

# Shifting the Paradigm: Broadening our Understanding of Agriculture and its Impact on Climate Change

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\* J.D., 2009, University of Michigan; B.A., 2003, University of Notre Dame. I owe a special thanks to Professor David Uhlmann for finding time in his incredibly busy schedule to provide guidance and feedback on this Article. I would also like to thank my former supervisors and co-interns at the Center for International Environmental Law in Geneva, Switzerland, and my friend Jason Hickey, for their willingness to read and provide comments on this Article.

## INTRODUCTION

Scientists have determined that the Earth is warming at an unprecedented rate; mean surface temperatures around the world have increased 0.74°C in the last 100 years.<sup>1</sup> “Eleven of the last 12 years (1995-2006) are among the warmest years recorded since 1850.”<sup>2</sup> Even with recent controversy over the accuracy of the science and claims surrounding global warming,<sup>3</sup> governments around the world and the scientific community are in agreement about the existence of climate change and the threat it poses.<sup>4</sup> There is a growing consensus that the primary cause of climate change is increased emissions of greenhouse gases (“GHGs”) related to human activities.<sup>5</sup> At the very least, it appears clear that human actions are exacerbating the natural heating of the earth; worst-case scenario, humans are the primary cause of the rapid rise in temperatures. Regardless of which argument one personally accepts, it is becoming apparent to the scientific community and policymakers that efforts to combat climate change must take into account all human activities that substantially contribute to increased emissions of GHGs.

Unfortunately, policies enacted to date fail to consider the broad spectrum of human activities responsible for increased atmospheric concentrations of GHGs. Rather than taking a holistic view of climate change and developing policies that will address as many sources of anthropogenic (human-influenced) GHG emissions as is feasible, the regulatory focus to date has been limited. Policymakers have focused almost exclusively on fossil fuels used in the electric, transportation and industrial sectors, at the expense of other sources of GHG emissions.<sup>6</sup> Although the transportation sector has become the most

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<sup>1</sup> U.S. Dep’t of Transp., Overview of Climate Change, <http://climate.dot.gov/about/overview/science.html> (last visited Mar. 6, 2010) [hereinafter U.S. DOT].

<sup>2</sup> *Id.*

<sup>3</sup> See Jack Kelly, *The Climate Change Hoax*, REAL CLEAR POLITICS, Nov. 24, 2009, [http://www.realclearpolitics.com/articles/2009/11/24/the\\_climate\\_change\\_hoax\\_99281.html](http://www.realclearpolitics.com/articles/2009/11/24/the_climate_change_hoax_99281.html). See also Christopher Booker, *Climate Change: This is the Worst Scientific Scandal of Our Generation*, TELEGRAPH.CO.UK, Nov. 28, 2009, <http://www.telegraph.co.uk/comment/columnists/christopherbooker/6679082/Climate-change-this-is-the-worst-scientific-scandal-of-our-generation.html>; Ben Webster, *Climate Chief was Told of False Glacier Claims Before Copenhagen*, TIMES ONLINE UK, Jan. 30, 2010, <http://www.timesonline.co.uk/tol/news/environment/article7009081.ece>.

<sup>4</sup> One hundred and eight (108) countries have “engaged” with the Copenhagen Accord. See U.S. Climate Action Network, *Who’s On Board With The Copenhagen Accord?*, <http://www.usclimatenetwork.org/policy/copenhagen-accord-commitments> (last visited Mar. 17, 2010). Another fifty-five developed and developing nations have submitted emissions reduction plans. See John Broder, *Countries Submit Emission Goals*, N.Y. TIMES, Jan. 31, 2010, <http://www.nytimes.com/2010/02/02/science/earth/02copenhagen.html>. U.N. Secretary-General Ban Ki-Moon still lists climate change as a “priority for action.” See Ban Ki-Moon, *My Priorities as Secretary-General*, <http://www.un.org/sg/priority.shtml> (last visited Mar. 3, 2010).

<sup>5</sup> U.S. DOT, *supra* note 1.

<sup>6</sup> “Current energy policies (and proposed climate change legislation) focus almost exclusively

visible target of climate change regulation in recent years,<sup>7</sup> mobile sources of GHG emissions such as cars, trains, airplanes, and boats are not the primary causes of global warming.<sup>8</sup> That distinction belongs to the “electricity and heat” sector, which is responsible for 24.6% of global GHG emissions.<sup>9</sup> After the shared emissions from electricity and heat, industry is the next largest polluter, emitting 21.1% of all GHG emissions.<sup>10</sup> The third largest source of global GHG emissions is land use change and forestry, which emits 18.2% of all gases.<sup>11</sup>

While transportation is estimated to be responsible for 13.5% of total global GHG emissions,<sup>12</sup> agriculture contributes an estimated 14.9% to the total.<sup>13</sup> When all activities related to agricultural production are included in this calculation, agriculture’s contribution to global GHG emissions is estimated to be 32%.<sup>14</sup> Defining agriculture broadly to include forestry, land use changes, and crop and cattle farming, agriculture’s shared contribution of global GHG emissions rises to 33.1%.<sup>15</sup> This greatly exceeds emissions from electricity and heat, and is almost equal to emissions from the industry and transportation sectors combined.<sup>16</sup> Looking at just one segment of agriculture, animal farming, reveals the extent to which agricultural practices are contributing to increased atmospheric concentrations of GHGs. In a 2006 report,<sup>17</sup> the UN Food and Agriculture Organization (“FAO”) found that “the livestock sector generates

on electricity and transportation fuels.” *EESI Update: Don’t Forget About Heating and Cooling*, ENVTL. & ENERGY STUDY INST., 2009, <http://www.eesi.org/update12> [hereinafter EESI]. See also U.S. DOT, *supra* note 1 (follow “State/Local Actions & Policies” and “Federal Actions” hyperlinks).

<sup>7</sup> See generally *Obama Moves to Curb Car Emissions*, BBC NEWS, May 20, 2009, <http://news.bbc.co.uk/2/hi/8056908.stm> (first federal vehicle emissions standards); Steven Mufson, *Vehicle Emissions Rules to Tighten*, WASH. POST, May 18, 2009, <http://www.washingtonpost.com/wp-dyn/content/article/2009/05/18/AR2009051801848.html> (Administration’s plans to more strictly regulate vehicle emissions); Gordon Trowbridge, *EPA Targets Car Emissions*, DETROIT NEWS, Apr. 18, 2009, <http://detnews.com/article/20090418/POLITICS03/904180337/EPA-targets-car-emissions> (regulation of greenhouse gases emitted from vehicle tailpipes).

<sup>8</sup> KEVIN A. BAUMERT ET AL., WORLD RESOURCES INSTITUTE, NAVIGATING THE NUMBERS: GREENHOUSE GAS DATA AND INTERNATIONAL CLIMATE POLICY 57 (2005), available at [http://pdf.wri.org/navigating\\_numbers.pdf](http://pdf.wri.org/navigating_numbers.pdf).

<sup>9</sup> *Id.* at 6.

<sup>10</sup> *Id.* at 57.

<sup>11</sup> *Id.* at 16.

<sup>12</sup> *Id.* at 6.

<sup>13</sup> *Id.* at 67.

<sup>14</sup> SARAH ELLIS, INST. FOR AGRIC. & TRADE POL’Y, THE CHANGING CLIMATE FOR FOOD AND AGRICULTURE: A LITERATURE REVIEW 3 (2008), available at <http://www.iatp.org/iatp/publications.cfm?refid=104516>.

<sup>15</sup> Percentage reflects the total emissions-percentages for land-use change, forestry, and agriculture combined.

<sup>16</sup> BAUMERT ET AL., *supra* note 8, at 4-6.

<sup>17</sup> U.N. FOOD AND AGRIC. ORG., LIVESTOCK’S LONG SHADOW – ENVIRONMENTAL ISSUES AND OPTIONS (2006), available at <http://www.fao.org/docrep/010/a0701c/a0701e00.HTM>.

more greenhouse gas emissions as measured in CO<sub>2</sub> equivalent—18%—than transport.”<sup>18</sup>

Although scientists and policymakers have historically analyzed agriculture as independent from forestry and land use changes,<sup>19</sup> this Article argues these sectors are so interconnected that a broad definition of agriculture that incorporates all of them is appropriate. There are four reasons that this Article defines agriculture so broadly. First, suggestions by international bodies, such as the U.N.’s Intergovernmental Panel on Climate Change (“IPCC”), that seek to address the contributions of agriculture to climate change increasingly incorporate land use and forestry practices with their examination of farming.<sup>20</sup> This suggests interrelation between the sectors. Second, in many instances, agriculture and forestry practices are considered under a single umbrella for the purposes of economic analyses in a region.<sup>21</sup> Third, in both the United States and abroad, governments often address agriculture and forestry issues within a single legislative committee, providing further institutional support for defining agriculture as inclusive of farming, forestry, and land use activities.<sup>22</sup> Finally, in many cases, the primary reasons for problems associated with one sector are the direct result of activities undertaken to achieve results in another sector. Therefore solutions for one sector will necessarily affect the other. For example, the number one reason forests are cleared is for agriculture—both for crop farming and as grazing pastures for cattle.<sup>23</sup> Thus, any mitigation or adaptation

<sup>18</sup> The 18% figure represents emissions of carbon dioxide combined with the CO<sub>2</sub> equivalents for methane and nitrous oxide. *Livestock a Major Threat to Environment*, FAO NEWSROOM, Nov. 29, 2006, <http://www.fao.org/newsroom/en/news/2006/1000448/index.html> [hereinafter FAO Livestock].

<sup>19</sup> BAUMERT ET AL., *supra* note 8, at 4-6.

<sup>20</sup> “A variety of options exists for mitigation of GHG emissions in agriculture. The most prominent options are improved crop and grazing land management . . . restoration of organic soils that are drained for crop production and restoration of degraded lands. Lower but still significant mitigation is possible with improved water and rice management; set-asides, land use change (e.g., conversion of cropland to grassland) and agro-forestry; as well as improved livestock and manure management.” *Executive Summary: Agriculture*, in INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2007: MITIGATION OF CLIMATE CHANGE – CONTRIBUTION OF WORKING GROUP III TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 499 (Bert Metz et al. eds., Cambridge Univ. Press 2007), available at <http://www.ipcc.ch/ipccreports/ar4-wg3.htm> (follow “Chapter 8: Agriculture” hyperlink).

<sup>21</sup> See BRADLEY G. BOND, MISSISSIPPI: A DOCUMENTARY HISTORY 281 (Univ. Press of Miss. 2003). “Agriculture and forestry have been, are now and, for the foreseeable future, will remain the largest elements in the Mississippi economy.” *Id.*

<sup>22</sup> See generally U.S. Senate Comm. on Agriculture, Nutrition & Forestry, <http://agriculture.senate.gov/> (last visited Mar. 6, 2010); Canada’s Standing Comm. on Agriculture & Forestry, [http://www.parl.gc.ca/common/committee\\_Senhome.asp?Language=E&parl=40&Ses=2&comm\\_id=2](http://www.parl.gc.ca/common/committee_Senhome.asp?Language=E&parl=40&Ses=2&comm_id=2) (last visited Mar. 6, 2010); Parliament of Finland, Agriculture & Forestry Comm., <http://web.eduskunta.fi/Resource.phx/parliament/committees/agriculture.htx> (last visited Mar. 6, 2010).

<sup>23</sup> See Rhett A. Butler, *Deforestation in the Amazon*, <http://www.mongabay.com/brazil.html>

plans concerning deforestation will necessarily address farming activities, and vice versa.

Historically, the primary sources of atmospheric carbon dioxide (CO<sub>2</sub>) were plant respiration and the decomposition of organic matter, which both release ten times more carbon dioxide than human activities.<sup>24</sup> The atmosphere was capable of processing the carbon dioxide releases from these natural sources without substantial atmospheric warming because of the carbon dioxide absorbed by plant photosynthesis.<sup>25</sup> Unfortunately, human activities such as industrialization, deforestation and development, over the “last few hundred years” have increased so rapidly that the releases are no longer in balance with CO<sub>2</sub> emissions.<sup>26</sup> While the use of fossil fuels and changes in land use are primarily responsible for global increases in atmospheric concentrations of carbon dioxide,<sup>27</sup> increases in concentrations of the two other key GHGs—methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O)—are predominantly due to agriculture.<sup>28</sup>

Although human agricultural practices are contributing to increased emissions of the primary GHGs, there has been little effort made thus far to target agriculture through regulatory approaches.<sup>29</sup> This is problematic, as these increased emissions intensify and accelerate the global warming process.<sup>30</sup> The primary focus of regulation, both in the United States and abroad, has been limited to the transportation, energy, and industrial sectors, at the expense of other major contributors such as agriculture.<sup>31</sup> The UN has determined that to

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(last visited Mar. 3, 2010) (detailing the primary reasons for deforestation in the Brazilian Amazon. In order, they are: 1) clearing land for cattle pastures, 2) colonization and subsistence agriculture, 3) infrastructure improvements, 4) commercial agriculture, and 5) logging); David Pimentel, *Land Degradation and Environmental Resources*, available at [http://academic.cengage.com/resource\\_uploads/static\\_resources/0495015989/12886/mili15\\_essay\\_pimentel.pdf](http://academic.cengage.com/resource_uploads/static_resources/0495015989/12886/mili15_essay_pimentel.pdf) (last visited Mar. 17, 2010) (“[A]t least 24 million hectares (59 million acres) of forest are being cleared each year throughout the world; most of this land is used to grow food and graze cattle.”); UN FOOD & AGRIC. ORG., LIVESTOCK POLICY BRIEF: CATTLE RANCHING AND DEFORESTATION I, <ftp://ftp.fao.org/docrep/fao/010/a0262e/a0262e00.pdf> (last visited Mar. 3, 2010) (“During the 1990s, the portion of the globe covered by forests shrank by an estimated 94,000 square kilometres a year, an area roughly the size of Portugal. Most of the land that was cleared and burned was converted to growing crops and grazing livestock.”) [hereinafter LIVESTOCK POLICY BRIEF].

<sup>24</sup> U.S. DOT, *supra* note 1.

<sup>25</sup> *Id.*

<sup>26</sup> *Id.*

<sup>27</sup> INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS – CONTRIBUTION OF WORKING GROUP I TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 2-3 (Susan Solomon, et al. eds., Cambridge Univ. Press 2007), available at <http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-spm.pdf> [hereinafter IPCC 2007].

<sup>28</sup> *Id.*

<sup>29</sup> U.S. DOT, *supra* note 1 (follow “GHG Reduction Strategies” hyperlink).

<sup>30</sup> FAO Livestock, *supra* note 18.

<sup>31</sup> EESI, *supra* note 6. See also U.S. DOT, *supra* note 1; Europa, European Climate Change Programme, <http://ec.europa.eu/environment/climat/eccp.htm> (follow “Adaptation” hyperlink; then follow “EU Domestic Actions” hyperlink) (last visited Mar. 3, 2010) [hereinafter Europa --European

prevent the worst predicted effects of climate change from being realized and to limit global warming to an increase of no more than 2–3°C, the world must decrease its emissions by 26 billion tons by the year 2030.<sup>32</sup> To achieve these goals, no nation can afford to limit its focus to only one or two sources of GHG emissions. To do so limits any efforts from being made to address other major contributors to atmospheric concentrations of GHGs, such as agriculture.

