbon or reduce greenhouse gas emissions through their operations. First, a number of programs under the federal farm bill encourage agricultural practices that sequester carbon. For example, the Environmental Quality Incentives Program (EQIP) rewards farmers who convert from conventional to no-till farming or improve their manure handling, while the Conservation Stewardship Program pays farmers who previously converted to reduced or no-till farming.¹⁸¹

Emerging state and regional climate mitigation programs may provide a second source of potential revenue.¹⁸² In 1997, Oregon became the first state to address climate change when its legislature authorized the Oregon Energy Facility Siting Council to set carbon dioxide emission standards for new energy facilities. If a facility cannot meet the Oregon carbon dioxide standard directly through plant design, it can meet the standard either by developing and funding offset

176. SHIPLEY ET AL., *supra* note 171, at 14.

177. *Id.*

178. Ugarte, *supra* note 106, at 13; *see also* SHIPLEY ET AL., *supra* note 171, at 14 (discussing the Tennessee study).

179. Ugarte, *supra* note 106, at 15. The Tennessee study predicts that, at prices of about \$160 per metric ton, about forty million acres of cropland would convert to forests. *Id.*

180. *See, e.g., id.* at 13 (finding that changes to crop prices would be within ten percent, “a magnitude typical to those caused by normal market forces”).

181. *See* OR. DEP’T OF AGRIC., *supra* note 144, at 7, 11 (describing incentives under these programs, as well as the Conservation Reserve Program).

182. These offset markets are not limited to the United States. Alberta and British Columbia, Canada, also have significant offset programs for agriculture, including soil sequestration. *Id.* at 4.

projects or by paying a predetermined amount (currently \$1.27 per short ton of carbon dioxide) to a state-recognized nonprofit that selects and manages offset projects.¹⁸³ This law led to the creation of the nonprofit Climate Trust, which now also creates and manages offsets for state programs in Colorado, Massachusetts, Montana, and Washington.¹⁸⁴ The Oregon offset program is open to agricultural producers, although verifiability is a significant issue.¹⁸⁵

California's climate legislation, AB 32, could generate significant offset opportunities for the state's agriculture.¹⁸⁶ AB 32 chose not to regulate agriculture directly for administrative (and probably political) reasons, but allows agricultural offsets.¹⁸⁷ The California Air Resources Board (CARB), which is responsible for implementing AB 32, has identified a number of agricultural practices that may provide significant offsets, including cover crops, tillage practices, and methane digesters.¹⁸⁸ Because CARB is still designing California's carbon market, the size of the opportunity that a future offset market will provide to the state's farmers is still an open question and will depend, once again, in part on resolving often difficult questions of verifiability and additionality.

The New England states' Regional Greenhouse Gas Initiative (RGGI) may also generate offset opportunities for farmers in states that are party to RGGI. RGGI regulates the carbon emissions of regional power plants and permits limited offsets. Of most relevance to agriculture, RGGI currently permits offsets for methane destruction and reforestation of cropland, although offset use by regional power plants is currently limited to only 3.3% of the plants' compliance obligation.¹⁸⁹

Voluntary cap-and-trade markets currently provide a final set of offset opportunities. Governmental carbon legislation will ultimately crowd out and replace the existing voluntary market (which often operates under slack standards), but that market currently provides a small yet significant opportunity to farmers wishing to sell agricultural offsets. The largest formal program in this voluntary marketplace is the Chicago Climate Exchange (CCX). From 2003 through 2010, CCX was a cap-and-trade program in which a number of private companies voluntarily committed to reduce their carbon emissions and then met their targets

183. BILL DRUMHELLER, OR. DEP'T OF ENERGY, INTRODUCTION TO THE OREGON CARBON DIOXIDE STANDARD (2010), available at http://www.oregon.gov/energy/siting/docs/rulemaking/Intro_to_Carbon_Dioxide_Standard.pdf?ga=t.

184. CLIMATE TRUST, CLIMATE OFFSET WORK, http://www.climatetrust.org/compliance_off.html (last visited Nov. 26, 2010).

185. OR. DEP'T OF AGRIC., *supra* note 144, at 4.

186. See generally SUMNER, *supra* note 151 (providing a general overview of AB 32 and agricultural impacts).

187. *Id.*

188. *Id.*

189. Ribaldo et al., *supra* note 6, at 2087; ENVIRONMENT-NORTHEAST, *supra* note 149, at 1-2; SHIPLEY ET AL., *supra* note 168, at 4.

