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

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Abstract

Scientists have determined that the Earth is warming at an unprecedented rate. Governments around the world are in near unanimous agreement about the existence of climate change and the threat it poses. Further, there is a growing consensus within the global scientific community that the primary cause of climate change is increased emissions of greenhouse gases (GHGs) related to human activities. At best, it appears that human actions are exacerbating the natural heating of the earth; at worst, humans are the primary cause of the rapid rise in temperatures.

Unfortunately, policies enacted to date have failed to take into account the broad spectrum of human activities responsible for increased atmospheric concentrations of GHGs. A primary source of GHG emissions are from agriculture and related activities, yet these sources are almost entirely ignored in national and international legislation designed to combat climate change. Because of the substantial role that agriculture plays in contributing to atmospheric concentrations of the three key GHGs, the regulation of agriculture – accomplished either through initiatives adopted by individual States to encourage more sustainable agricultural practices, or through international mechanisms requiring reductions of emissions resulting from agricultural activities – is necessary to mitigate climate change.

This article explains the basic science behind agriculture and GHG emissions, agriculture’s role in climate change and legal and policy initiatives that could be implemented to mitigate climate change.
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.1 “Eleven of the last 12 years (1995-2006) are among the warmest years recorded since 1850.”2 Governments around the world are in near unanimous agreement about the existence of climate change and the threat it poses. Further, there is a growing consensus within the global scientific community that the primary cause of climate change is increased emissions of greenhouse gases (GHGs) related to human activities.3 At best, it appears that human actions are exacerbating the natural heating of the earth; at worst, humans are the primary cause of the rapid rise in temperatures. Regardless of which argument one accepts, it is becoming apparent that any 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 have failed to take into account 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 on fossil fuels used in the electric, transport and industry sectors, at the expense of other sources of GHG emissions. Although the transportation sector has become the most visible target of climate change regulation in recent years, cars, planes, trains, airplanes and boats are not the primary causes of global warming. That honor goes to electricity and heat, which are

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2 Id.
3 Id.
responsible for 24.6% of global GHG emissions.\textsuperscript{4} Nor is transportation the second, third, or even fifth leading cause of GHG emissions. After the shared emissions from electricity and heat, industry is the next largest polluter, emitting 21.1% of all GHG emissions.\textsuperscript{5} The third largest source of global GHG emissions is land use change and forestry, which emits 18.2% of all gases.\textsuperscript{6}

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<th>GHG Emissions by Sector</th>
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While transportation is estimated to be responsible for 13.5% of global GHG emissions,\textsuperscript{7} agriculture is estimated to be responsible for contributing to 14.9% of global GHG emissions.\textsuperscript{8} When all activities related to agricultural production are included in this calculation, agriculture’s contribution to global GHG emissions is estimated to be 32%.\textsuperscript{9} Or, from another

\textsuperscript{5} Id.
\textsuperscript{6} Id.
\textsuperscript{7} Id.
\textsuperscript{8} Id.
perspective, defining agriculture broadly to include forestry, land use changes, crop and cattle farming, agriculture’s shared contribution of global GHG emissions is 33.1%, far in excess of emissions from electricity and heat, and almost equal to emissions from the industry and transportation sectors combined. 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 titled “Livestock’s Long Shadow –Environmental Issues and Options,” the UN Food and Agriculture Organization (FAO) found that “the livestock sector generates more greenhouse gas emissions as measured in CO2 equivalent – 18 percent – than transport.”

Although farming, forestry and land use changes have been historically discussed individually, this paper argues that these sectors are so interconnected that a broad definition of agriculture which incorporates crop and animal farming, forestry and land use changes is appropriate. There are four reasons that this paper defines agriculture so broadly. First, suggestions by international bodies – the United Nation’s (UN) Intergovernmental Panel on Climate Change (IPCC), for example – to mitigate climate change in the area of agriculture increasingly incorporate land use and forestry practices, suggesting that the farming, forestry and land use changes are interrelated. Second, in many instances, agriculture and forestry practices

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10 This percentage was calculated by adding together the total emissions-percentages for land-use change, forestry, and agriculture.
11 Baumert et al., supra note 4.
13 “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 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
are considered under a single umbrella for the purposes of economic analyses in a region.\textsuperscript{14} Third, in both the U.S. and abroad, governments often address agriculture and forestry issues within a single committee, providing further institutional support for defining agriculture as inclusive of farming, forestry and land use activities.\textsuperscript{15} 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, and therefore solutions for one sector will necessarily affect the other. For example, the primary reason forests are cleared is for agriculture – both for crop farming and as grazing pastures for cattle.\textsuperscript{16} Thus, any mitigation or adaptation plans concerning deforestation will necessarily address farming activities, and vice versa.

Historically, the primary sources of carbon dioxide (CO2) were plant respiration and the decomposition of organic matter; both of which release ten times more carbon dioxide than human activities.\textsuperscript{17} Yet, the environment was able to handle the carbon dioxide releases from these natural sources without substantial atmospheric warming because of the carbon dioxide

\textsuperscript{14} 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.