This Article argues that to prevent the worst predicted effects of climate change, regulation at both international and national levels must address agricultural activities. Admittedly, human rights issues related to agriculture and sustainable farming practices are of critical importance, particularly in the developing world. However, this Article solely focuses on the need for a change in the approach to environmental policies without considering the social impacts of global warming. Part I identifies the problematic current trend of addressing climate change by only regulating the combustion of fossil fuels at the expense of other causes and explains agriculture's contribution to climate change. The section also summarizes the science surrounding climate change, the relationship between the three primary GHGs and climate change, and the specific agricultural practices that present problems for the environment. To illustrate the universal lack of regulation on agriculture's contribution to climate change, Part II examines various international treaties and State<sup>33</sup>-specific laws, including proposed measures that address climate change and then identifies their deficiencies. Part III proposes solutions that could be implemented for more holistic and successful climate change mitigation policies.

## I. AGRICULTURE'S CONTRIBUTION TO CLIMATE CHANGE

Climate change presents a serious threat to global security,<sup>34</sup> the global economy,<sup>35</sup> human health,<sup>36</sup> and even the continued existence of entire species

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CCP].

<sup>32</sup> David Adam, *UN: We Have the Money and Know-How to Stop Global Warming*, THE GUARDIAN, Apr. 28, 2007, available at <http://www.guardian.co.uk/environment/2007/apr/28/climatechange.climatechangeenvironment>.

<sup>33</sup> 'State' refers to the international meaning of the term, as in 'nation', and not as in a 'state in the United States'.

<sup>34</sup> A growing number of international leaders now warn that climate change is, in the words of U.K. Chief Scientific Advisor David King, "the most severe problem that we are facing today—more serious even than the threat of terrorism." JANET L. SAWIN, WORLD WATCH INSTITUTE, GLOBAL SECURITY BRIEF #3: CLIMATE CHANGE POSES GREATER SECURITY THREAT THAN TERRORISM (2005), available at <http://www.worldwatch.org/node/77>.

<sup>35</sup> "Global warming could cut the world's annual economic output by as much as 20% an influential report by Sir Nicholas Stern is expected to say. While that is a worst case scenario, the report claims that at the very best the cost of tackling global warming would be 1% of annual economic output." *Global Warming "Threat to Growth"*, BBC NEWS, Oct. 27, 2006, <http://news.bbc.co.uk/2/hi/business/6093396.stm>.

<sup>36</sup> David A. Fahrenthold & Juliet Eilperin, *Warming is Major Threat to Humans, EPA Warns*, WASH. POST, July 18, 2008, available at <http://www.washingtonpost.com/wp->

of animals<sup>37</sup> and communities of people.<sup>38</sup> Even when faced with a problem of such large proportions, many governments have failed to adopt comprehensive measures for mitigating climate change.<sup>39</sup> To meet the short- and long-term goals established to avoid the worst predicted effects of climate change, governments must implement measures account for all major anthropogenic sources of GHG emissions. Presently, though widespread consensus regarding the existence of climate change exists, some questions about how much human activities actually impact climate change remain.<sup>40</sup> Although advances in science leave little doubt that human actions are significantly contributing to climate change,<sup>41</sup> current legislative and regulatory proposals, treaties, and agreements fail to address anthropogenic sources of emissions. Instead, they are limited to activities in the transportation, industrial, and electric sectors.<sup>42</sup> The combustion of fossil fuels used in these sectors is a significant contributor to the problem of climate change and one that merits continued attention and regulation.<sup>43</sup> However, the disproportionate focus on these sources of emissions means some major sources of GHG emissions are ignored and remain unregulated.

The failure to initiate a global response to climate change derives from the failure to effectively regulate fossil fuels and provide attention to other significant contributors, like agriculture. During a conference held in Copenhagen, Denmark, in March of 2009, a group representing more than 1,600 scientists and other experts predicted that the “worst-case scenario trajectories” stated by the IPCC in 2007 are already being realized.<sup>44</sup> The report also noted that there is “a significant risk that many of the trends will accelerate, leading to

[dyn/content/article/2008/07/17/AR2008071701557.html](http://www.nature.org/content/article/2008/07/17/AR2008071701557.html).

<sup>37</sup> “Experts predict that one-fourth of Earth’s species will be headed for extinction by 2050 if the warming trend continues at its current rate.” Nature Conservancy, *Climate Change - Climate Change and Biodiversity: An Interactive Map*, <http://www.nature.org/initiatives/climatechange/strategies/art21202.html> (last visited Mar. 3, 2010).

<sup>38</sup> Henrique Almeida, *Maldives Warns Global Warming Threatening Islands*, REUTERS, Nov. 7, 2009, <http://www.reuters.com/article/idUSL07611784>. See also John D. Sutter, *Climate Change Threatens Way of Life in Shishmaref, Alaska*, CNN, Dec. 3, 2009, <http://edition.cnn.com/2009/TECH/science/12/03/shishmaref.alaska.climate.change/index.html>.

<sup>39</sup> See Europa - European CCP, *supra* note 31.

<sup>40</sup> See Foster Friess, *Leading Environmental Scientist Disputes Human Causes of Climate Change*, <http://www.fosterfriess.com/articles/20023/> (last visited Mar. 3, 2010).

<sup>41</sup> “Changes in the atmosphere, the oceans and glaciers and ice caps now show unequivocally that the world is warming due to human activities . . . .” *Evidence is Now “Unequivocal” that Humans are Causing Global Warming*, UN NEWS CENTRE, Feb. 2, 2007, <http://www.un.org/apps/news/story.asp?NewsID=21429&Cr=climate&Cr1=change>.

<sup>42</sup> See U.N. FCCC, *Kyoto Protocol*, <http://unfccc.int/resource/docs/convkp/kpeng.pdf> (last visited Feb. 9, 2010). See also American Clean Energy and Security Act of 2009, HR 2454, 111<sup>th</sup> Cong. (2009) [hereinafter ACES Act].

<sup>43</sup> BAUMERT ET AL., *supra* note 8, at 41-46.

<sup>44</sup> Frank McDonald, *Global Green New Deal Needed to Save the Planet*, IRISH TIMES, Mar. 18, 2009, available at <http://www.irishtimes.com/newspaper/opinion/2009/0318/1224243006437.html>.

an increasing risk of abrupt or irreversible climatic shifts.”<sup>45</sup> The article goes on to quote the assembled experts as stating the following:

Temperature rises above two degrees [Celsius] will be very difficult for contemporary societies to cope with, and will increase the level of climate disruption through the rest of the century. . . . ‘[R]apid, sustained and effective’ measures to reduce greenhouse gas emissions ‘based on co-ordinated global and regional action’ is now required to avoid dangerous climate change. ‘Weaker targets for 2020 increase the risk of crossing tipping points and make the task of meeting 2050 targets more difficult.’<sup>46</sup>

To effectively combat climate change and meet the goals set forth during the UN Framework Convention on Climate Change (“UNFCCC”), the global community must adopt policies that address all major sources of GHG emissions, including agriculture.

#### A. Agriculture as a Major Industry

Images of farmers who rise when the rooster crows to lovingly care for their animals and till their crops are largely romanticized notions of what once was—at least in the developed world. Rather than a small-scale production necessary to feed only one’s family or community, agriculture is one of the world’s largest industries. Agriculture employs nearly 1.3 billion people globally.<sup>47</sup> Modern factory farms produce the majority of farmed goods in the United States. These are “large operations using state-of-the-art computers, marketing consultants and technologies that cut labor, time and costs. The owners are frequently college graduates who are as comfortable with a spreadsheet as with a tractor. They cover more acres and produce more crops with fewer workers than ever before.”<sup>48</sup> Modern large-scale family farms are defined as those with profits of at least \$250,000 per year and make up only 7% of farms in the United States.<sup>49</sup> Nonetheless, these large-scale farms account for almost 60% of all production and receive over 54% of government agriculture subsidies.<sup>50</sup> In 2004 revenues for U.S. livestock and dairy operations exceeded \$120 billion.<sup>51</sup> Revenues from crop production added another \$116 billion in agricultural profits.<sup>52</sup>

Agriculture as a major global industry is not in and of itself problematic for

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<sup>45</sup> *Id.*

<sup>46</sup> *Id.*

<sup>47</sup> ELLIS, *supra* note 14, at 5.

<sup>48</sup> Gilbert Gaul et al., *Federal Subsidies Turn Farms Into Big Business*, WASH. POST, Dec. 21, 2006, available at <http://www.washingtonpost.com/wp-dyn/content/article/2006/12/20/AR2006122001591.html>.

<sup>49</sup> *Id.*

<sup>50</sup> *Id.*

<sup>51</sup> Viney P. Aneja et al., *Emerging National Research Needs for Agricultural Air Quality*, 87 EOS 3, 25, 29 (2006), available at [http://www.esa.org/AirWorkshop/files/EOS\\_Feature\\_Article.pdf](http://www.esa.org/AirWorkshop/files/EOS_Feature_Article.pdf).

<sup>52</sup> *Id.*



the environment. The danger agriculture presents stems from current farming practices and the resulting consequences for the ecosystem. The agricultural industry developed around a model that focused on maximizing profits rather than balancing growth in concert with environmentally sustainable practices.<sup>53</sup> Global water use patterns provide one example of the danger posed by contemporary agricultural practices. "In developing countries, agriculture uses 87% of total extracted water."<sup>54</sup> The developed world is no more efficient; for example, in the United States, agriculture is responsible for 80% to 90% of consumptive water use.<sup>55</sup> Worldwide, 70% to 90% of fresh water is used for agricultural irrigation.<sup>56</sup>

While agriculture is composed of many different practices, the primary activities responsible for the most burdensome effects on the environment include: (1) deforestation and harmful land use practices, (2) crop farming, and (3) animal farming. Before discussing how these agricultural practices contribute to climate change, it is important to understand the basic science of climate change. This basic understanding includes the difference between the many GHGs, how human activities contribute to the accumulation of GHGs, and the risks these emissions pose for the environment.

### *B. The Science Behind Climate Change*

Although a naturally occurring greenhouse effect is necessary for life to exist on Earth, humans are enhancing the natural warming cycle by adding chemicals that do not naturally occur in the atmosphere. The addition of new chemicals, and increased quantities of naturally occurring chemicals, is causing increased warming.<sup>57</sup> Rising temperatures accelerate evaporation rates, which in turn increases the atmospheric concentration of water vapor,<sup>58</sup> resulting in further

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<sup>53</sup> Anup Shah, *Poverty and the Environment*, <http://www.globalissues.org/article/425/poverty-and-the-environment#globalissues-org> (follow "Diverting Resources to Non-Productive Uses" hyperlink) (last visited Mar. 17, 2010).

<sup>54</sup> ELLIS, *supra* note 14, at 5.

<sup>55</sup> ENERGY CONSERVATION STRATEGIES COMM'N, DRAFT SUBCOMMITTEE REPORTS, BACKGROUND INFORMATION, AND INITIAL RESEARCH 253 (2008), available at <https://govconnect.alachuacounty.us/committees/ECSC/Strategies/olgies/combo/Shared%20Documents/DraftECSCBackgroundRpt.pdf> [hereinafter DRAFT Report].

<sup>56</sup> UN ENVIRONMENT PROGRAMME, A GLOBAL GREEN NEW DEAL- EXECUTIVE SUMMARY 11 (2009), available at <http://www.unep.org/greeneconomy/>. See also *No Global Water Crisis - but Many Developing Countries will Face Water Scarcity*, FAO NEWSROOM, Mar. 12, 2003, <http://www.fao.org/english/newsroom/news/2003/15254-en.html>.

<sup>57</sup> PEW CTR. ON GLOBAL CLIMATE CHANGE, CLIMATE CHANGE: SCIENCE, STRATEGIES & SOLUTIONS 7 (Eileen Claussen et al. eds., 2001) [hereinafter CLIMATE CHANGE: SCIENCE, STRATEGIES & SOLUTIONS].

<sup>58</sup> "Water Vapor is the most abundant greenhouse gas in the atmosphere . . ." Nat'l Oceanic and Atmospheric Admin., Greenhouse Gases, Frequently Asked Questions, <http://lwf.ncdc.noaa.gov/oa/climate/gases.html> (last visited Mar. 6, 2010).

warming.<sup>59</sup> This cycle has become known in the scientific community as the “enhanced greenhouse effect.”<sup>60</sup> This effect is responsible for much of the presently occurring and future predicted harms to the environment.<sup>61</sup>

This Article will focus on the primary GHGs—carbon dioxide, methane, and nitrous oxide. It will not focus on the “lesser GHGs,” which include sulfur hexafluoride, hydrofluorocarbons, perfluorocarbons, chlorofluorocarbons, and water vapor. The heat-trapping properties of the three primary GHGs are “undisputed,”<sup>62</sup> and the result of the increased atmospheric concentrations of these gases is an accelerated global warming process that is in part due to agricultural practices.<sup>63</sup> While “[t]he global increases in carbon dioxide concentration are due primarily to fossil fuel use and land use change, [] those of methane and nitrous oxide are primarily due to agriculture.”<sup>64</sup>

### 1. Carbon Dioxide (CO<sub>2</sub>)

At the most basic level, the science surrounding carbon, carbon dioxide, and the greenhouse effect is relatively simple. The majority of the earth’s carbon is found in plants and soil.<sup>65</sup> The carbon in plants comes from the carbon dioxide in the atmosphere, which is absorbed by leaves and crops during photosynthesis—the process during which sunlight is converted into food.<sup>66</sup> Plants, particularly trees, are so effective at removing carbon dioxide from the atmosphere that they are known as “carbon sinks” because they take in more carbon than they release.<sup>67</sup> “Trees grouped together in forests are even more efficient. Scientists estimate that the Earth’s forests currently store more than 75 % of the planet’s aboveground carbon. And the forests store almost that much of the planet’s soil carbon.”<sup>68</sup>

Carbon dioxide has been described as the most important of all GHGs

<sup>59</sup> CLIMATE CHANGE: SCIENCE, STRATEGIES & SOLUTIONS, *supra* note 57, at 7.

<sup>60</sup> *Id.* See also Atmosphere, Climate & Environment Information Programme, Encyclopedia of the Atmospheric Environment: Enhanced Greenhouse Effect, [http://www.ace.mmu.ac.uk/eae/Global\\_Warming/Older/Enhanced\\_Greenhouse\\_Effect.html](http://www.ace.mmu.ac.uk/eae/Global_Warming/Older/Enhanced_Greenhouse_Effect.html) (last visited Mar. 3, 2010); Adrienne Lewis & Doyle Rice, *Enhanced ‘Greenhouse Effect’ Causes Global Warming*, USA TODAY, April 16, 2008, available at [http://www.usatoday.com/weather/graphics/2008-04-14-global-warming-graphic\\_N.htm](http://www.usatoday.com/weather/graphics/2008-04-14-global-warming-graphic_N.htm); UNFCCC, The Greenhouse Effect and the Carbon Cycle, [http://unfccc.int/essential\\_background/feeling\\_the\\_heat/items/2903.php](http://unfccc.int/essential_background/feeling_the_heat/items/2903.php) [hereinafter UNFCCC Greenhouse Effect] (last visited Mar. 3, 2010).

<sup>61</sup> UNFCCC Greenhouse Effect, *supra* note 60.

<sup>62</sup> U.S. DOT, *supra* note 1.

<sup>63</sup> IPCC 2007, *supra* note 27, at 2.

<sup>64</sup> *Id.*

<sup>65</sup> Susan Gaidos, *For Kids: Getting the Dirt on Carbon*, SCIENCE NEWS, Mar. 2009, [http://www.sciencenews.org/view/generic/id/41298/title/FOR\\_KIDS\\_Getting\\_the\\_dirt\\_on\\_carbon](http://www.sciencenews.org/view/generic/id/41298/title/FOR_KIDS_Getting_the_dirt_on_carbon).