either through direct reductions, by purchasing carbon credits from other members, or by purchasing offsets from nonmembers, including farmers; since 2010, CCX has run an offset program (the Chicago Climate Exchange Offsets Registry Program) available to qualified participants.¹⁹⁰ CCX currently permits offsets for various agricultural practices, including soil sequestration, methane destruction, and reforestation of cropland.¹⁹¹ Soil sequestration accounted for almost half of the thirty-five million metric tons of CO₂ traded on the CCX between 2003 and 2008.¹⁹²

The voluntary market consists not only of CCX but also a diverse variety of other private and nonprofit organizations promoting carbon reduction and markets. Together, these other organizations trade significantly more carbon than CCX—slightly more than forty million tons in 2007 alone.¹⁹³ However, in contrast to the significance of farm offsets to the CCX exchange, farms contributed only a small percentage (probably less than ten percent) of the carbon offsets in this broader market.¹⁹⁴ Most of these offsets involved either soil sequestration or methane destruction.¹⁹⁵

One lesson from the existing state and voluntary offset programs is the importance of aggregators. Most programs look for offsets of a minimum size, which often can be too large for an individual farm to provide. Individual farmers, however, can use aggregators who bundle individual farm projects together and sell them through a state or voluntary program. In some cases, local farm bureaus or other agricultural trade organizations have created aggregators to work with their members.¹⁹⁶

Unfortunately, where existing state, regional, or voluntary carbon programs do not provide a sufficient incentive to engage in current carbon-mitigating practices, the potential for future offsets actually might undermine current adoption of favorable practices. Because of additionality concerns, most carbon mitigation programs are unlikely to provide offsets for steps taken long before the adoption of the authorizing legislation; otherwise, offsets might be awarded for

190. See OR. DEP'T OF AGRIC., *supra* note 144, at 4 (discussing the role that CCX played in facilitating offsets, including agricultural offsets); CHICAGO CLIMATE EXCHANGE, FACT SHEET (Dec. 2011), available at https://www.theice.com/publicdocs/ccx/CCX_Fact_Sheet.pdf [hereinafter FACT SHEET]; *Markets: Chicago Climate Exchange*, INTERCONTINENTALEXCHANGE, INC., <https://www.theice.com/ccx.jhtml> (last visited Jan. 26, 2012).

191. Ribaldo et al., *supra* note 6, at 2087.

192. *Id.* According to CCX, its “protocols pioneered practices in the agriculture sector, facilitating the participation of more than 15,000 farmers, ranchers and foresters who conduct mitigation practices on more than 25 million acres of land.” FACT SHEET, *supra* note 190, at 4.

193. Ribaldo et al., *supra* note 6, at 2088.

194. *Id.*

195. *Id.*

196. See, e.g., OR. DEP'T OF AGRIC., *supra* note 144, at 4 (highlighting the Woodlands Carbon Company, which was created in 2008 by the Oregon Small Woodlands Association (OSWA), in partnership with the American Forest Foundation).

reductions that would have occurred in any case.¹⁹⁷ Farmers thinking about adopting such practices therefore may wait in the hope of ultimately being rewarded for the practices.

C. *Hydrologic Services*

Hydrologic services already provide funding for some farmers and enjoy significant future potential. Most of the opportunity, both now and in the future, lies in agricultural practices that can increase water quality—primarily through protection of wetlands and other riparian buffers. Farms, however, also can help reduce downstream flood risks to densely populated areas by agreeing to serve as flood areas during periods of high water flow. Farms also may be able to increase the quantity of water available for consumptive uses or improve flow for hydroelectric purposes, although it is difficult to determine how various farming practices contribute to these latter services and, partly as a result, there are few examples of payments that have been made for them.

1. *Water Quality*

At least four sources of funding already exist for farmers wishing to promote water quality, and the amount of funding is likely to grow over time. First, several federal farm programs provide direct cost-sharing or compensation to farmers who agree to manage their land for water quality. For example, the principal purpose of the Conservation Reserve Program (CRP), the oldest and best known of the farm conservation programs, is to retire highly erodible and environmentally sensitive land from crop production to reduce erosion and water pollution.¹⁹⁸ The Wetlands Reserve Program (WRP) pays farmers to protect, restore, and enhance wetlands on their property, in part to protect and improve water quality.¹⁹⁹ The Conservation Security Program (CSP) rewards good stewards who adopt new practices to improve local water quality.²⁰⁰

Second, a number of cities, driven to protect the sources of their water in large part by governmental regulation, have paid farmers to manage agricultural land in the cities' watersheds to protect and improve water quality.²⁰¹ In the best-known example related earlier, New York City has paid farmers to improve their land management in the city's Delaware and Catskills watersheds. Other major cities, including Boston and Seattle, have also invested in watershed improvement.²⁰²

197. *Id.* at 1.

198. Cox, *supra* note 3, at 146.

199. *See id.* at 148.

200. *Id.* at 147.