<sup>66</sup> *Id.*

<sup>67</sup> *Id.*

<sup>68</sup> *Id.*

because it is responsible for the largest proportion of “trace gases” in the atmosphere.<sup>69</sup> Sixty percent of the enhanced greenhouse effect has been attributed to carbon dioxide.<sup>70</sup> Atmospheric carbon dioxide comes from a variety of natural sources, including volcanic eruptions and as waste produced by animal respiration.<sup>71</sup> Human activities, however, like fossil fuel combustion, intensive tillage practices, and crop residue removal, are also major sources of atmospheric concentrations of carbon dioxide.<sup>72</sup> Modern, large-scale agricultural activities are particularly damaging. These practices clear land of trees capable of absorbing carbon dioxide and release significant amounts of carbon dioxide previously stored in the land through intensive tilling activities.<sup>73</sup> Agriculture also produces GHG emissions through the use of fossil fuels as an energy source for farm equipment, irrigation pumps, and other agricultural practices, such as the drying of grain.<sup>74</sup> Additionally, carbon dioxide is emitted during the manufacture of fertilizers and pesticides used in agricultural practices.<sup>75</sup>

With emissions of carbon dioxide continuing to increase, and a strained ecosystem less able to absorb as much carbon as it had in the past, scientific predictions are somber. Scientists predict that atmospheric concentrations of carbon dioxide will double the amount in existence prior to the Industrial Revolution by 2100, and possibly as soon as 2045.<sup>76</sup> Increased emissions and atmospheric concentrations of carbon dioxide result in higher atmospheric temperatures. In hotter climates the plants and soil are less able to soak up carbon than in cooler climates causing “permafrost to thaw, potentially releasing

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<sup>69</sup> CLIMATE CHANGE: SCIENCE, STRATEGIES & SOLUTIONS, *supra* note 57, at 15.

<sup>70</sup> BBC Weather Ctr., Climate Change: Carbon Dioxide, [http://www.bbc.co.uk/climate/evidence/carbon\\_dioxide.shtml](http://www.bbc.co.uk/climate/evidence/carbon_dioxide.shtml) (last visited Mar. 3, 2010) [hereinafter BBC Weather Ctr. CO2].

<sup>71</sup> *Id.*

<sup>72</sup> CHANTELE WASHENFELDER, KYOTO PROTOCOL: EFFECTS ON AGRICULTURE 2 (2000), available at <http://www.usask.ca/agriculture/caedac/pubs/ghgRhonda.PDF>.

<sup>73</sup> Seshadri Reddy & Chandra Seshadri, *Soil Carbon Sequestration in No-till Cotton Production Systems*, Paper presented at the annual meeting of the Soil and Water Conservation Society, July 26, 2008, available at [http://www.allacademic.com/meta/p\\_mla\\_apa\\_research\\_citation/2/7/4/9/4/p274949\\_index.html](http://www.allacademic.com/meta/p_mla_apa_research_citation/2/7/4/9/4/p274949_index.html). See also James J. Hooran, et al., *Using Cover Crops to Convert to No-Till* (Ohio State Univ. 2009), available at <http://ohioline.osu.edu/sag-fact/pdf/0011.pdf>.

<sup>74</sup> Evan Branosky, Policy Note, *Agriculture and Climate Change: The Policy Context*, WORLD RESOURCES INST. (2006), available at [http://pdf.wri.org/policynote\\_agriculture\\_climate.pdf](http://pdf.wri.org/policynote_agriculture_climate.pdf).

<sup>75</sup> *Id.*

<sup>76</sup> JAMES J. DOOLEY, ET AL., CARBON DIOXIDE CAPTURE AND GEOLOGIC STORAGE: A CORE ELEMENT OF A GLOBAL ENERGY TECHNOLOGY STRATEGY TO ADDRESS CLIMATE CHANGE 13 (2006), available at [http://www.pnl.gov/gtsp/docs/ccs\\_report.pdf](http://www.pnl.gov/gtsp/docs/ccs_report.pdf). See also ECOHHO – Green Energy Blog, What is CO<sub>2</sub> ... Lower Carbon footprint?, <http://ecohho.wordpress.com/2008/09/22/what-is-CO2-lower-carbon-footprint/> (last visited Mar. 18, 2010).

large quantities of methane.”<sup>77</sup>

## 2. Methane (CH<sub>4</sub>)

Methane is an odorless, colorless gas that is also referred to as “marsh gas.”<sup>78</sup> “Methane is generated naturally by bacteria that break down organic matter,” and scientists estimate that it is twenty<sup>79</sup> to thirty<sup>80</sup> times more powerful than carbon dioxide.<sup>81</sup> The “power” of GHGs is measured by using the Global Warming Potential (“GWP”). The GWP is a comparison of the total warming effect a gas, other than carbon dioxide, over a set period of time, to the warming effect of carbon dioxide.<sup>82</sup> For methane, this means that the GWP of one ton is equal to twenty to thirty tons of carbon dioxide. While the increase in carbon dioxide emissions since pre-industrial times is significant—around 31%—atmospheric concentrations of methane have doubled during the same period.<sup>83</sup> Furthermore, human activities are responsible for “one and a half times as much methane as all natural sources.”<sup>84</sup>

Methane released from the sea floor approximately 55 million years ago caused global temperatures to rise “by 4-8 degrees Celsius,”<sup>85</sup> and it took the earth almost 100,000 years to return to a “normal state.”<sup>86</sup> Presently, methane is

<sup>77</sup> NICHOLAS STERN, *THE ECONOMICS OF CLIMATE CHANGE: THE STERN REVIEW 2* (Cambridge Univ. Press 2006), available at [http://www.hm-treasury.gov.uk/stern\\_review\\_report.htm](http://www.hm-treasury.gov.uk/stern_review_report.htm) (follow “Chapter 1: The science of climate change” hyperlink).

<sup>78</sup> *Large Methane Release Could Cause Abrupt Climate Change As Happened 635 Million Years Ago*, SCIENCE DAILY, May 29, 2008, available at <http://www.sciencedaily.com/releases/2008/05/080528140255.htm> [hereinafter SCIENCE DAILY] (citing Martin Kennedy et al., *Snowball Earth Termination by Destabilization of Equatorial Permafrost Methane Clathrate*, NATURE, May 29, 2008, at 642-45).

<sup>79</sup> U.S. Env'tl. Prot. Agency, Methane, <http://www.epa.gov/methane/> (last visited Mar. 6, 2010). See also BBC Weather Ctr., Climate Change: Methane, <http://www.bbc.co.uk/climate/evidence/methane.shtml> (last visited Mar. 6, 2010) [hereinafter BBC Weather Ctr. Methane].

<sup>80</sup> SCIENCE DAILY, *supra* note 78.

<sup>81</sup> BBC Weather Ctr. CO<sub>2</sub>, *supra* note 70.

<sup>82</sup> “Emissions of other greenhouse gases (such as methane) can also be measured in ‘carbon dioxide equivalent’ units by multiplying their emissions (in metric tons) by their global warming potentials (GWPs). Carbon dioxide equivalents are the amount of carbon dioxide by weight emitted into the atmosphere that would produce the same estimated radiative forcing as a given weight of another radiatively active gas.” ENERGY INFO. ADMIN., EMISSIONS OF GREENHOUSE GASES IN THE UNITED STATES 2003 (2004), <http://www.eia.doe.gov/oiaf/1605/archive/gg04rpt/units.html>.

<sup>83</sup> NOAM MOHR, A NEW GLOBAL WARMING STRATEGY: HOW ENVIRONMENTALISTS ARE OVERLOOKING VEGETARIANISM AS THE MOST EFFECTIVE TOOL AGAINST CLIMATE CHANGE IN OUR LIFETIMES 2 (EARTHSAVE INTL. 2005), available at [http://www.earthsave.org/news/earthsave\\_global\\_warming\\_report.pdf](http://www.earthsave.org/news/earthsave_global_warming_report.pdf).

<sup>84</sup> *Id.*

<sup>85</sup> SCIENCE DAILY, *supra* note 78.

<sup>86</sup> Bruce Malfait, *Rapid Release of Sea-Floor Methane Caused Extreme Global Warming 55 Million Years Ago*, INNOVATIONS REPORT, May 13, 2003, available at [http://www.innovations-report.com/html/reports/earth\\_sciences/report-18375.html](http://www.innovations-report.com/html/reports/earth_sciences/report-18375.html).

credited as the source of 20% of the enhanced greenhouse effect.<sup>87</sup> While the majority of methane is emitted through livestock digestive processes,<sup>88</sup> there are many other causes of methane releases, including both anthropogenic and natural sources.<sup>89</sup> Natural sources of methane emissions “include wetlands, gas hydrates, permafrost, termites, oceans, freshwater bodies, non-wetland soils, and other sources such as wildfires.”<sup>90</sup> However, human-related activities have overtaken these natural sources of methane emissions. Anthropogenic sources are responsible for some 60% of global methane emissions, including fossil fuel combustion, animal husbandry, rice farming, burning of biomass, and waste management.<sup>91</sup>

Increased methane emissions present a variety of serious environmental challenges. First, there are concerns that the release of methane has the potential to cause major oceanic extinctions.<sup>92</sup> When methane is released into the atmosphere it reacts with oxygen and forms carbon dioxide, which can cause marine dysoxia.<sup>93</sup> Marine dysoxia kills oxygen-using animals, which could cause the extinction of many species of animals living in the ocean.<sup>94</sup> Another serious threat is that methane currently trapped in ice sheets will be released due to climate change, causing a rapid rise in global temperatures and triggering a new environmental era. Martin Kennedy, a professor of geology at the University of California-Riverside, led a team of scientists who explored the consequences of the last major methane release on earth some 635 million years ago. That release was far more substantial than the release 55 million years ago discussed above.<sup>95</sup> The scientists concluded that a sudden release of methane previously trapped in ice sheets resulted in an extreme change in the global climate by setting off a chain of events that caused substantial global warming and marked the end of the earth’s last “snowball ice age.”<sup>96</sup> Describing why an event that occurred more than 600 million years is relevant today, Professor Kennedy stated:

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<sup>87</sup> BBC Weather Ctr. Methane, *supra* note 79.

<sup>88</sup> Branosky, *supra* note 74.

<sup>89</sup> U.S. Evtl. Prot. Agency, Methane: Sources and Emissions, <http://www.epa.gov/methane/sources.html> (last visited Mar. 6, 2010) [hereinafter EPA].

<sup>90</sup> *Id.* See also CLIMATE CHANGE 2001: WORKING GROUP I: THE SCIENTIFIC BASIS, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (Cambridge Univ. Press 2001), available at <http://www.ipcc.ch/ipccreports/tar/wg1/127.htm> (follow “4.2.1.1 Methane (CH<sub>4</sub>)” hyperlink) [hereinafter IPCC 2001].

<sup>91</sup> EPA, *supra* note 89. See also IPCC 2001, *supra* note 90.

<sup>92</sup> SCIENCE DAILY, *supra* note 78.

<sup>93</sup> *Id.*

<sup>94</sup> *Id.*

<sup>95</sup> *Id.*

<sup>96</sup> *Id.* “The snowball Earth hypothesis posits that the Earth was covered from pole to pole in a thick sheet of ice for millions of years at a time.” *Id.*

Once methane was released at low latitudes from destabilization in front of ice sheets, warming caused other clathrates ["solid cages of water that form around small gas molecules such as methane, hydrogen, or carbon dioxide"<sup>97</sup>] to destabilize because clathrates are held in a temperature-pressure balance of a few degrees. . . . But not all the Earth's methane has been released as yet. These same methane clathrates are present today in the Arctic permafrost as well as below sea level at the continental margins of the ocean, and remain dormant until triggered by warming. *This is a major concern because it's possible that only a little warming can unleash this trapped methane.* Unzipping the methane reservoir could potentially warm the Earth tens of degrees, and the mechanism could be geologically very rapid. Such a violent, zipper-like opening of the clathrates could have triggered a catastrophic climate and biogeochemical reorganization of the ocean and atmosphere around 635 million years ago.<sup>98</sup>

In other words, the methane released from ice sheets approximately 635 million years ago—a release which transformed the earth from one giant ice sheet into a climate habitable by plant and animal life—was only a partial release. Methane hydrates are still stored in ice sheets and glaciers, but a continued rise in global temperatures threatens to melt these ice sheets and release the methane. One potential result of another abrupt release of methane into the atmosphere is a rise in global temperatures so significant that our planet could no longer sustain existing forms of plant and animal life.

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<sup>97</sup> "Methane hydrates are of interest as a potential energy source. It is estimated that the amount of methane in hydrates is equivalent to twice that of all other fossil fuels combined. It has been hypothesized that methane hydrate dissociation may explain a 4-8°C temperature rise over approximately 10<sup>3</sup> years." NSF CRC Project on Gas Hydrates, <http://sag1.chem.pitt.edu/clathrate/> (last visited Mar. 3, 2010).

<sup>98</sup> SCIENCE DAILY, *supra* note 78.

### 3. Nitrous Oxide (N<sub>2</sub>O)

The final primary gas that contributes to climate change, and the most powerful of the three GHGs, is nitrous oxide. Commonly known as “laughing gas,” nitrous oxide is colorless and non-flammable.<sup>99</sup> It is generated by microbial reactions in water and soil.<sup>100</sup> Nitrous oxide remains in the atmosphere for as long as 150 years,<sup>101</sup> and “the GWP [for NO<sub>2</sub> is] 310, making it a far more potent [GHG] than CH<sub>4</sub> or CO<sub>2</sub>.”<sup>102</sup> One ton of nitrous oxide has the equivalent warming effect of 310 tons of carbon dioxide, meaning that “the cumulative effect of any human-induced or anthropogenic emissions of nitrous oxide will be greater than those of carbon dioxide.”<sup>103</sup>

Although nitrous oxide has natural and anthropogenic sources, emissions resulting from human activities outweigh emissions from nature. Nitrous oxide is naturally generated by oceans and rainforests, and is even found in soil.<sup>104</sup> Even considering this variety of natural sources, experts attribute the 8.8% increase in atmospheric concentrations of nitrous oxide since industrialization to human activities.<sup>105</sup> The primary anthropogenic source of the increase in nitrous oxide emissions is the use of nitrogen fertilizers.<sup>106</sup> Globally, the production of fertilizer deposits 55 Teragrams (Tg)<sup>107</sup> of nitrogen into the soil annually.<sup>108</sup> “Nitrogen [fertilizer] is made either by mining nitrates or by ‘fixing’ atmospheric nitrogen (into the usable form of nitrate or ammonium) by industrial processes. When this artificially enriched soil is denitrified, or when [fertilizers] leach into groundwater, nitrous oxide goes into the atmosphere.”<sup>109</sup> Another anthropogenic source of nitrous oxide emissions is deforestation, particularly of tropical rainforests. Emissions of nitrous oxide increase three-fold when rainforests are converted to pastures for agricultural use.<sup>110</sup> “All in

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<sup>99</sup> Nat’l Oceanic & Atmospheric Admin., Chemical Datasheet: Nitrous Oxide, <http://cameochemicals.noaa.gov/chemical/8909> (last visited Mar. 16, 2010).

<sup>100</sup> THE NATIONAL ACADEMIES PRESS, CLIMATE CHANGE SCIENCE: AN ANALYSIS OF SOME KEY QUESTIONS (2001), [http://www.nap.edu/openbook.php?record\\_id=10139&page=1](http://www.nap.edu/openbook.php?record_id=10139&page=1).

<sup>101</sup> BBC Weather Center, Climate Change: Nitrous Oxide, [http://www.bbc.co.uk/climate/evidence/nitrous\\_oxide.shtml](http://www.bbc.co.uk/climate/evidence/nitrous_oxide.shtml) (last visited Mar. 3, 2010).

<sup>102</sup> Branosky, *supra* note 74.

<sup>103</sup> BBC Weather Center, Climate Change: Earth Gases - Nitrous Oxide, [http://www.bbc.co.uk/weather/features/gases\\_nitrousoxide.shtml](http://www.bbc.co.uk/weather/features/gases_nitrousoxide.shtml) (last visited Mar. 6, 2010) [hereinafter BBC Weather Center CC].

<sup>104</sup> Forecast Earth, Greenhouse Gases: Nitrous Oxide, <http://climate.weather.com/science/greenhouse-gases/nitrous.html> (last visited Mar. 3, 2010).

<sup>105</sup> BBC Weather Center CC, *supra* note 103.

<sup>106</sup> *Id.*

<sup>107</sup> One Teragram is equal to one million metric tons. See William H. Schlesinger, *Ecofocus: Even Older Forests Help Control CO<sub>2</sub>*, June 10, 2007, [http://www.ecostudies.org/ecofocus\\_2007-06-10.html](http://www.ecostudies.org/ecofocus_2007-06-10.html).

<sup>108</sup> BBC Weather Center CC, *supra* note 103.

<sup>109</sup> *Id.*

<sup>110</sup> INST. OF SCI. IN SOC’Y, FEEDING THE WORLD UNDER CLIMATE CHANGE (2004),

all, land conversion is leading to the release of around half a million [tons] a year of nitrogen in the form of nitrous oxide."<sup>111</sup> The primary risk of harm related to nitrous oxide emissions is the length of time it takes for the gas to leave the earth's atmosphere, making it a substantial contributor to the enhanced greenhouse effect.

## II. AGRICULTURAL PRACTICES THAT CONTRIBUTE TO INCREASED ATMOSPHERIC CONCENTRATIONS OF GHGs

Human activities have caused a dramatic increase in atmospheric levels of the key GHGs, and no activity has been as transformative as agriculture. Land used for agricultural activities covers 40% to 50% of the earth's ground surface, and GHG emissions attributed to agricultural production increased 17% globally between 1990 and 2005.<sup>112</sup> Agriculture, as such a large and rapidly growing industry, represents one of the largest threats to the environment. For the same reasons, it simultaneously presents one of the biggest opportunities to reduce emissions and atmospheric concentrations of the primary GHGs, and therefore significantly reduce the enhanced greenhouse effect.

In preparation for the 2009 Copenhagen Climate Change Conference, the UN prepared a report evaluating the predicted savings, measured in million tons carbon dioxide equivalent, which would result from improved practices in transportation, industrial, energy supply, agriculture and forestry, buildings, and waste sectors.<sup>113</sup> The results confirm that agriculture provides one of the largest opportunities for curbing global GHG emissions.<sup>114</sup> The potential environmental savings by 2030 for the agriculture and forestry sector<sup>115</sup> are estimated to be 6 billion tons CO<sub>2</sub> equivalent, which is second only to industry (estimated to save 6.5 billion tons), and is almost double the potential savings of transport (3.2 billion tons).<sup>116</sup> To develop solutions that will effectively mitigate the harm being exerted on the ecosystem by agriculture it is important to understand how agricultural practices contribute to climate change.

### A. Deforestation and Harmful Land Use Practices

Deforestation is the process of changing forested lands into non-forested land uses; that is, the removal of trees from an area without reciprocal reforestation

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<http://www.i-sis.org.uk/FTWUCC.php>.

<sup>111</sup> *Id.*

<sup>112</sup> ELLIS, *supra* note 14, at 5.

<sup>113</sup> Adam, *supra* note 32.

<sup>114</sup> *Id.*

<sup>115</sup> These sectors, and the calculated potential savings figure, were combined in the article and not for the purposes of this paper.

<sup>116</sup> Adam, *supra* note 32.



efforts.<sup>117</sup> “The clearing of the forests has been one of the most historic and prodigious feats of humanity. About one half of the forests that covered the Earth are gone.”<sup>118</sup> According to the National Geographic Society, forests still cover approximately 30% of the earth’s surface, but each year deforestation results in the loss of forest cover equal to the size of Panama.<sup>119</sup> At present rates of deforestation the world could lose all of its rainforests in one hundred years.<sup>120</sup>

Forests are important to the global ecosystem because they provide habitats for wildlife,<sup>121</sup> influence regional climate and weather patterns, protect top soil, foster medicinal conservation,<sup>122</sup> recharge aquifers, and serve as storage for organic carbon.<sup>123</sup> Forests extract carbon dioxide from the atmosphere, and in so doing contribute to the stability of the environment.<sup>124</sup> Without the sun-blocking cover of trees, normally moist soils dry out and are depleted of the nutrients necessary for carbon capture.<sup>125</sup> The absence of tree cover and increased ground temperatures lead to more extreme temperature changes between the day and night, which further harms plants and animals.<sup>126</sup> Trees are also a necessary part of maintaining the water cycle; absent the return of water vapor into the air, many deforested lands become barren deserts.<sup>127</sup> In summary, forests are critical to fighting global warming because of their ability to absorb “the greenhouse gases that fuel global warming.”<sup>128</sup> For example, for each two cubic meters of wood growth, forests can capture around one ton of carbon from the atmosphere.<sup>129</sup> “Fewer forests [mean] larger amounts of greenhouse gases

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<sup>117</sup> BRUNO GERVET, DEFORESTATION CONTRIBUTES TO GLOBAL WARMING 2 (2007), available at [http://www.ltu.se/polopoly\\_fs/1.5035!deforestation%20-%20final.pdf](http://www.ltu.se/polopoly_fs/1.5035!deforestation%20-%20final.pdf).

<sup>118</sup> *Id.*

<sup>119</sup> Nat’l Geographic, Deforestation, <http://environment.nationalgeographic.com/environment/global-warming/deforestation-overview.html> (last visited Mar. 3, 2010).

<sup>120</sup> *Id.*

<sup>121</sup> “Seventy percent of Earth’s land animals and plants live in forests . . .” *Id.*

<sup>122</sup> Rainforest plants are responsible for 25% of drugs used by Western medicine, but only about 1% of plants in the rainforest have been tested by scientists. Amer. Ass’n for Laboratory Animal Sci., Medicine and the Rainforests, [http://www.aalas.org/doc/Sect-2\\_4.doc](http://www.aalas.org/doc/Sect-2_4.doc) (last visited Mar. 3, 2010). “Experts estimate that we are losing 137 plant, animal, and insect species every single day due to rainforest deforestation.” *Id.*

<sup>123</sup> GERVET, *supra* note 117. See also The Global Change Program, Univ. of Mich., Global Deforestation, <http://www.globalchange.umich.edu/globalchange2/current/lectures/deforest/deforest.html> (last visited Mar. 3, 2010).

<sup>124</sup> GERVET, *supra* note 117.

<sup>125</sup> Nat’l Geographic, *supra* note 119.

<sup>126</sup> *Id.*

<sup>127</sup> *Id.*

<sup>128</sup> *Id.*

<sup>129</sup> UN FOOD & AGRIC. ORG., KYOTO PROTOCOL - IMPORTANT TOOL FOR SUSTAINABLE DEVELOPMENT (2005), <http://www.fao.org/newsroom/en/news/2005/89781/index.html> [hereinafter UN FAO KYOTO PROTOCOL].

entering the atmosphere—and increased speed and severity of global warming.”<sup>130</sup> Approximately six billion tons of carbon dioxide—representing one quarter of all GHGs—are released on an annual basis due to deforestation.<sup>131</sup>

The primary reason forests are cleared is agriculture, as land is cleared to grow crops and to provide grazing pastures for animals.<sup>132</sup> Deforestation is harmful to the environment not only because of the resulting environmental damage, but also because of the methods used to clear the land. Many common methods of deforestation, such as clear cutting,<sup>133</sup> partial cut harvesting,<sup>134</sup> and slash and burning, render the land useless for years. The most destructive of these three practices is slash and burn farming.

Slash and burn farming involves clearing forested land by burning down all vegetation and trees, freeing the terrain of most weeds, and providing a natural source of fertilizer for a few years to follow.<sup>135</sup> Unfortunately, after only a few years of cultivation the land becomes unusable and the farmer must then burn down another part of the forest to continue farming crops.<sup>136</sup> Most cleared areas are never restored to secondary forest bush and instead remain permanently deforested.<sup>137</sup> The use of slash and burn farming and the resulting permanent deforestation has become a significant contributor to carbon emissions and global climate change.<sup>138</sup> It is not only the method of farming, but the widespread use of the practice that contributes to environmental degradation.<sup>139</sup> It is estimated that 200 to 500 million people around the world use the slash and burn method.<sup>140</sup> The breadth of the practice is responsible for contributing “as

<sup>130</sup> Nat'l Geographic, *supra* note 119.

<sup>131</sup> UN FAO KYOTO PROTOCOL, *supra* note 129.

<sup>132</sup> Nat'l Geographic, *supra* note 119. See also Butler, *supra* note 23; LIVESTOCK POLICY BRIEF, *supra* note 23; Pimentel, *supra* note 23.

<sup>133</sup> Clear cutting is “the felling and removal of all trees from a given tract of forest.” Natural Res. Def. Council, What Is Clearcutting?, <http://www.nrdc.org/land/forests/fcut.asp> (last visited Mar. 16, 2010).

<sup>134</sup> “[T]he initial harvest does not remove all the merchantable trees from any unit of land.” Gov't of Alberta, Agric. & Rural Dev., Should You Harvest Timber?, [http://www1.agric.gov.ab.ca/\\$department/deptdocs.nsf/all/agdex3490](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex3490) (last visited Mar. 16, 2010).

<sup>135</sup> Encyclopedia Britannica, Slash-and-Burn Agriculture, *available at* <http://www.britannica.com/EBchecked/topic/548086/slash-and-burn-agriculture> (last visited Mar. 3, 2010).

<sup>136</sup> *Id.*

<sup>137</sup> *Id.*

<sup>138</sup> Mary Spiro, *Ancient Slash-and-Burn Farming Method May Have Altered Global Climate*, BOSTON SCIENCE NEWS EXAMINER, Aug. 17, 2009, *available at* <http://www.examiner.com/x-6378-Baltimore-Science-News-Examiner-y2009m8d17-Ancient-slashandburn-farming-method-may-have-altered-global-climate>.

<sup>139</sup> See Wu Zhongmin & Zhou Guangyi, *Ecological Consequences of Slash-and-Burn Agriculture in the Tropical Areas of China*, 25 *AMBIO* 3, 210-11 (1996), *available at* <http://www.jstor.org/pss/4314455>. See also Butler, *supra* note 23.

<sup>140</sup> INSTITUT DE RECHERCHE POUR LE DÉVELOPPEMENT, ACTUALITÉ SCIENTIFIQUE, A ROLE FOR SLASH AND BURN FARMING IN GREENHOUSE EFFECT CONTROL (2008), *available at* <http://www.ird.fr/us/actualites/fiches/2008/fas307.pdf>.

much as 25% to global warming.”<sup>141</sup>

The incineration of fossil fuels and deforestation (particularly in the tropics) combined with the resulting land use changes represent as much as 33% of total anthropogenic carbon dioxide emissions.<sup>142</sup> To gain a more complete picture of present harms that have been caused by deforestation, scientist James Randerson spearheaded a six-year study that focused on the connection between deforestation, droughts, and global warming.<sup>143</sup> Randerson measured atmospheric carbon dioxide levels resulting from deforestation in Asia to determine carbon dioxide emissions from forests during the six year period and concluded that “deforestation and carbon emissions are substantial and important contributors to the buildup of greenhouse gases in the atmosphere.”<sup>144</sup> Randerson reached this conclusion by analyzing satellite images showing climate and fire patterns.<sup>145</sup> Studying these images, Randerson discovered that the use of fire to clear forested lands and remove organic soil increased substantially during dry years, resulting in the release of “huge amounts” of carbon dioxide.<sup>146</sup> The study also found that the climate in New Guinea, the islands of Sumatra and Borneo, and other regions of equatorial Asia in 2006 was three times drier than just six years earlier. However, “carbon emissions from deforestation were 30 times greater—exceeding emissions from fossil fuel burning.”<sup>147</sup> Randerson, concerned with warming temperatures in the region that could result in the increasing frequency of fires and deforestation, stated that the relationship between deforestation and drought is “very sensitive.”<sup>148</sup>

### *B. Crop Farming*

The most commonly utilized crop farming practices in the world are typically classified as either extensive or intensive agriculture. Extensive agriculture is a farming practice that uses small amounts of labor and money relative to the size of the land being farmed.<sup>149</sup> Extensive agriculture is dependent on the fertility of the soil, the climate, and an available water supply.<sup>150</sup> The impacts on the

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<sup>141</sup> Global Env't Facility, *Alternatives to Slash and Burn*, [http://www.gefweb.org/Outreach/outreach-PUBlications/Project\\_factsheet/Global-alte-1-cc-undp-eng-ld.pdf](http://www.gefweb.org/Outreach/outreach-PUBlications/Project_factsheet/Global-alte-1-cc-undp-eng-ld.pdf) (last visited Mar. 6, 2010).

<sup>142</sup> IPCC 2007, *supra* note 27.

<sup>143</sup> Jennifer Fitzenberger, *Global Warming Aided By Drought, Deforestation*, UNIV. OF CAL., IRVINE, Dec. 8, 2008, <http://www.universityofcalifornia.edu/news/article/19124>.

<sup>144</sup> *Id.*

<sup>145</sup> *Id.*

<sup>146</sup> *Id.*

<sup>147</sup> *Id.*

<sup>148</sup> *Id.*

<sup>149</sup> Encyclopedia Britannica, *Extensive Agriculture*, available at <http://www.britannica.com/EBchecked/topic/198903/extensive-agriculture> (last visited Mar. 3, 2010).

<sup>150</sup> *Id.*

land and ecosystem resulting from this method of agriculture include: "increased variability and changes to seasonality of rainfall; reduced soil moisture; changes to the dynamics of pests, diseases and weeds; increased heat shock/stress; reduced grain quality /nutrient content; and increased yields in higher rainfall areas due to decreased incidence of soil water logging."<sup>151</sup>

Intensive agriculture relies on a significant amount of labor and money relative to the size of the land being farmed.<sup>152</sup> Farmers who utilize intensive farming rely heavily on fertilizers, fungicides, insecticides, and herbicides to assist with crop growth, as well as high-efficiency machinery and irrigation systems.<sup>153</sup> This type of farming impacts the ecosystem by:

decreased frost frequency, [which causes] changes in crop selection to take into account vernalisation requirements [and] expansion of frost sensitive crops into current frost risk areas; increased temperature [and] CO<sub>2</sub>. . . which affects the water demand and causes changes in the harvesting and sowing periods; "altered range and incidence of pests and diseases; [and] reduced quality (nutritional, appearance due to water/temp stress, and increased CO<sub>2</sub> concentrations).<sup>154</sup>

In addition to extensive and intensive farming practices, other elements of agriculture that significantly impact the environment include the use of machinery, products such fertilizers and pesticides, and even the choice of crops that a farmer grows. For example, rice production contributes substantially to the increase in atmospheric levels of GHGs.