201. For general discussions of the efforts of cities, both in the United States and abroad, to protect their watersheds for water quality purposes, see Postel & Thompson, *supra* note 42, at 104–05, and Salzman et al., *supra* note 7, at 313–19, 329–31.

202. Salzman et al., *supra* note 7, at 329–31.

Absent pressure from governmental regulation, however, most water suppliers seem uninterested in paying watershed farmers to manage their lands for reduced water pollution. The principal regulatory driver in the United States, EPA's Surface Water Treatment Rule, applies only to water suppliers who do not filter their water, and the vast majority of water suppliers—over ninety-five percent—filter.²⁰³ In a 2005 survey, major water suppliers in California reported having taken few actions within the prior decade to protect watershed lands that they did not own.²⁰⁴

Third, water quality trading under the Clean Water Act is likely to drive significant demand for on-farm measures to reduce nonpoint pollution. Under rules established by EPA, states can develop trading programs under which point sources of pollution, such as factories and wastewater treatment plants, can partially meet their discharge standards by paying others, including farmers, to reduce their discharges. Water quality trading is still in its infancy in the United States and faces difficult technical hurdles presented by the need to determine how emission reductions in one location will affect water quality in another location.²⁰⁵ Although tighter water quality regulation has driven the number of trading programs to grow from only eight in 1995 to approximately one hundred today, most of the programs are only experimental pilots, and just one program (involving the Long Island Sound) accounts for eighty percent of the trades to date.²⁰⁶ More importantly, agriculture is a potential source of credits in only fifteen of the trading programs, and only three of these have involved actual trades with farmers.²⁰⁷ The most common form of pollutant for these programs is nutrients,²⁰⁸ although similar water quality trading in Australia has successfully addressed salinity and other water quality problems.²⁰⁹

A recent study of wetlands restoration in the Mississippi alluvial valley illustrates the potential importance of water quality markets, as well as the opportunity for EcoFarming more generally.²¹⁰ The study examined opportunities

203. Thompson, *supra* note 16, at 480 n.70.

204. *Id.* at 106–07. The survey covered water retailers with fifty thousand or more customers. *Id.*

205. ELLEN HANAK ET AL., *MANAGING CALIFORNIA'S WATER: FROM CONFLICT TO RECONCILIATION* 286–89 (2011); SALZMAN & THOMPSON, *supra* note 83, at 170–71 (noting that the “problem of determining whether a particular trade will ensure that overall pollution remains the same is particularly difficult in the case of point/non-point trades”).

206. SALZMAN & THOMPSON, *supra* note 83, at 171.

207. Marc Ribaldo & C.J. Nickerson, *Agriculture and Water Quality Trading: Exploring the Possibilities*, 64 J. SOIL & WATER CONSERVATION 1, 2 (2009); Ribaldo et al., *supra* note 6, at 2087.

208. Ribaldo et al., *supra* note 6, at 2087.

209. M.D. YOUNG, ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, ENVIRONMENTAL EFFECTIVENESS AND ECONOMIC EFFICIENCY OF WATER USE IN AGRICULTURE: THE EXPERIENCE OF AND LESSONS FROM THE AUSTRALIAN WATER REFORM PROGRAMME 8 (2008), available at http://www.myoung.net.au/water/publications/oecd_lessons_paper.pdf.

210. Jenkins et al., *supra* note 93.

for restoring wetlands on farming land in the valley. The study focused on a variety of potential ecosystem services from wetlands restoration, including carbon sequestration; reductions in emission of methane and nitrous oxide; water quality improvements through nitrogen mitigation; promotion of habitat for frogs, black bears, and migratory birds; and recreational value from waterfowl hunting.

The study found that the societal value of these services far exceeded the purely agricultural value of the land, but that society currently does not reward farmers for any of these services in the Mississippi alluvial valley except for waterfowl hunting that could bring in a small and relatively inconsequential sum per acre of wetland (thirty-seven dollars).²¹¹ However, a combination of carbon offsets and water quality trades could provide sufficient income to farmers to support wetlands restoration and protection.²¹² Of these two sources of income, the value from water quality trading (approximately \$1540 per acre) was over one-and-a-half times the revenue achievable from carbon offsets (\$980 per acre).²¹³

Finally, a growing mitigation market under the Clean Water Act provides funding for farmers and other landowners wishing to enhance or restore wetlands on their property—which in turn can help improve water quality.²¹⁴ Under section 404 of the Clean Water Act, no one can drain or fill a wetland without offsetting the loss with new or improved wetlands elsewhere. The resulting demand for enhanced or restored wetlands has led to the development of over 600 mitigation banks in the United States.²¹⁵ Almost two-thirds of all counties with mitigation programs contain at least some agricultural lands, although only one farmer to date appears to have become a mitigation banker.²¹⁶

2. *Flood Mitigation*

Farmers also can reduce downstream flood risks in several ways. First, farmers can help to even out flood flows through protection and restoration of wetlands.²¹⁷ As discussed above, a variety of programs already compensate farmers for such wetlands.²¹⁸ Second, farmers can enter into so-called flowage easements in which they agree to permit their lands to be flooded during periods of high water flow in order to reduce downstream risks. Federal agencies such as the Army Corps of Engineers that are responsible for flood management, as well as state and local governments seeking to protect their residents and property,

211. *Id.* at 1057 (fifteen dollars per hectare).