The process of farming rice requires farmers to prepare fields, flood the fields with water, and then air-drop the seeds.<sup>155</sup> The fields remain flooded by an irrigation system throughout the growing season and then are dried in preparation for harvest.<sup>156</sup> Flooding fields to farm rice produces the perfect environment for bacteria to grow and thrive.<sup>157</sup> The bacteria living in the

<sup>151</sup> AUSTL. DEP'T. OF ENV'T, WATER, HERITAGE & THE ARTS, TECHNICAL REPORT NO. 5: RURAL LANDHOLDERS ADAPTING TO CLIMATE CHANGE 10 (2008), [http://athene.riv.csu.edu.au/~acurtis/reports/No%205\\_P2\\_Mazur\\_climate%20change.pdf](http://athene.riv.csu.edu.au/~acurtis/reports/No%205_P2_Mazur_climate%20change.pdf) [hereinafter TECHNICAL REPORT NO. 5].

<sup>152</sup> Encyclopedia Britannica, Intensive Agriculture, available at <http://www.britannica.com/EBchecked/topic/289876/intensive-agriculture> (last visited Mar. 3, 2010).

<sup>153</sup> *Id.*

<sup>154</sup> TECHNICAL REPORT NO. 5, *supra* note 151 at 10.

<sup>155</sup> Patty Arnold, Season of Rice: Learning the Process, <http://www.pattyarnold.com/process.html> (last visited Mar. 3, 2010).

<sup>156</sup> *Id.*

<sup>157</sup> Associated Press, *Experts: Rice Farming Huge Source of Methane Emissions*, FOX NEWS, May 2, 2007, <http://www.foxnews.com/story/0,2933,269478,00.html>.

flooded fields produce methane by decomposing manure and other organic matter, and then emit the methane through the plants or directly into the atmosphere.<sup>158</sup> In an interview with the Associated Press, Reiner Wassmann, a specialist on climate change at the International Rice Research Institute in the Philippines, stated that “[t]here is no other crop that is emitting such a large amount of greenhouse gases.”<sup>159</sup> Wassmann’s interview was conducted shortly after the Spring 2007 IPCC meeting in Bangkok, Thailand.<sup>160</sup> During this meeting the IPCC released a report concluding “rice production was a main cause of rising methane emissions in the 20th century.”<sup>161</sup>

### *C. Livestock Farming*

Even with all of the problems that crop farming can cause for the environment, these practices pale in comparison to the environmental harm exacted through livestock agriculture. Approximately 30% of the earth’s surface is devoted to livestock production.<sup>162</sup> In the continental United States, 50% of the total land area is covered by grasslands used as grazing land for livestock.<sup>163</sup> The majority of this land is used as permanent pastures, although a considerable amount is used for the production of livestock feed.<sup>164</sup> Livestock farming is perhaps the most significant agricultural practice if measured by its contribution to climate change.<sup>165</sup> The livestock sector alone accounts for 40% of the total agricultural Gross Domestic Product (GDP).<sup>166</sup> The farming of animals accounts for 18% of GHG emissions globally—which is greater than the entire transport sector—and plays a large role in the loss of biodiversity and increasing shortages of water.<sup>167</sup> Livestock farming is also a major cause of deforestation as land is cleared to create grazing pastures.<sup>168</sup> Approximately 70% of land in the Amazon has been deforested for the purpose of livestock

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<sup>158</sup> *Id.*

<sup>159</sup> *Id.*

<sup>160</sup> *Id.*

<sup>161</sup> *Id.*

<sup>162</sup> FAO Livestock, *supra* note 18.

<sup>163</sup> JAMES R. GILLESPIE, MODERN LIVESTOCK & POULTRY PRODUCTION 9 (Delmar Thompson Learning, 7th ed. 2004).

<sup>164</sup> FAO Livestock, *supra* note 18.

<sup>165</sup> *Id.*

<sup>166</sup> ELLIS, *supra* note 14, at 12. “Agricultural GDP is the Gross Domestic Product (GDP) coming from the agricultural sector. Total GDP is defined as the sum of the value added from total agriculture, industry and the services sectors. If the value added of these sectors is calculated at purchaser values, total value added is derived by subtracting net product taxes from GDP.” UN Educ., Scientific & Cultural Org., World Water Assessment Program, <http://www.unesco.org/water/wwap/wwdr/indicators/> (follow “Agriculture GDP as share of total GDP” hyperlink) (last visited Mar. 16, 2010).

<sup>167</sup> FAO Livestock, *supra* note 18. *See also* ELLIS, *supra* note 14, at 12.

<sup>168</sup> FAO Livestock, *supra* note 18.

grazing.<sup>169</sup> The amount of crops produced exclusively for animal consumption is also staggering. For example, the average cow consumes about 900 pounds of vegetation every month.<sup>170</sup>

Livestock farming contributes to climate change through the emission of GHGs. Factoring in land use and land use changes, livestock farming accounts for 9% of anthropogenic carbon dioxide emissions, 37% of methane emissions, and 65% of nitrous oxide emissions.<sup>171</sup> Scientists estimate that animal husbandry may be responsible for the release of more than 500 million tons of methane into the atmosphere annually.<sup>172</sup> “The world’s 1.3 billion cattle and other ruminant livestock emit about 60 million tons of the total, or 12% of all the methane released into the atmosphere. The burning of forests, grasslands, and agricultural wastes releases an additional 50 to 100 million tons of methane.”<sup>173</sup>

Contemporary livestock agriculture practices also represent a highly inefficient use of both energy and resources. Even though “the ratio of energy use to agricultural output has fallen by about 50 percent since 1978,”<sup>174</sup> the amount of energy required to produce one calorie of meat far outweighs the caloric value realized.<sup>175</sup> As a basis for comparison, one calorie of energy expended to grow corn results in four calories of edible food—a 1:4 ratio.<sup>176</sup> The ratio of energy expended for animal farmed goods compared to the caloric value realized is 4:1 for chicken, 10:1 for turkey, 14:1 for both dairy and swine, 39:1 for eggs, 40:1 for beef cattle, and 57:1 for lamb.<sup>177</sup>

Another indication of the environmental harm resulting from existing livestock agricultural practices is the amount of water consumed. Estimates of the amount of water needed to produce one kilogram of beef cattle vary widely, ranging from 3682 liters of water up to as many as 100,000 liters.<sup>178</sup> Compare this to the amount of water required for crops such as potatoes, which require only 500-630 liters per kilogram produced, or even one of the most water intensive crops—rice, which requires 1600 to 1912 liters per kilogram produced.<sup>179</sup> Given the existing water shortages in many arid regions of the

<sup>169</sup> *Id.*

<sup>170</sup> Interview with Jeremy Rifkin, president of the Foundation on Economic Trends, with the Animal Liberation Front (n.d.), available at <http://www.animalliberationfront.com/Practical/Health/BEYOND%20BEEF.htm> (last visited Mar. 3, 2010) [hereinafter Interview with Jeremy Rifkin].

<sup>171</sup> FAO Livestock, *supra* note 18.

<sup>172</sup> Interview with Jeremy Rifkin, *supra* note 170.

<sup>173</sup> *Id.*

<sup>174</sup> U.S. DEP’T. OF AGRIC., 2007 FARM BILL THEME PAPER: ENERGY AND AGRICULTURE I (2006), available at <http://www.usda.gov/documents/Farmbill07energy.pdf>.

<sup>175</sup> DRAFT Report, *supra* note 55.

<sup>176</sup> *Id.*

<sup>177</sup> *Id.*

<sup>178</sup> *Id.*

<sup>179</sup> *Id.*

world and the predicted increase in size and number of such regions as a result of global warming, regulation of agriculture is necessary. Such regulation presents a substantial opportunity for both climate change mitigation and adaptation in the area of water conservation. Unfortunately, such approaches have not been included in any of the few existing mechanisms adopted to address climate change.

### III. CURRENT MECHANISMS FOR COMBATING CLIMATE CHANGE

Most mechanisms developed to combat the effects of climate change focus on the use of fossil fuels in the energy, transportation, industry, and electric sectors, with little or no emphasis on agriculture. This section will examine the only legally binding, international, multilateral treaty addressing climate change—the Kyoto Protocol (“the Protocol”) to the UNFCCC and regional mechanisms put in place to carry out its goals. It will also examine other proposed mechanisms such as pending legislation in the United States and the agreements resulting from the Copenhagen Climate Change Conference of December 2009. There is a significant amount of scholarship devoted to how these various mechanisms address climate change, so this section will instead be dedicated to examining what is absent from the policies and procedures—agricultural initiatives.

#### *A. Kyoto Protocol*

The IPCC’s Third Assessment Report, created after meetings with more than 2000 scientific experts from around the world, projects that global temperatures could increase by as much as 5.8°C by 2100.<sup>180</sup> One of the first major, concerted, international environmental actions taken to address this risk was the establishment of the UNFCCC. One hundred and eighty six (186) countries are parties to the UNFCCC, including the United States and the European Community (“EC”).<sup>181</sup> Parties to the Convention committed to stabilizing their emissions of GHGs by the year 2000 to levels existing in 1990.<sup>182</sup>

To build on the goals established by the UNFCCC, in 1997 many countries adopted the Kyoto Protocol in Kyoto, Japan.<sup>183</sup> The Protocol entered into force in December of 2005.<sup>184</sup> The goal of the Protocol is to achieve “stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent

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<sup>180</sup> Europa, *The Kyoto Protocol and climate change—background information*, May 31, 2002, <http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/02/120&format=HTML&aged=0&language=EN&guiLanguage=en> [hereinafter *Europa-Kyoto and CC*].

<sup>181</sup> *Id.*

<sup>182</sup> *Id.*

<sup>183</sup> *Kyoto Protocol, UN Framework Convention on Climate Change, available at* [http://unfccc.int/kyoto\\_protocol/items/2830.php](http://unfccc.int/kyoto_protocol/items/2830.php) (last visited Mar. 6, 2010) [hereinafter *UNFCCC Kyoto*].

<sup>184</sup> *Id.*

dangerous anthropogenic interference with the climate system.”<sup>185</sup> It goes beyond the UNFCCC by requiring developed nations to reduce emissions of GHGs from 1990 levels by 5% by 2012.<sup>186</sup> To achieve a 5% cut in global emissions of the six key GHGs by the period 2008-2012, countries considered the worst polluters committed to reducing emissions by upwards of 8%, while some developing nations were permitted to increase emissions by as much as 10%.<sup>187</sup> Although a 5% reduction in global emissions is the goal, actual reductions of GHG emissions will be significantly larger than this percent. “[F]or the developed countries as a whole, the 5% Protocol target represents an actual cut of around 20% when compared with the emissions levels that are projected for 2010 if no emissions-control measures are adopted.”<sup>188</sup>

To achieve these reductions, Kyoto established commitments that are legally binding for the parties that have signed onto the agreement. These commitments aim to: (1) reduce emissions of the primary GHGs discussed in this Article, along with sulphur hexafluoride; (2) reduce hydrofluorocarbons and perfluorocarbons produced by industrialized countries; and (3) establish general commitments for all other nations.<sup>189</sup> To satisfy these objectives, countries are permitted to design a plan that works best for their particular circumstances.<sup>190</sup> The Protocol also allows for the use of mechanisms intended to provide developed nations with economic incentives to satisfy the GHG emissions limits, such as emissions trading, Clean Development Mechanism (“CDM”),<sup>191</sup> and joint implementation.<sup>192</sup>

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<sup>185</sup> UN FRAMEWORK CONVENTION ON CLIMATE CHANGE, Article 2: Objectives, *available at* [http://unfccc.int/essential\\_background/convention/background/items/1353.php](http://unfccc.int/essential_background/convention/background/items/1353.php) (last visited Mar. 3, 2010).

<sup>186</sup> Europa-Kyoto and CC, *supra* note 180.

<sup>187</sup> Eur. Comm’n., The Kyoto Protocol, <http://ec.europa.eu/environment/climat/kyoto.htm> (last visited Mar. 3, 2010).

<sup>188</sup> *Id.*

<sup>189</sup> UN FRAMEWORK CONVENTION ON CLIMATE CHANGE, KYOTO PROTOCOL: TARGETS, [http://unfccc.int/kyoto\\_protocol/items/3145.php](http://unfccc.int/kyoto_protocol/items/3145.php) (last visited Mar. 16, 2010).

<sup>190</sup> *Id.*

<sup>191</sup> “The Clean Development Mechanism (CDM), defined in Article 12 of the Protocol, allows a country with an emission-reduction or emission-limitation commitment under the Kyoto Protocol (Annex B Party) to implement an emission-reduction project in developing countries. Such projects can earn saleable certified emission reduction (CER) credits, each equivalent to one tonne of CO<sub>2</sub>, which can be counted towards meeting Kyoto targets.” UNFCCC, Clean Development Mechanism (CDM), [http://unfccc.int/kyoto\\_protocol/mechanisms/clean\\_development\\_mechanism/items/2718.php](http://unfccc.int/kyoto_protocol/mechanisms/clean_development_mechanism/items/2718.php) (last visited Mar. 3, 2010).

<sup>192</sup> UNFCCC Kyoto, *supra* note 183. Joint implementation is found under “Article 6 of the Kyoto Protocol, [and] allows a country with an emission reduction or limitation commitment under the Kyoto Protocol (Annex B Party) to earn emission reduction units (ERUs) from an emission-reduction or emission removal project in another Annex B Party, each equivalent to one tonne of CO<sub>2</sub>, which can be counted towards meeting its Kyoto target.” UNFCCC, Joint Implementation (JI), [http://unfccc.int/kyoto\\_protocol/mechanisms/joint\\_implementation/items/1674.php](http://unfccc.int/kyoto_protocol/mechanisms/joint_implementation/items/1674.php) (last visited Mar. 6, 2010).



The Kyoto Protocol emphasizes the importance of reducing emissions from agriculture almost as much as it discusses reductions in the transport, energy, and industry sectors. Article 2 of the Kyoto Protocol states that Parties “shall” promote sustainable agricultural practices and Article 10 requires the Parties to formulate plans for mitigating climate change and to develop measures to facilitate adaptation.<sup>193</sup> Any plan developed in accordance with Article 10 “would” take into account agriculture, forestry, and waste management in addition to industry, energy, and transportation.<sup>194</sup> Additionally, the Protocol recognizes the importance of forests as natural carbon sinks.<sup>195</sup> Under the flexible mechanisms it allows developed countries with the ability to “offset a limited amount of their emission reduction commitments through investments in projects in developing countries, which sequester carbon. For the amount of carbon sequestered the country receives certified emissions reductions, which can then be traded [with other countries].”<sup>196</sup>

The Protocol’s approach to agriculture provides a good foundation for the Parties to develop climate change mitigation and adaptation plans that include the regulation of agricultural practices. The Protocol explicitly calls on Parties to incorporate agriculture into any climate change mitigation plan<sup>197</sup> and emphasizes the potential benefits this would have on the environment and the economy.<sup>198</sup> However, the Protocol does not mandate that Parties take specific actions; instead, it provides a good deal of flexibility in how Parties can incorporate agriculture into a mitigation plan.<sup>199</sup> The absence of a specific plan allows individual countries to pursue policies that will have the greatest impact on climate change in their borders, without having to consider what would work best for all countries combined. Another significant aspect of the Protocol is that it can serve as a model for countries that have not signed on as parties, but are signatories to the UNFCCC and have therefore committed to reducing GHG emissions.

Unfortunately, the mechanisms adopted by most countries rely almost exclusively on regulating industry, transportation, and electricity.<sup>200</sup> The same limited focus exists in proposed climate change plans, the majority of which fail to fully appreciate the extent to which agriculture provides an opportunity to mitigate the negative effects of climate change. Absent a more comprehensive international mechanism, this is unlikely to change anytime in the near future.