212. *Id.* at 1058–60.

213. *Id.* at 1057 (\$624 per hectare through water quality trading and \$396 per hectare through carbon offsets).

214. *See* Ruhl & Gregg, *supra* note 86, at 365–66.

215. Ribaldo et al., *supra* note 6, at 2087.

216. *Id.*

217. Postel & Thompson, *supra* note 42, at 98–99; Salzman et al., *supra* note 7, at 319–22.

218. *See, e.g., supra* note 196 and accompanying text.

have paid farmers for such easements in various parts of the nation.²¹⁹

D. Biodiversity Habitat

Farms also can provide important habitat for imperiled species. Given that over seventy percent of land in the United States is privately held and that this land is often the most productive, it is not surprising that private land is also habitat for almost eighty percent of all species listed under the federal Endangered Species Act as endangered or threatened.²²⁰ Although there has been no comprehensive study of the nation as a whole, farms would appear to constitute an important segment of this habitat. In one California study, approximately twenty percent of species listed under the federal or state Endangered Species Acts were found in both natural habitats and on agricultural lands; another twenty percent were found in natural habitats, on farms, and in urban areas.²²¹ In short, agricultural lands provided partial but important habitat for approximately forty percent of the species.

Farmers can take various steps to increase the habitat value of their properties. Farmers, for example, can manage their lands to mimic species' natural habitat—e.g., by planting perennials or, in the case of rice farmers, imitating natural wetlands. Farmers can reduce threats, such as pesticide use, that may threaten species. Finally, farmers can purposefully manage their lands as part of a larger landscape—e.g., by creating wildlife corridors across their property that link other important areas of habitat.²²²

Several types of programs—including government payments, philanthropic support, and government-driven markets—currently reward farmers who promote habitat on their lands for listed or otherwise imperiled species. First, various programs under the U.S. farm bill reward the creation and enhancement of habitat. The Wildlife Habitat Incentive Program (WHIP), in particular, provides cost-sharing funds to farmers who develop and improve wildlife habitat on their lands.²²³ Both the Environmental Quality Incentives Program (EQIP) and the Conservation Security Program (CSP) also provide funding to farmers who

219. See, e.g., U.S. ARMY CORPS OF ENGINEERS, FLOWAGE EASEMENT, <http://www.swf-wc.usace.army.mil/cooper/realestate/flowage%20easement.asp> (last visited Nov. 26, 2010) (describing the Corps' practice of acquiring perpetual flowage easements).

220. U.S. GEN. ACCOUNTING OFFICE, ENDANGERED SPECIES ACT: INFORMATION ON SPECIES PROTECTION ON NONFEDERAL LANDS 5–6 (1994).

221. Berry J. Brosi et al., *Agricultural and Urban Landscapes*, in 2 THE ENDANGERED SPECIES ACT AT THIRTY: CONSERVING BIODIVERSITY IN HUMAN-DOMINATED LANDSCAPES 256 (J. Michael Scott, et al., eds., 2006).

222. See, e.g., SARA VICKERMAN, NATIONAL STEWARDSHIP INCENTIVES: CONSERVATION STRATEGIES FOR OREGON'S WORKING LANDSCAPE 5–6 (Defenders of Wildlife ed., 1998); William Pauli, Statement of the American Farm Bureau Federation to the Committee on Environment and Public Works: Habitat Conservation Planning and the Endangered Species Act (Oct. 19, 1999), available at http://epw.senate.gov/107th/pau_1019.htm.

223. Cox, *supra* note 3, at 122.

enhance the wildlife-habitat value of their land,²²⁴ while programs such as the Wetlands Reserve Program promote habitat by rewarding farmers who restore natural habitat features on their properties.²²⁵

Second, conservation organizations are increasingly recognizing the value of and rewarding the improvement of habitat on farms and other working landscapes. The Nature Conservancy, Audubon California, and Point Reyes Bird Observatory Conservation Science, for example, have joined together with California rice farmers to promote practices that will increase the value of rice fields as habitat for wintering waterfowl and shorebirds.²²⁶ Rice farming has long provided habitat for such birds in California, where only ten percent of native wetlands remain. The joint program to improve the habitat value of rice farms provides payments to farmers in return for conservation easements and contracts specifying practices.

Finally, the Endangered Species Act (ESA) can drive markets for habitat creation, improvement, and protection on agricultural lands.²²⁷ The ESA prohibits any modification of private habitat that might lead to the death or injury of an endangered species, unless the landowner develops and implements a Habitat Conservation Plan (HCP) that will provide adequate alternative protection. In some cases, regional governments will work with landowners and environmental groups to develop regional HCPs that provide for the protection of some lands in the region in return for the regulated development of other lands.

HCPs historically focused on the protection of natural habitats,²²⁸ but some recent regional HCPs have encouraged the enhancement of wildlife habitat on farms. For example, the Natomas Basin HCP in California allows housing developments in return for payments to a fund to be used to create and support an 8750-acre reserve.²²⁹ Fifty percent of the reserve consists of rice farms, and another twenty-five percent of upland row crops and fallowed agricultural lands.²³⁰ The HCP pays farms within the reserve both to enhance the wildlife values of their land and to control predators that could endanger the local listed species.

The Natomas Basin HCP illustrates an important point regarding the “production” of wildlife habitat. Habitat improvement on an individual farm or other parcel of land will seldom be of significant value to imperiled wildlife. Even efforts by multiple farmers or landowners may fail unless they are coordinated

224. *Id.* at 142, 144. *See also supra* notes 71–73 and accompanying text.

225. *See Cox, supra* note 3, at 145; *supra* note 69 and accompanying text.

226. Tom Butler, *Our Wild Side*, CALIFORNIA RICE BLOG (March 1, 2010), <http://www.calrice.org/Industry+Info/CRC+Blog.htm?id=1267453500>.

227. *See Thompson, supra* note 88 (describing the role of the ESA).

228. *Id.* at 116.

229. *Id.* at 116–18.

230. *Id.* at 116–18.

across a landscape to provide required scale and needed corridors. Landscape-level programs such as regional HCPs help overcome this problem by ensuring the creation of an adequate system of reserves.

E. *Lessons Moving Forward*

The experiences discussed above suggest a number of important lessons for promoting EcoFarming in the future. First, government support will remain critical, whether in the form of direct funding, government-driven markets, or tax leverage. While renewable energy is a private good, government assistance will be needed in the short run to overcome current cost disadvantages, provide the infrastructure needed for a transition away from fossil fuels, and promote research on new and improved technologies. All of the other ecosystem services of likely importance to EcoFarming are public goods and depend in large part on government support.

Second, governmental support would benefit from at least two forms of integration—integration across programs, and integration across landscapes. As this section highlights, current support programs are highly fragmented. The federal farm bill alone supports ten major conservation programs, as well as another fifteen more minor programs.²³¹ Other federal programs, as well as state programs, add to a growing mix. Farmers who wish to take advantage of these governmental incentive payments must apply individually to all relevant support programs, which typically have divergent requirements and processes. The resulting transaction costs can deter farmers from participating, undercutting the movement toward a broader set of agricultural products. The federal government could help reduce the transaction costs by developing a whole farm program that allows farmers to apply for multiple federal incentives at the same time and through one process.²³² The federal government also could help reduce transaction costs by coordinating with states to ensure that similar state and federal programs work in concert to promote common goals.²³³

For many ecosystem services, governmental support also should strive to promote production across an entire landscape rather than on a farm-by-farm basis.²³⁴ As discussed in Section D above, efforts by an individual farmer to improve habitat are unlikely to be effective unless neighboring farmers make

231. Cox, *supra* note 3, at 124.

232. See Arha et al., *supra* note 4, at 221–22 (proposing coordinated delivery of conservation programs through “Whole Farm Stewardship Agreement[s]”).

233. See Kaush Arha et al., *Coordinated State and Federal Ag-Conservation Efforts: The Case of Missouri and Nebraska*, in U.S. AGRICULTURAL POLICY AND THE 2007 FARM BILL, *supra* note 3, at 189 (discussing the advantages of greater state-federal coordination of farm bill conservation programs).

234. See Arha et al., *supra* note 4, at 220–21 (emphasizing the importance of a landscape approach, perhaps along watershed lines); Rebecca L. Goldman et al., *Institutional Incentives for Managing the Landscapes: Inducing Cooperation for the Production of Ecosystem Services*, 64 *ECOLOGICAL ECON.* 333 (2007) (same).

similar efforts; the same is true of various other ecosystem services including water quality and flood protection. Many ecosystem services are produced at a landscape scale and require incentives that coordinate efforts across a landscape.²³⁵ Rather than rewarding individual farmers for particular actions, government incentive programs therefore should provide incentives for coordinated action by farmers across a relevant landscape.