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<sup>193</sup> Kyoto Protocol to the United Nations Framework Convention on Climate Change, Dec. 10, 1997, 37 I.L.M. 22 [hereinafter Kyoto Protocol].

<sup>194</sup> *Id.* at art. 10(b).

<sup>195</sup> UN FAO KYOTO PROTOCOL, *supra* note 129.

<sup>196</sup> *Id.*

<sup>197</sup> Kyoto Protocol, *supra* note 193.

<sup>198</sup> UN FAO KYOTO PROTOCOL, *supra* note 129.

<sup>199</sup> UNFCCC Kyoto, *supra* note 183.

<sup>200</sup> See generally *supra* note 6; Adam, *supra* note 32.

The regulation of the above mentioned sectors, which is viewed by the public as the regulation of businesses, receives less opposition than the regulation of agriculture. This is because agriculture is viewed by many as the regulation of individuals—a far more difficult political battle.

*B. The European Union's Climate Change Program and the United Kingdom's Climate Change Act*

Even before the EU and its member States completed the ratification process they began taking the steps necessary to achieve the emissions reductions goals set forth in Kyoto. In response, the European Commission (“the Commission”) launched the European Climate Change Programme (“ECCP”).<sup>201</sup> Prior to the creation of the ECCP, the Commission identified various initiatives as necessary for improving energy efficiency.<sup>202</sup> These initiatives included increasing the production of electricity from renewable sources, securing “voluntary commitments” by auto makers to cut carbon dioxide emissions by one quarter, and advancing proposals for a tax on energy products.<sup>203</sup> The Commission created the ECCP as a mechanism for implementing the Kyoto Protocol, pinpointing all the elements necessary for the EU to develop an effective strategy for implementation.<sup>204</sup>

The First ECCP was divided into two phases; the first phase (2000-2001) addressed flexible mechanisms, focusing almost exclusively on carbon trading systems.<sup>205</sup> During this period, the following measures were achieved: a proposal on an EU emissions trading framework; a proposal on the promotion of biofuels; a separate proposal addressing the promotion of combined heat and power biofuels; and a communication on vehicle taxation.<sup>206</sup> The second phase (2002-2003) resulted in a more comprehensive set of measures, yet still focused exclusively on the energy, transportation, and electric sectors.<sup>207</sup> The second phase also included the formation of working groups to address agriculture, sinks and agricultural soils, and forestry issues.<sup>208</sup> Each of these working groups produced a detailed report addressing the problems associated with the various agricultural practices and actions each could take to mitigate the harm.<sup>209</sup>

<sup>201</sup> Europa - European CCP, *supra* note 31.

<sup>202</sup> *Id.*

<sup>203</sup> *Id.*

<sup>204</sup> *Id.*

<sup>205</sup> EUR. COMM’N, FINAL REPORT: ECCP WORKING GROUP I “FLEXIBLE MECHANISMS” 1-6 (2006), available at [http://ec.europa.eu/environment/climat/pdf/final\\_report.pdf](http://ec.europa.eu/environment/climat/pdf/final_report.pdf).

<sup>206</sup> Eur. Comm’n, First European Climate Change Programme: Second Phase of the European Climate Change Programme (2002-2003), [http://ec.europa.eu/environment/climat/second\\_phase.htm](http://ec.europa.eu/environment/climat/second_phase.htm) (last visited Mar. 17, 2010).

<sup>207</sup> *Id.*

<sup>208</sup> *Id.*

<sup>209</sup> *Id.*

In October 2005 the Commission launched the Second ECCP (“ECCP II”).<sup>210</sup> ECCP II was composed of six working groups charged with: following up on ECCP I (with subgroups on transport, energy supply, energy demand, non-carbon dioxide gases, and agriculture and forestry); aviation; carbon dioxide and automobiles; carbon capture and storage; adaptation; and a review of the EU emissions trading plan.<sup>211</sup> A major component of ECCP II was the establishment of a working group on impacts and adaptation. This working group identified issues critical to adaptation and developed reports on the following issues: water resource management; marine resources, coastal zones and tourism; human health; agriculture and forestry; biodiversity; regional planning and infrastructure; urban planning; development cooperation; insurance industry; and national strategies for adaptation.<sup>212</sup>

Even with such comprehensive efforts by the European Commission, most environmental regulations and adaptation policies are implemented at the State level, limiting the influence regional initiatives can have. At present, the United Kingdom is the only Member of the EU “to have a legally binding long-term framework to cut carbon emissions”—the Climate Change Act 2008.<sup>213</sup> The Act requires a 26% reduction in carbon dioxide emissions by 2020 and a 50% reduction by 2050.<sup>214</sup> The Act also requires to government to publish five annual carbon budgets beginning in 2008, create a committee to advise on establishing carbon budgets and the balance between domestic emissions reductions and the use of carbon credits, and conduct a climate change risk assessment.<sup>215</sup> The Act also authorizes the establishment of trading schemes to limit GHG emissions, allows for waste reduction pilot schemes, and amends the Energy Act 2004 with respect to provisions on renewable transport fuel obligations.<sup>216</sup> The Act does not, however, discuss the regulation of agriculture, and land use is mentioned only as part of the definition of “UK removals”.<sup>217</sup> Thus, the only legally binding mechanism for reducing emissions in the EU—the UK Climate Change Act—is both narrow in its scope and in breadth. Scope because its focus is limited to reducing carbon dioxide emissions, and breadth

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<sup>210</sup> Eur. Comm’n, Second European Climate Change Programme (ECCP II), [http://ec.europa.eu/environment/climat/second\\_phase.htm](http://ec.europa.eu/environment/climat/second_phase.htm) (last visited Mar. 17, 2010).

<sup>211</sup> *Id.*

<sup>212</sup> Eur. Comm’n, European Climate Change Programme II: Impacts and Adaptation, [http://ec.europa.eu/environment/climat/eccp\\_impacts.htm](http://ec.europa.eu/environment/climat/eccp_impacts.htm) (last visited Mar. 3, 2010).

<sup>213</sup> Dep’t for Env’t Food and Rural Affairs, Adaptation in the Climate Change Act of 2008, available at <http://www.defra.gov.uk/environment/climate/legislation/index.htm> (follow “Read the Climate Change Act” hyperlink) (last visited Mar. 18, 2010).

<sup>214</sup> U.K. Parliament, Climate Change Bill [HL] 2007-08: Summary of the Bill, available at <http://services.parliament.uk/bills/2007-08/climatechangehl.html> (last visited Mar. 3, 2010).

<sup>215</sup> *Id.*

<sup>216</sup> *Id.*

<sup>217</sup> U.K. Parliament, Climate Change Bill [HL], Amended in Public Bill Committee, available at <http://www.publications.parliament.uk/pa/cm200708/cmbills/129/08129-i-v.html> (last visited Mar. 3, 2010).

because agriculture and land use are not included as regulated sectors in the mitigation policies.

The absence of agricultural regulations in the UK Climate Change Act is likely due to politics—the same reason that international mechanisms have not successfully integrated agriculture into climate change mitigation. Passing comprehensive legislation is always difficult, and the more sectors a government attempts to regulate under a single law, the greater the opposition it faces. Thus, it is likely that Parliament decided to focus on the most visible sectors responsible for the emission of GHGs—and the most well-known gas, carbon dioxide—rather than to adopt a more comprehensive approach to avoid significant political opposition to the Act.

### C. Proposed Climate Change Legislation in the United States

In the spring of 2009 the House Energy and Commerce Committee introduced a new climate change bill.<sup>218</sup> The “American Clean Energy and Security Act of 2009”<sup>219</sup> (“ACES”) has two main objectives. The first objective is to develop a cap and trade system to reduce GHG emissions and to increase use of renewable sources of energy for electricity.<sup>220</sup> ACES offers industry two million tons in annual offsets to cut emissions, and in return requires a 20% cut below 2005 levels by 2020 and an 83% cut in GHG emissions by 2050.<sup>221</sup> The second objective of ACES is focused on adaptation.<sup>222</sup> This marks a significant change from prior climate change bills proposed in Congress, which focused exclusively on mitigation.<sup>223</sup> ACES proposes various measures to help state and local governments develop initiatives to address the unavoidable consequences of climate change.<sup>224</sup> Among the measures suggested are the establishment of a National Climate Service, which will be placed within the National Oceanic and Atmospheric Administration, and inter-agency cooperation to develop plans to assist with adaptation of natural resources.<sup>225</sup> In its current form, the Act is divided into six primary parts, which are then divided into multiple subtitles and sections, as illustrated below.<sup>226</sup>

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<sup>218</sup> *US Climate Change Bill Submitted*, TIMES ONLINE, Apr. 1, 2009, <http://www.timesonline.co.uk/tol/news/environment/article6011584.ece> [hereinafter TIMES ONLINE].

<sup>219</sup> ACES Act, *supra* note 42.

<sup>220</sup> TIMES ONLINE, *supra* note 218.

<sup>221</sup> *Id.*

<sup>222</sup> Lauren Morello & Sara Goodman, *House Bill Shifts Focus to Climate Change Adaptation*, N.Y. TIMES, Apr. 1, 2009, <http://www.nytimes.com/cwire/2009/04/01/01climatewire-house-bill-shifts-focus-to-climate-change-im-10371.html?pagewanted=1>.

<sup>223</sup> *Id.*

<sup>224</sup> *Id.*

<sup>225</sup> *Id.*

<sup>226</sup> ACES Act, *supra* note 42.

Title No.	Title Name	Subtitles/Parts
I	Clean Energy	Renewable Electricity Standard Carbon Capture and Sequestration Clean Transportation State Energy and Environment Development Funds Smart Grid Advancement Transmission Planning Federal Purchases of Electricity Generated by Renewable Energy Technical Corrections to Energy Laws
II	Energy Efficiency	Building Energy Efficiency Programs Lighting and Appliance Energy Efficiency Programs Transportation Efficiency Utilities Energy Efficiency Industrial Energy Efficiency Programs Improvements in Energy Savings Performance Contracting Public Institutions
III	Reducing Global Warming Pollution	Reducing Global Warming Pollution
VII	Global Warming Pollution Reduction Program	Global Warming Pollution Reduction Goals and Targets Designation and Registration of Greenhouse Gases Program Rules Offsets Supplemental Emissions Reductions from Reduced Deforestation Carbon Market Assurance (Subtitle B: Disposition of Allowances) (missing) Disposition of Allowances (Subtitle C: Additional Greenhouse Gas Standards)
VIII	Additional Greenhouse Gas Standards	Stationary Source Standards (missing) Exemptions from Other Programs (missing) Black Carbon Miscellaneous
IV	Transitioning to a Clean Energy Economy	Ensuring Domestic Competitiveness Green Jobs and Worker Transition Consumer Assistance Exporting Clean Technology Adapting to Climate Change

Noticeably absent from ACES are any requirements on the agricultural industry. Rather than incorporating the regulation of agriculture into the legislation, ACES continues to focus almost exclusively on the industry, transportation, and electric sectors. In its 648 pages, ACES does not mention “farming” or “livestock” once.<sup>227</sup> Agriculture is discussed only four times, and none of these references concerns the regulation of the agricultural industry or requirements that the agricultural industry institute sustainable farming practices.<sup>228</sup>

The first reference to agriculture notes that “damage to plants, forests, lands, and waters” is a source of GHG emissions.<sup>229</sup> The second reference requires the National Academy of Sciences to submit a report by 2012, and then every four years thereafter, including an analysis of scientific information and data relevant to climate change.<sup>230</sup> Subsection (C)(4)(H) requires the consideration of “agriculture and forest systems, including effects on potential growing season, distribution, and yield” as a part of the scientific analysis conducted pursuant to section 705(a).<sup>231</sup> The next mention of agriculture is in section 422.<sup>232</sup> This section requires the Secretary of Labor to carry out a training program on sustainability and to provide grants to institutions of higher learning to provide training on “sustainable agriculture and farming,” among other things.<sup>233</sup> The final reference to agriculture in ACES is in section 455.<sup>234</sup> Again, the focus on agriculture is limited to a required assessment of local measures being taken to adapt to climate change impacts on farming.<sup>235</sup>

The only agricultural or land use practice that receives any real attention is deforestation, and the policies concerning this issue are directly tied to the proposed cap and trade program. Section 704 (“Supplemental Pollution Reductions”) is designed to incentivize developing countries to reduce deforestation and encourage reforestation.<sup>236</sup> It does so by offering industrialized nations “greenhouse gas reductions in an amount equal to an additional 10 percentage points of reductions from United States greenhouse gas emissions in 2005.”<sup>237</sup> Section 741 (“Environmental Considerations”) then

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<sup>227</sup> *Id.*

<sup>228</sup> See discussion *supra* Part IV.

<sup>229</sup> ACES Act, *supra* note 42, § 701 (“Findings and Purpose”).

<sup>230</sup> *Id.* at 329-33, § 705(a)(1) (“Scientific Review”).

<sup>231</sup> *Id.* at 333.

<sup>232</sup> ACES Act, *supra* note 42, at 566 (“Workforce Training and Education in Clean Energy, Energy Efficiency, Climate Change Mitigation, and Sustainable Environmental Practices”). The organization of the draft version of the Act places Title IV at the end, therefore Section 422 follows section 705, rather than preceding it.

<sup>233</sup> *Id.*

<sup>234</sup> *Id.* at 582 (“National Climate Change Vulnerability Assessments”).

<sup>235</sup> *Id.*

<sup>236</sup> *Id.* at 329.

<sup>237</sup> *Id.*

states that for any forestry activities listed by the Administrator as eligible offset projects, the Administrator “shall” promulgate regulations on the type and selection of trees used in projects.<sup>238</sup> The intended purpose is to protect biodiversity and native species of plants and animals.<sup>239</sup> Conditions for applying offsets for reduction of deforestation nationally are discussed in Section 743 (“International Offset Credits”).<sup>240</sup> Several subsequent sections provide standards for ensuring the protection of forests when projects are permitted, but deforestation is consistently discussed as an important aspect of the cap and trade system and not as an end or goal in and of itself.<sup>241</sup>

The failure to approach climate change mitigation in the United States from a more comprehensive perspective could be based on a number of factors. It may have to do with the relatively small percentage of CO<sub>2</sub> equivalent GHG emissions in the United States that come from agriculture versus industry, electricity and transportation.<sup>242</sup> However, it is unlikely that this is the primary reason for the lack of regulation. Despite having fewer GHG emissions nationally than international figures, a regulation of agricultural activities—defining agriculture by this Article’s standards—still offers the potential of reducing as much as one-quarter of all anthropogenic GHG emissions in the United States.<sup>243</sup> The more likely explanation is politics.

The agricultural lobby is one of the most powerful special interest groups in the United States and wields substantial influence over climate change proposals.<sup>244</sup> Larry Combest, an expert and insider on the lobby, described it as “a self-perpetuating cycle of money, votes and political power that has made agriculture one of Washington’s most entrenched special interests, even as the number of farmers has dwindled to about 1% of the population.”<sup>245</sup> Agricultural interests are described as a “wheel of fortune” for farmers, lobbyists and

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<sup>238</sup> *Id.* at 422.

<sup>239</sup> *Id.*

<sup>240</sup> *Id.* at 431.

<sup>241</sup> *Id.* at 436-48.