Third, scientific and technical uncertainty remains a significant obstacle to the development of effective markets or incentives for a variety of important ecosystem services.²³⁶ As discussed earlier, carbon offsets require verifiability, yet we still have insufficient information in order to accurately predict or measure the impact of various farming practices on greenhouse gas emissions and sequestration. Similar measurability problems plague water quality trading, wetland banking, conservation banking, and other environmental markets.²³⁷ Beneficiaries of ecosystem services are unlikely to pay farmers to produce particular services unless they have a strong sense of the flow and value of the ecosystem services that will result.²³⁸ Better measurement tools and information are also needed to ensure that direct government support is efficient and properly directed. There is thus an important need for new scientific research and the development of new tools that can do a better job of predicting and measuring the effect of particular farming practices on the flow of ecosystem services.²³⁹

The cost to farmers of participating in new ecosystem-service markets and programs is also frequently uncertain, deterring many farmers from engaging in the practices.²⁴⁰ For example, if engaging in a water quality trade will require a farmer to change his operations in a way that might reduce his yield to an unknown degree, the farmer might not take the risk that the additional revenue from the trade will be greater than the lost revenue from the reduced yield. Governments or nonprofits may wish to create new insurance programs to overcome the risk adversity of many farmers. The American Farmland Trust, a nonprofit organization focused on protecting farmland and improving farms' environmental performance, is currently experimenting with a prototype insurance system that protects farmers who engage in best management practices for nutrient management or reduced tillage against loss.²⁴¹

Finally, farmers need organizations that can help facilitate ecosystem-service markets and incentive programs. As emphasized already, engaging in new markets and incentive programs can be costly to farmers. To participate, farmers must

235. Goldman et al., *supra* note 234, at 333, 335.

236. Ribaudo et al., *supra* note 3, at 2088.

237. *Id.*

238. Thompson, *supra* note 16, at 477; Postel & Thompson, *supra* note 42, at 106–07.

239. Ribaudo et al., *supra* note 3, at 2088.

240. *Id.*

241. AMERICAN FARMLAND TRUST, AFT'S BMP CHALLENGE, <http://www.farmland.org/programs/environment/solutions/bmp-challenge.asp> (last visited Nov. 28, 2010).

learn of the opportunities, determine exactly what steps are needed to take advantage of the opportunities (including what technically they must do on their farms), follow whatever process is required, and then undertake whatever follow-up actions are required (e.g., reporting requirements or verification oversight).²⁴² Some of the steps outlined above, such as the development of a whole farm program, can reduce these costs, but they will not eliminate them. Organizations are therefore needed that can (1) help link farmers with appropriate programs, (2) assist farmers in meeting the programs' requirements, and (3) provide needed technical assistance.²⁴³ New organizations may sometimes arise to meet these needs. The rise of offset aggregators discussed earlier in this section is an example. Some have also suggested the need for the formation of ecosystem service districts that could tax the beneficiaries of ecosystem services and use the resulting funding to work with farmers and other landowners to produce the needed services.²⁴⁴ In other situations, existing organizations may help assume one or more of these tasks. For example, the American Farmland Trust is working to help farmers take advantage of water quality markets.²⁴⁵ Conservation districts, which have long assisted farmers on soil conservation, might also be well situated to provide advice and assistance on ecosystem services.²⁴⁶

V. CONCERNS ABOUT ECOFARMING

This Article has focused so far on the potential advantages of EcoFarming. But EcoFarming also generates concerns, two of which are the focus of this Part. First, should we pay farmers to produce the ecosystem services discussed above, or should it be their social responsibility to provide them? We do not pay factories to reduce their pollution. Why should we pay farmers to do what some people argue is environmentally "correct"? Second, what is the risk that agriculture will capture governmental programs to encourage the production of ecosystem services—maximizing the revenue to farmers, while minimizing the benefits to society?

A. *The Baseline Question*

Society expects all individuals, firms, and industries to meet a minimum environmental standard—what is sometimes called a baseline standard.²⁴⁷ We

242. Ribaldo et al., *supra* note 6, at 2089–90.

243. *Id.*

244. *See, e.g.*, Geoffrey Heal et al., *Protecting Natural Capital Through Ecosystem Service Districts*, 20 STAN. ENVTL. L.J. 333 (2001); Thompson, *supra* note 16, at 484.

245. AMERICAN FARMLAND TRUST, WATER QUALITY TRADING MARKETS, <http://www.farmland.org/programs/environment/water-quality/water-quality-trading/What-is-Water-Quality-Trading.asp> (last visited Nov. 28, 2010).