<sup>242</sup> Agriculture, limited to the CO<sub>2</sub> equivalent of crop and livestock farming, is responsible for 6% of GHG emissions in the U.S. U.S. ENVTL. PROT. AGENCY, INVENTORY OF U.S. GREENHOUSE GAS EMISSIONS AND SINKS: 1990–2007, AGRICULTURE (2009), <http://www.epa.gov/climatechange/emissions/downloads09/Agriculture.pdf> [hereinafter AGRICULTURE]. Land use, land use changes, and forestry sectors are responsible for an additional 17.4% of total U.S. GHG emissions. U.S. ENVTL. PROT. AGENCY, INVENTORY OF U.S. GREENHOUSE GAS EMISSIONS AND SINKS: 1990–2007, LAND USE, LAND USE CHANGE, AND FORESTRY (2009), <http://www.epa.gov/climatechange/emissions/downloads09/LULUCF.pdf> [hereinafter LAND USE].

<sup>243</sup> AGRICULTURE, *supra* note 242; LAND USE, *supra* note 242.

<sup>244</sup> Dan Morgan, *In U.S. Climate Debate, Farms Are Crucial Lobby*, EUR. INST. (2009), available at <http://www.europeaninstitute.org/Winter/Spring-2009/climate-policy-in-the-us-has-to-reckon-with-the-farm-lobby.html>.

<sup>245</sup> Mike Dorning & Andrew Martin, *Farm Lobby’s Power has Deep Roots*, CHI. TRIB., June 4, 2006, available at <http://www.floridafarmers.org/news/articles/Farmlobby’spowerhasdeeproots.htm>.

representatives from farm-states.<sup>246</sup> As stated by former Senator Peter Fitzgerald, former member of the Senate Agriculture Committee, "If you believe that farm policy is ever going to be reformed, then I got some swamp land to sell you in Louisiana . . . It ain't going to happen."<sup>247</sup>

#### IV. PROPOSED SOLUTIONS

Even though the regulation of agriculture will require tough political negotiations, there are ways to successfully incorporate agriculture into climate change mitigation and adaptation plans. This section will provide suggestions for actions at both national and international levels that will increase the presence of agriculture in climate change mechanisms.

##### A. National Proposals

This section explores how individual countries can improve their climate change mitigation policies by making a range of proposals that would result in a more comprehensive approach to climate change mitigation. The suggested mechanisms will range from comprehensive plans affecting all agricultural practices to more limited options that focus on regulation in only one area. The United States has historically been the largest global emitter of GHGs<sup>248</sup> and still remains the largest polluter per capita.<sup>249</sup> In addition to being the only Western, industrialized nation that is a member of the UNFCCC but has not ratified the Kyoto Protocol,<sup>250</sup> this section focuses on the changes that the United States could, and should, make. However, most suggestions and policies for reform in the United States offered in this Article could likely be implemented by other nations around the world as well.

The least comprehensive measure, yet one that would still help reduce agricultural emissions of GHGs, the United States should alter existing federal farm subsidies by offering subsidies for more environmentally friendly agricultural practices, such as organic farming. Agricultural subsidies provided to United States farmers are a huge burden on taxpayers,<sup>251</sup> present substantial

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<sup>246</sup> *Id.*

<sup>247</sup> *Id.*

<sup>248</sup> Brad Knickerbocker, *China Now World's Biggest Greenhouse Gas Emitter*, CHRISTIAN SCI. MONITOR, June 28, 2007, available at <http://www.csmonitor.com/2007/0628/p12s01-wogi.html>.

<sup>249</sup> *Id.*

<sup>250</sup> See UN FRAMEWORK CONVENTION ON CLIMATE CHANGE, KYOTO PROTOCOL STATUS OF RATIFICATION, Jan. 14, 2009, [http://unfccc.int/files/kyoto\\_protocol/status\\_of\\_ratification/application/pdf/kp\\_ratification.pdf](http://unfccc.int/files/kyoto_protocol/status_of_ratification/application/pdf/kp_ratification.pdf). See also Rod McGuirk, *Australia Signs Kyoto Protocol: U.S. Now Only Holdout*, NAT'L GEOGRAPHIC NEWS, Dec. 3, 2007, <http://news.nationalgeographic.com/news/2007/12/071203-AP-aus-kyoto.html>.

<sup>251</sup> U.S. subsidies for farming cost \$10 - \$30 billion annually. Chris Edwards, *Agricultural Subsidies*, CATO INST., June 13, 2007, <http://www.downsizinggovernment.org/agriculture/subsidies>.



problems for international trade,<sup>252</sup> and contribute to environmental degradation.<sup>253</sup> From 2001 to 2006 the United States provided over \$95 billion in agricultural subsidies.<sup>254</sup> Of this amount, over 90% of subsidies are provided to farmers who grow five crops—wheat, soybeans, rice, corn, and cotton.<sup>255</sup> A yearlong report conducted by three journalists with the *Washington Post* in 2006 identified more than \$15 billion in “wasteful, unnecessary, and redundant spending.”<sup>256</sup> Under the current system for distributing subsidies, the reporters discovered the following:

- more than \$1.3 billion paid to farmers who have not grown any crops since 2000;
- farmers were often over-compensated, to the tune of billions of dollars annually, when goods were competitive in the market without a subsidy;
- drought aid was often funneled to private interests, instead of reaching farmers; and,
- the majority of subsidies were provided to large farms, accelerating the demise of small farming operations that cannot remain competitive.<sup>257</sup>

These were just a few of the problems noted by the reporters. Other notable problems are insurance compensation related to large farms, disaster payments, and deeply troubling statistics revealing that a farmer’s race may have a significant impact on the amount of aid she receives.<sup>258</sup>

Altering federal farm subsidies could be accomplished in several ways, including: reducing or eliminating subsidies for farms that make profits in excess of a specific, predetermined amount annually; eliminating subsidies from crops that are not at a competitive disadvantage in a given year and from land no longer used for farming; reducing the overall amount of money set aside for agricultural subsidies; shifting subsidies from the current focus on five major crops to subsidizing organic farming; or, by tying GHG emissions directly to subsidies.

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<sup>252</sup> Trade barriers on farmed goods have created significant conflict between developed and developing nations. See Associated Press, *US Offers a Subsidy Concession at Trade Talks*, July 23, 2008, available at <http://www.globalpolicy.org/soecon/trade/subsidies/2008/0723usreduction.htm>.

<sup>253</sup> Crop subsidies encourage overproduction and the excessive use of pesticides and fertilizers, and trade barriers encourage farming on marginal lands that could otherwise be used as parks or forests. Edwards, *supra* note 251.

<sup>254</sup> Morgan et al., *Harvesting Cash: A Yearlong Investigation by the Washington Post*, WASH. POST, 2006, available at <http://www.washingtonpost.com/wp-srv/nation/interactives/farmaid/>.

<sup>255</sup> Edwards, *supra* note 251.

<sup>256</sup> Morgan et al., *supra* note 254.

<sup>257</sup> *Id.*

<sup>258</sup> “Southern Rural Development Initiative found that less than 1[%] of agriculture subsidy payments between 2001 and 2003 went to Blacks, Native Americans and Asian Americans.” Jessica Hoffman, *Farm Subsidies Overwhelmingly Support White Farmers*, Jan. 2009, [http://www.organicconsumers.org/articles/article\\_16762.cfm](http://www.organicconsumers.org/articles/article_16762.cfm).

In February 2009, President Obama announced the proposed federal budget, which included proposals for reforming agricultural subsidies.<sup>259</sup> President Obama's proposals focused largely on three areas: first, limiting subsidies given regardless of market conditions or whether the land is actively used for agricultural practices;<sup>260</sup> second, eliminating subsidies to farmers with sales in excess of \$500,000 annually;<sup>261</sup> and third, reducing the overall cap on subsidy payments.<sup>262</sup> The proposed measures would have resulted in nearly \$10 billion in savings over the next ten years,<sup>263</sup> but were so broadly worded that even members of the Democratic Party opposed the measures.<sup>264</sup> The proposed changes to agricultural subsidies were eventually dropped from the budget.<sup>265</sup>

There are many reasons given for the substantial opposition to President Obama's proposed changes. Some have to do with the political climate and the farm lobby's resistance to any changes in agricultural subsidies, while others criticized the measures as too broad and feared that they would reduce subsidies necessary for the survival of small farms.<sup>266</sup> However, it is also possible that his attempts at regulation failed because they were viewed by those with agricultural interests as eliminating benefits.<sup>267</sup> A better approach would have been to ensure that the farm lobby recognized the measures as an exchange in benefits, or conditions—separate from profits—that are tied to the receipt of federal money.

One way to alter federal farm subsidies without appearing anti-agriculture would be to shift funding from subsidies given for the production of the five major crops to the production of organic goods, rather than cutting subsidies altogether. Organic farming is a "system of crop cultivation employing biological methods of fertilization and pest control as substitutes for chemical fertilizers and pesticides."<sup>268</sup> It has the potential to "lower input costs, decrease

<sup>259</sup> See David M. Herszenhorn, *Obama's Farm Subsidy Cuts Meet Stiff Resistance*, N.Y. TIMES, Apr. 4, 2009, available at <http://www.nytimes.com/2009/04/04/us/politics/04farm.html>. See also Joseph Morton, *Obama's Budget Takes Aim at Farm Subsidies*, ENVTL. WORKING GROUP, Feb. 27, 2009, <http://www.ewg.org/node/27669>.

<sup>260</sup> Herszenhorn, *supra* note 259.

<sup>261</sup> *Id.*

<sup>262</sup> *Id.*

<sup>263</sup> *Id.*

<sup>264</sup> Dan Looker, *Obama Farm Subsidy Changes Dropped from Budget*, AGRIC. ONLINE, Apr. 3, 2009, <http://www.agriculture.com/ag/story.jhtml?storyid=/templatedata/ag/story/data/1238791237756.xml>.

<sup>265</sup> *Id.*

<sup>266</sup> *Id.*

<sup>267</sup> Henry J. Pulizzi & Corey Boles, *Farm Subsidy Cuts Highlight Political Challenge*, WALL ST. J., May 7, 2009, available at <http://online.wsj.com/article/SB124170947406396379.html>. See also Charles Abbott, *U.S. Farm-cut Fight Far From Over: Vilsak*, REUTERS, Mar. 27, 2009, <http://www.reuters.com/article/idUSTRE52Q6HU20090327>.

<sup>268</sup> Encyclopedia Britannica, *Organic Farming*, available at <http://www.britannica.com/EBchecked/topic/431991/organic-farming> (last visited Mar. 3, 2010).

reliance on nonrenewable resources, capture high-value markets and premium prices, and boost farm income.<sup>269</sup> Further, organic agriculture enables ecosystems to better adapt to the impacts of climate change and has substantial potential for reducing agricultural GHG emissions.<sup>270</sup> However, organic farming receives far less government assistance than non-organic farming,<sup>271</sup> despite being recognized as a solution to environmentally destructive large-scale farming practices.<sup>272</sup>

Organic farming provides one method for combating climate change that could be implemented in both industrialized and developing countries. Organic farming has the potential to dramatically reduce greenhouse gas emissions due to its reliance on energy-friendly practices.<sup>273</sup> A 2002 UNFAO report states that “organic agriculture enables ecosystems to better adjust to the effects of climate change and has major potential for reducing agricultural greenhouse gas emissions.”<sup>274</sup> This is because organic farming “performs better than conventional agriculture on a per hectare scale, both with respect to direct energy consumption (fuel and oil) and indirect consumption (synthetic fertilizers and pesticides), with high efficiency of energy use.”<sup>275</sup>

In addition to the above-mentioned benefits, organic farming has proven benefits for soil fertility, biodiversity, water quality, animal health and welfare, and for the ecosystem generally.<sup>276</sup> Organic farming can reduce GHG emissions

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<sup>269</sup> Briefs: St. Onge, Ruff Completes Two Grocery Distribution Centers, FROZEN FOOD DIGEST, July 1, 2000, available at <http://www.allbusiness.com/finance/593547-1.html>.

<sup>270</sup> Urs Niggli et al., *Issues Paper: Organic Agriculture and Environmental Stability of the Food Supply*, International Conference on Organic Agriculture and Food Security 8-10, May 3-5, 2007, available at <http://orgprints.org/10752/01/niggli-et-al-2007-environmental-stability.pdf>.

<sup>271</sup> The 2008 Farm Bill included the following financial provisions for organic farming: “\$22 million in mandatory funds to continue a cost-share program to help farmers obtain organic certification; \$5 million in mandatory funds and \$25 million in authority for appropriated funds over five years to support the collection and analysis of organic production and marketing data; and \$78 million in mandatory funds over four years to support the organic agriculture research and extension initiative.” Renée Johnson, *Organic Agriculture in the United States: Program and Policy Issues*, in CRS REPORT FOR CONGRESS, CONG. RESEARCH SERV., Nov. 25, 2008, available at <http://www.fas.org/sgp/crs/misc/RL31595.pdf>.

<sup>272</sup> Miguel A. Altieri, *Modern Agriculture: Ecological Impacts and the Possibilities for Truly Sustainable Farming* (U.C. Berkeley), available at [http://www.cnr.berkeley.edu/~agroeco3/modern\\_agriculture.html](http://www.cnr.berkeley.edu/~agroeco3/modern_agriculture.html) (last visited Mar. 3, 2010). See also Sam Burcher, *FAO Promotes Organic Agriculture*, INST. OF SCI. IN SOC’Y, Oct. 9, 2007, <http://www.i-sis.org.uk/FAOPromotesOrganicAgriculture.php>.

<sup>273</sup> Burcher, *supra* note 272. See also David Pimentel, *Impacts of Organic Farming on the Efficiency of Energy Use in Agriculture*, ORGANIC CTR. STATE OF SCI. REVIEW, Aug. 2006, [http://www.organic-center.org/reportfiles/ENERGY\\_SSR.pdf](http://www.organic-center.org/reportfiles/ENERGY_SSR.pdf).

<sup>274</sup> Mae-Wan Ho & Lim Li Ching, *Mitigating Climate Change through Organic Agriculture and Localized Food Systems*, *Institute of Science in Society Report*, INST. OF SCI. IN SOC’Y, Jan. 31, 2008, <http://www.i-sis.org.uk/mitigatingClimateChange.php>.

<sup>275</sup> *Id.*

<sup>276</sup> Eur. Comm’n Dept. of Agric. & Rural Dev., *What is Organic Farming? On the Farm*, [http://ec.europa.eu/agriculture/organic/organic-farming/what-organic/the-farm\\_en](http://ec.europa.eu/agriculture/organic/organic-farming/what-organic/the-farm_en) (last visited Mar. 3, 2010).

by reducing the consumption of fossil fuels used for energy, reducing the overall emissions of the primary GHGs, causing soils to be less vulnerable to erosion, and increasing carbon stocks and carbon sinks.<sup>277</sup> Studies conducted in the United States reveal that the energy input required for organic farming is 28% to 32% less than the energy required for conventional farming.<sup>278</sup> “Organic, sustainable agriculture that localizes food systems has the potential to mitigate nearly thirty percent of global greenhouse gas emissions and save one-sixth of global energy use.”<sup>279</sup>

The economic advantages of organic farming are not limited to the profit potential for individual farmers or the industrialized world. Because organic farming does not rely on the use of pesticides and other common chemicals, it is much more labor intensive, providing jobs and economic stimulation that would be particularly helpful in the current economic climate.<sup>280</sup> A 2006 study of farming in the United Kingdom conducted by Britain’s Soil Association found “that organic farming provides 32% more jobs per farm . . . than conventional agriculture.”<sup>281</sup>

Critics argue that organic farming is not feasible for most of the world because of the high cost of food produced without the use of chemicals and major machinery.<sup>282</sup> A closer look at the process reveals that such arguments are unsubstantiated. In fact, the short term economic savings associated with current farming practices are far outweighed by long term negative consequences for the economy, environment, conditions of farmed animals, and human health.