246. Thompson, *supra* note 16, at 484.

247. *See generally* Thompson, *supra* note 16, at 482 (emphasizing the importance of baselines to ecosystem-service markets).

might be willing to provide a financial incentive to encourage someone to go beyond the baseline, but we generally do not believe that it is appropriate to pay someone to meet the baseline itself. The baseline is an ethical obligation that no one should be paid to achieve. For example, few would suggest that the government should pay factories to stop polluting rivers or should pay hunters not to kill endangered mammals.

EcoFarming raises the question of the appropriate baseline environmental standards for farming. For example, if we believe that farmers should manage their farmland in order to minimize polluting runoff from their operations, paying farmers to reduce their use of fertilizer and other potential contaminants would be no more appropriate than paying a factory not to pollute. Society should expect and require all farmers to meet certain minimum standards, including the maintenance and production of a minimum set and quantity of ecosystem services. These minimum baseline standards are non-negotiable and should not depend on the profitability of the practices required to achieve them. Once minimum standards are set, society can compensate EcoFarmers for achieving higher standards and or further increasing the flow and value of ecosystem services. But it should not compensate EcoFarmers to meet the minimum standards themselves.

Stating the problem unfortunately does not help determine the appropriate standard. Baseline standards are frequently contested and can vary over time. One reason why regulatory takings has been a much debated constitutional issue in recent years is due to shifting baselines and consequent debates over the appropriateness of the shift. For example, once permissible water diversions and land development are now illegal under the Endangered Species Act. Whether the water or property owners deserve compensation for a regulatory taking is a debate over where the baseline should be.

Baselines are at one level political questions, to be determined and defined by legislatures. If Congress does not have the votes to require farmers to engage in conservation tillage, for example, conventional tillage practices are effectively the baseline—even if strong normative arguments can be made that the baseline should be higher. Addressed from a slightly different angle, environmentalists may prefer that Congress require farmers to meet particular environmental standards. If the standards are politically impossible, however, incentive systems may be the second-best option. Time adds complexity. Baselines are sticky; they have inertia. Environmentalists therefore may decide not to back an incentive program because they hope that political views will change and that Congress will strengthen the regulation of farmers in the future. The ultimate question, nonetheless, is still political.

Baselines are also a normative question: what *should* farmers be expected to do? While legislatures ultimately determine the baseline, normative considerations hopefully guide them, and political debates over baselines generally focus on

normative considerations. Unfortunately, there are no clear normative rules for determining appropriate baselines. Instead a complex and messy balancing of multiple factors generally determines our views of appropriate baselines. Key factors include:

- ❖ **Status Quo:** Baseline determinations often start with the status quo, which holds a strong grip on most people's normative views.²⁴⁸ Proponents of a different baseline generally have the burden of justifying the shift. Even when baselines other than the status quo are imposed on future entrants into a business, governments often maintain the status quo as the baseline for existing participants by grandfathering them.
- ❖ **Comparative Baselines:** One approach to determining the appropriate baseline for one segment of society (e.g., farmers) is to see where government has set the baseline for others. For example, if industrial factories are not expected to pollute waterways, farmers presumably should not be permitted to pollute (all other factors held equal).
- ❖ **Feasibility:** Another factor that may inform our view of the appropriate baseline is what is financially feasible for an individual or firm to do without governmental assistance. Although society might forbid some behaviors no matter how costly to an individual or firm because of the harm that would otherwise occur, society may decide that financial feasibility is an appropriate consideration in setting baselines involving less harmful or troubling behavior.²⁴⁹
- ❖ **Harm:** The degree of societal harm that various actions will cause also frequently informs our view of appropriate baselines. More harmful or dangerous activities are more likely to be addressed through regulation than incentives.
- ❖ **Action Versus Inaction:** Although the normative underpinnings are unclear, baselines often appear to differentiate between banning actions that are harmful and requiring actions that are beneficial. Few people, for example, would argue that farmers should be required to plant biofuels, while most would argue that they should not be permitted to unconditionally pollute. The distinction sometimes can seem ephemeral. In theory, most behaviors can be described in either way: a ban on nitrogen pollution, for example,

248. For a detailed and interesting discussion of the pull of "historic baselines," see J.B. Ruhl & James Salzman, *Gaming the Past: The Theory and Practice of Historic Baselines in the Administrative State*, 64 VAND. L. REV. 1 (2011).

249. A number of regulatory statutes, such as the Occupational Health & Safety Act (OSHA) and the Safe Drinking Water Act, use economic feasibility in determining the appropriate regulatory standard. SALZMAN & THOMPSON, *supra* note 83, at 188–89.

can be just the flip side of a requirement that farmers use less fertilizer. In practice, however, the distinction has strong intuitive pull.

- ❖ **Natural Conditions:** In recent years, natural conditions have also had a strong pull in determining baselines. If natural conditions are deemed the appropriate baseline, actions that adversely impact natural conditions (e.g., destruction of natural wetlands) would be impermissible, while other actions (e.g., the construction of a wind farm) can be the potential subject of incentives.

Looking at the various services discussed in Part IV, renewable energy would seem an appropriate focus for markets and incentives. None of the normative considerations just outlined would call for requiring farmers to provide renewable energy as a baseline standard. The various other services, however, are more contestable. Arguments could be made based on the above considerations both for and against requiring farmers to provide the services. At the moment, however, it seems politically unlikely that Congress or state legislatures will require farmers to provide the services without any type of incentive. As noted at the outset, EcoFarming therefore may be the only means of obtaining the services. Over time, more may be required of farmers and less provided through markets and incentives as environmental norms continue to evolve and baselines therefore shift, but EcoFarming will always remain important for those services viewed as beyond the baseline.

B. Capture

A second concern is that farmers will capture any governmental program developed to promote ecosystem services through EcoFarming and undermine their social benefits. Agriculture remains a potent political group. Once the government establishes a program of direct incentives, tax leverage, or government-driven markets, agriculture will be tempted to find ways to increase the income from these programs while minimizing the cost of taking advantage of them. If as a result the cost of government programs increases and the benefits to society decrease, the programs at some point might become a net burden on rather than benefit to society.

The concern is not theoretical. The farm lobby, for example, has sought to maximize federal subsidies for ethanol, while weakening the environmental standards that the ethanol must meet.²⁵⁰ During debates on the American Clean Energy and Security Act (ACES) (also known as the Waxman-Markey bill), the farm lobby similarly sought to minimize the regulatory requirements for agricultural offsets and to place oversight of the offsets in the Department of

250. Mark Clayton, *The Politics of Ethanol Outshine Its Costs*, CHRISTIAN SCI. MONITOR, Nov. 15, 2007, available at <http://www.csmonitor.com/2007/1115/p02s02-uspo.html>.

Agriculture rather than the Environmental Protection Agency (which would have had oversight of other forms of offsets).²⁵¹

The creation of government incentives or other programs to promote public goods inevitably carries the risk of capture. The major step that can be taken to reduce the risk of capture is to develop better measures of how particular agricultural actions will affect the flow of ecosystem services and the value of those services. Capture feeds on uncertainty. If the benefits of particular actions are uncertain, industries can use the uncertainty to argue for higher payments. If it is unclear whether a weakening of standards will actually affect social well-being, industries can use the uncertainty to argue for relaxed standards. The risk of capture thus highlights the need, discussed earlier, for new information and tools to measure and value the flow of ecosystem services from farm activities.

Legislatures can also design programs to try to minimize the dangers of capture. For example, rather than authorizing variable incentives for the production of ecosystem services (which could be readily captured), legislatures can provide for reverse auctions or similar mechanisms designed to force farmers to compete against each other for available funding. The Department of Agriculture has long used a form of reverse auction under the Conservation Reserve Program (CRP).²⁵²

VI. CONCLUSION

Farmers historically have thought of themselves largely as growers of crops and livestock. However, farmers are managers of one of our most precious resources—land. And they can use the land to produce not only crops and livestock, but also a wide variety of other ecosystem goods and services, including renewable energy, climate regulation, hydrologic services, and wildlife habitat. By focusing on only a limited segment of the valuable goods and services that they can produce, farmers have maximized crops and livestock to the disadvantage of the other goods and services. The concept of EcoFarming would enlarge the vision of agriculture and encourage farmers to manage their land for the optimum mix of goods and services.

EcoFarming is of immense importance. All but a handful of ecosystem services have declined over the last fifty years and are likely to continue to decline absent new policies and practices. Because farmers control a majority of the nation's and world's land, farming is key to the future condition of our natural capital. Although government could attempt to protect natural capital on farms

251. See, e.g., OLMSTEAD, *supra* note 142 (summarizing the ACE provisions); Christa Marshall, *Agricultural Offsets—a Saviour or a Boondoggle?*, N.Y. TIMES, June 12, 2009, available at <http://www.nytimes.com/cwire/2009/06/12/12climatewire-agriculture-offsets---a-savior-or-a-boondog-33517.html>.

252. See, e.g., *Policy Diversity*, *supra* note 53, at 372 (discussing the advantages of reverse auctions and their use under CRP).

through regulation, prior efforts to increase environmental regulation of farmers have often failed. Regulation, moreover, is largely static and typically does not promote performance beyond the standard that is set. EcoFarming, by contrast, would encourage farmers to continually find new ways to increase the overall flow of ecosystem goods and services from their lands.