The U.S. agricultural industry can now produce unlimited quantities of meat and grains at remarkably cheap prices. But it does so at a high cost to the environment, animals and humans. Those hidden prices are the creeping erosion of our fertile farmland, cages for egg-laying chickens so packed that the birds can’t even raise their wings and the scary rise of antibiotic-resistant bacteria among farm animals. Add to the price tag the acceleration of global warming — our energy-intensive food system uses 19% of U.S. fossil fuels, more than any other sector of the economy.<sup>283</sup>

<sup>277</sup> Niggli et al., *supra* note 270, at 8-10.

<sup>278</sup> *Id.*

<sup>279</sup> Mae-Wan Ho & Lim Li Ching, *supra* note 274.

<sup>280</sup> Alana Herro, *Organic Farms Provide Jobs, High Yields*, WORLDWATCH INST., July 3, 2006, <http://www.worldwatch.org/node/3975>.

<sup>281</sup> *Id.*

<sup>282</sup> Bethany Fong, *Organic Foods*, <http://www.spu.edu/depts/fcs/newsletter/articles.html> (last visited Mar. 3, 2010). See also Brian Halweil, *Can Organic Farming Feed Us All?*, WORLDWATCH INST., April 15, 2006, available at <http://www.worldwatch.org/node/4060>; *MedIndia*, *Organic Foods*, [http://www.medindia.net/patients/patientinfo/organicfood\\_disadvantages.htm](http://www.medindia.net/patients/patientinfo/organicfood_disadvantages.htm) (last visited Feb. 10, 2010).

<sup>283</sup> Bryan Walsh, *Getting Real About the High Price of Cheap Food*, TIME, Aug. 21, 2009, available at <http://www.time.com/time/health/article/0,8599,1917458,00.html>.

For the developing world, because labor is often cheaper than the chemicals used in conventional agricultural practices, “a switch to organic farming in developing countries is typically a profitable option and can lead to 20% to 90% increases in production.”<sup>284</sup> A University of Michigan research scientist, Catherine Badgley, stated, “a global shift to organic farming could produce enough calories to feed the entire human population and potentially 75% more calories than are produced now.”<sup>285</sup> Even if the cost of organic goods remains higher than goods produced from intensive agricultural practices, the cost need not trickle down to the consumer. The price concern could be ameliorated by shifting at least some agricultural subsidies away from wheat, soybeans, rice, corn, and cotton, and towards organically produced goods. This solution has the potential to alleviate the increased costs of the goods for the consumer while protecting farmers’ profits.

Another approach is to tie agricultural subsidies directly to GHG emissions. Instead of eliminating subsidies, making federal money for farmers contingent on reducing GHG emissions incentivizes farmers to improve current practices. Rather than attaching the subsidy only to the type of crop, receipt of federal monies would be contingent on satisfying emissions standards. The government could provide funding to assist farmers with costs of shifting to less intensive crop practices and/or more humane animal husbandry practices that will result in fewer GHG emissions, further reducing any economic burden for farmers to adopt more environmentally friendly agricultural practices. Emissions levels could be established that would provide minimum, median, and maximum benefits for the environment. Subsidies could be structured so that the fewer the GHG emissions from the farm, the greater the subsidy that a farmer would qualify for. A proposed rule published in the Federal Register on April 10, 2009, demonstrates that the Environmental Protection Agency (“EPA”) has the technology and resources available to measure GHG emissions from certain agricultural practices.<sup>286</sup> The rule is primarily focused on emissions of methane produced by livestock and would require farmers to report such emissions.<sup>287</sup> The EPA is also exploring options for ways to make the reporting of nitrous oxide and methane emissions resulting from fertilizer use economically feasible and reliable.<sup>288</sup> If the EPA already possesses such information and capabilities, a move from reporting requirements to establishing emissions limits that farmers must comply with is feasible with little cost to the agency or taxpayers.

Another measure for regulating GHG emissions would be to utilize existing regulations to subject larger farms (defined by the existing definition used for

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<sup>284</sup> *Id.*

<sup>285</sup> Herro, *supra* note 280.

<sup>286</sup> Mandatory Reporting of Greenhouse Gases, 74 Fed. Reg. 16,448 (Apr. 10, 2009) (codified in scattered parts of 40 C.F.R.).

<sup>287</sup> *Id.*

<sup>288</sup> *Id.*

large family-farms) to the same emissions standards that other industries and facilities are required to satisfy. Or, instead of using existing regulations, requiring inclusion of agricultural practices in any future cap and trade program (ensuring this inclusion is greater than that proposed in the American Clean Energy and Security Act of 2009). Under ACES, deforestation is the only activity related to agriculture incorporated into the cap and trade scheme. Rather than limiting regulation to agricultural activities that fall within a cap and trade program, agriculture should be regulated comprehensively. The additional regulations could be tied to economic incentives for farmers to switch to more environmentally friendly farming practices.<sup>289</sup> The potential benefits of regulating agriculture to reduce GHG emissions are substantial.

At moderate cost, [reforesting less productive lands with carbon dioxide-consuming trees and altering farming practices so carbon is absorbed and retained in agricultural soils] could offset up to 25% of current U.S. carbon-dioxide emissions. Many of the farming practices and land use changes involved in achieving these reductions have multiple benefits, including improving soil, water, and air quality; increasing wildlife habitat; and providing additional recreational opportunities.<sup>290</sup>

Considering other options for changes at the national level, comprehensive legislation regulating the agricultural industry, or GHG emissions from any source, should be enacted. In the United States, the American Clean Energy and Security Act of 2009 is a step in the right direction. However, in its current form, ACES provides a lengthy discussion of the energy sources that emit GHGs in Titles I and II, but limits the analysis to energy from the transport, electricity, and industry sectors. An additional title concerning energy used by agriculture would provide a more comprehensive analysis of all major contributors to climate change, and would permit legislators to more thoroughly develop solutions to mitigate climate change. The new section could be subdivided into sections on anthropogenic causes of deforestation and land degradation, as well as sections exploring the harms related to current crop and livestock agricultural practices. Once the connection between agriculture and climate change is developed, standards can be proposed to lower emissions from

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<sup>289</sup> Federal regulation of agriculture could be accomplished by adding an additional Title and Subsections to the current draft version of the American Clean Energy and Security Act of 2009, or by adding standards concerning agricultural practices and emissions into the existing sections of the Bill. If the former approach is taken, a Title IV or V could be added—fitting directly between existing sections on global warming pollution. Alternatively, a new Title could be inserted after Title II, so that the Bill would be organized as follows: an analysis of all energy sources that contribute to climate change, including agriculture, followed by a focus on reducing global warming, additional greenhouse gas standards, and concluding with the section on the transition to a clean energy economy.

<sup>290</sup> PEW CTR. ON GLOBAL CLIMATE CHANGE, CLIMATE CHANGE 101: TECHNOLOGICAL SOLUTIONS, available at [http://www.pewclimate.org/docUploads/101\\_Tech.pdf](http://www.pewclimate.org/docUploads/101_Tech.pdf) (last visited Mar. 3, 2010). See also PAUSTIAN ET AL., AGRICULTURE'S ROLE IN GREENHOUSE GAS MITIGATION (Pew Ctr. on Global Climate Change 2006).

agricultural activities. This could be accomplished under the same title, or within an existing title, such as Title VII.

If no new titles are added, the focus on agricultural practices could be incorporated into Title II: Energy Efficiency, and proposed regulations could be addressed in Title VII: Global Warming Pollution Reduction Program.<sup>291</sup> Title VII already contains a provision concerning deforestation, so mechanisms to regulate other agricultural practices could be designed to fit within the cap and trade program discussed in this section. For example, large-scale farming practices, livestock farming in particular, could be required to meet the emissions requirements that are imposed on other large industries. To ensure that such requirements are not economically burdensome, incentives and subsidies could be provided for farmers who produce organic goods by using natural sources of fertilizers instead of chemical-based products, reducing the amount of GHG emissions. The offsets currently proposed under Title VII for reforestation activities could be broadened to include farmers as a way to encourage the reforestation of marginalized farmlands.

### B. International Proposals

Perhaps even more important than the development of strong national mechanisms to regulate agricultural emissions of GHGs is developing a legally binding international instrument that requires a reduction in emissions from all sectors, including agriculture.<sup>292</sup> With the Kyoto Protocol set to expire in 2012, world leaders have been involved in a series of meetings that culminated in the December 2009 UN Climate Change Conference in Copenhagen. The goal of the Copenhagen Conference was ambitious; the organizing governments wanted every country in the world to participate in negotiations and agree to a legally binding agreement on climate change prior to the 2012 expiration of the Kyoto Protocol.<sup>293</sup> Although the Copenhagen Conference did not result in a legally binding international mechanism to combat climate change, participants did manage to develop a “noted document” with which countries can associate and set forth specific emissions reductions.<sup>294</sup> While many in the international community expressed frustration<sup>295</sup> that the Copenhagen Conference did not

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<sup>291</sup> ACES Act, *supra* note 42.

<sup>292</sup> Alexander Mueller, Assistant Director-General of the UN FAO has stated that “[a]griculture needs to be part and parcel of efforts to meet international and national climate change objectives.” Alexander Muller, Wendy Mann & Leslie Lipper, *Climate Change Mitigation: Tapping the Potential of Agriculture*, MEA BULLETIN: IISD, March 12, 2009, <http://www.iisd.ca/mea-1/guestarticle65.html>.

<sup>293</sup> *The Copenhagen Climate Conference: Key EU Objectives*, EUROPA, Dec. 2, 2009, <http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/09/534>.

<sup>294</sup> UNFCCC, DRAFT DECISION: COPENHAGEN ACCORD, Dec. 18, 2009, *available at* <http://unfccc.int/resource/docs/2009/cop15/eng/107.pdf>.

<sup>295</sup> M. Serajul Islam, *The Copenhagen Accord and the Frustration of Developing Nations*, BANGLADESH TODAY, Dec. 26, 2009,

result in a more concrete commitment, the benefit of a more flexible international agreement is that countries are free to implement any plan that would help them achieve their stated emissions reduction goals. This leaves the window open for States to develop comprehensive mitigation plans that include the reduction of emissions related to agricultural practices.

Mitigation actions in the agriculture sector present strong potential benefits for climate change adaptation. These benefits include the improvement of ecosystem resilience and sustainable development—including food security, a reduction in poverty among the 70% of impoverished persons living in rural areas, and for environmental services.<sup>296</sup> Soil carbon sequestration offers the potential benefit of reducing agricultural emissions of carbon dioxide by some 89%.<sup>297</sup> Reductions of emissions in methane and nitrous oxide could be accomplished through improved rice and livestock farming practices, as well as the use of more efficient fertilizers.<sup>298</sup> “Higher levels of organic matter in soil translate into better plant nutrient content, increased water retention capacity and better structure—eventually leading to higher yields and greater resilience.”<sup>299</sup> Because carbon is one of the main ingredients in organic matter, there is a strong correlation between increased production and both the mitigation of and adaptation to climate change through soil carbon sequestration.<sup>300</sup> Furthermore, the science in this area is well developed,<sup>301</sup> providing specific guidance on the types of agricultural practices and techniques should be used to accomplish these results. “Techniques developed for organic and conservation agriculture, including improved pasture management, agroforestry, mulching, composting, crop rotation, cover crops, low/no-till are relevant, as they help to accumulate soil organic matter.”<sup>302</sup>

Although the Copenhagen Conference drew wide international participation, it did not result in a legally binding international treaty or agreement. However,

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<http://www.bangladesh2day.com/news/finance/2009/December/26//The-Copenhagen-Accord-and-the-frustration-of-the-developing-nations.php>. See also Alan Fisher, *Little Accord in Copenhagen*, AL JAZEERA ENGLISH, Dec. 19, 2009,

<http://english.aljazeera.net/focus/climatesos/2009/12/20091219174523761297.html>.

<sup>296</sup> Mueller, *supra* note 292.

<sup>297</sup> *Id.*

<sup>298</sup> *Id.*

<sup>299</sup> *Id.*

<sup>300</sup> *Id.*

<sup>301</sup> See Dep’t of Energy Nat’l Energy Tech. Lab., Technologies: Carbon Sequestration, available at [http://www.netl.doe.gov/technologies/carbon\\_seq/](http://www.netl.doe.gov/technologies/carbon_seq/) (last visited Mar. 3, 2010). See also Dep’t of Agric. Forest Serv., Development of Technology to Enhance Carbon Sequestration in Forests, available at [http://www.nrs.fs.fed.us/clean\\_air\\_water/carbon\\_sequestration/](http://www.nrs.fs.fed.us/clean_air_water/carbon_sequestration/) (last visited Mar. 3, 2010); Dan Krotz, *Geologic Carbon Sequestration Program*, BERKELEY LAB NEWS CTR., Nov. 12, 2009, <http://esdnews.wordpress.com/tag/geologic-carbon-sequestration-program/> (last visited Mar. 3, 2010).

<sup>302</sup> UN FAO, *Mitigation through Agriculture*, E-NEWSLETTER ON CLIMATE CHANGE & FOOD SEC., Apr. 2009, <http://www.fao.org/climatechange/56744/en/>.



all participants seemed to recognize the urgency of taking action, and the door is open for additional meetings following up on the Conference's outcomes. While it is frustrating to many in the international community that the parties could not agree on a more comprehensive agenda, the lack of specificity actually presents an opportunity for countries to incorporate agriculture into their plans for mitigating climate change. This means the plans can be designed more holistically to curb the current warming trends more quickly. It is critical that countries recognize the necessity of including agriculture in any climate change mitigation or adaptation plans and insist that the UN include agriculture on future agendas.

#### CONCLUSION

Climate change is continuing to increase at a pace far more rapid than scientists had predicted only a few years ago.

Most climate models show that a doubling of pre-industrial levels of greenhouse gases is very likely to commit the Earth to a rise of between 2–5°C in global mean temperatures. This level of greenhouse gases will probably be reached between 2030 and 2060. . . . If annual greenhouse gas emissions remained at the current level, concentrations would be more than triple pre-industrial levels by 2100, committing the world to 3–10°C warming, based on the latest climate projections.<sup>303</sup>

With temperatures on the rise, scientists, governments, and organizations around the world are raising awareness of the anthropogenic causes of climate change; among these, agricultural activities are a primary source of increasing atmospheric concentrations of GHGs. Failure to make significant strides towards the reduction of GHG emissions internationally reduces the likelihood that the UNFCCC climate change goals will be realized. This further increases the chance that scientists' most serious predictions about the impacts of global warming will happen. Because of the substantial role that agriculture plays in contributing to atmospheric concentrations of the three primary GHGs, the regulation of agriculture—accomplished either through initiatives adopted by individual States or through international mechanisms—is necessary to mitigate climate change.

There are many actions that individual countries and the international community can adopt to effectively incorporate agriculture as one aspect of combating climate change. Specific agricultural practices can be targeted for reform, cap and trade programs can be designed to incentivize farmers to utilize

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<sup>303</sup> Stern, *supra* note 77.

more sustainable practices that emit few GHGs, governments can use new or existing laws to regulate emissions from agricultural practices, and the international community can incorporate agriculture into mitigation and adaptation conversations at post-Copenhagen conferences. Regardless of the approach taken, to avoid the worst predicted effects of climate change, the paradigm must shift and the world must view agriculture for what it is—a major contributor to climate change and necessary for its successful mitigation.