\textsuperscript{16} See David Pimentel, Land Degradation and Environmental Resources (2005), at http://academic.cengage.com/resource_uploads/static_resources/0495015989/12886/mili15_essay_pimentel.pdf (“[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.”); Rhett A. Butler, Deforestation in the Amazon, at http://www.mongabay.com/brazil.html (last visited May 1, 2009) (the primary reasons for deforestation in the Brazilian Amazon are, in the following order: 1) clearing land for cattle pastures, 2) colonization and subsistence agriculture, 3) infrastructure improvements, 4) commercial agriculture, and 5) logging); Livestock Policy Brief: Cattle Ranching and Deforestation, UN FOOD & AGRIC. ORG. 1, at ftp://ftp.fao.org/docrep/fao/010/a0262e/a0262e00.pdf (last visited May 1, 2009) (“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].

\textsuperscript{17} FAO Livestock, supra note 12.
absorbed by plant photosynthesis. The most significant change to the balance of carbon
dioxide release and absorption is the amount of extra carbon dioxide that is released by human
activities. While global increases in atmospheric concentrations of carbon dioxide are
primarily attributed to the use of fossil fuels and changes in land use, increases in concentrations
of the two other key GHGs – methane (CH4) and nitrous oxide (N20) – are predominantly due to
agriculture.

Although human agricultural practices are contributing to increased emissions of the primary
GHGs – which in turn intensifies and accelerates the global warming process – there has been
little effort made thus far to target agriculture. The primary focus of regulation both in the
United States and abroad has been, and continues to be, limited to the transport, electric, and
industry sectors, at the expense of other major contributors such as agriculture. The UN has
determined that, to 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. To achieve these goals, no longer can any
nation afford to limit its focus to only one or two sources of GHG emissions, especially when
that prevents any efforts from being made to address other major contributors to atmospheric
concentrations of GHGs, such as agriculture.

This paper will argue that, to prevent the worst predicted effects of climate change from
occurring, regulation at both international and national levels must address agricultural activities.

18 Id.
19 Id.
Admittedly, human rights issues related to agriculture and sustainable farming practices are of critical importance, in particular for the developing world. However, in order to limit the scope of issues examined in this paper, I will solely focus on the need for a change in the approach to environmental policies without considering the social impacts of global warming. Part I will first identify the problematic current trend of addressing climate change by only regulating the combustion of fossil fuels at the expense of other causes, and second, will explain agriculture’s contribution to climate change. This section will then summarize the science surrounding climate change and the relationship between the three primary GHGs and climate change, and will also address the specific agricultural practices that are presenting problems for the environment. To illustrate the universal lack of regulation on agriculture’s contribution to climate change, Part II will examine various international treaties and State-specific laws, including proposed measures, which address climate change, and identify their deficiencies. The final section of this paper, Part III, will propose solutions that could be implemented for more holistic, and successful, climate change mitigation policies.

**Part I: Agriculture’s Contribution to Climate Change**

Climate change presents a serious threat to global security, for the global economy and for the continued existence of human and animal life on the planet. Even when faced with problems of such a large proportion, many governments have failed to adopt holistic measures for mitigating climate change. To meet the short- and long-term goals established to avoid the

22 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, *Global Security Brief #3: Climate Change Poses Greater Security Threat than Terrorism*, at http://www.worldwatch.org/node/77 (Apr. 1, 2005).

23 “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 WORLD NEWS, Oct. 27, 2006, at http://news.bbc.co.uk/2/hi/business/6093396.stm.
worst predicted effects of climate change, governments must implement measures that take into account all major sources of anthropogenic emission of GHGs. However, until just a few years ago, debates raged as to whether climate change even existed; presently, there remain some questions about how much human activities actually impact climate change.\textsuperscript{24} Although advances in science leave little doubt that human actions are significantly contributing to climate change,\textsuperscript{25} solutions proposed thus far to address anthropogenic sources of emissions have been limited to activities in the transport, industry and electric sectors. The combustion of fossil fuels used in these sectors is unarguably a significant contributor to the problem of climate change and one that merits continued attention and regulation. However, the disproportionate focus on these sources of emissions has obscured other causes of climate change, leaving some major sources of GHG emissions unregulated.

The failure to effectively regulate fossil fuels and the lack of attention given to other significant contributors, such as agriculture, has resulted in a failed global response to climate change. During a conference held in Copenhagen, Denmark, during March of this year, a group representing more than 1,600 scientists and other experts predicted that the “worst-case scenario trajectories” stated by the IPCC only two years ago are already being realized.\textsuperscript{26} The report also noted that there is “a significant risk that many of the trends will accelerate, leading to an

\textsuperscript{24} See Leading Environmental Scientist Disputes Human Causes of Climate Change, Foster Friess, at http://www.fosterfriess.com/articles/20023/ (last visited April 16, 2009).
\textsuperscript{25} “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, at http://www.un.org/apps/news/story.asp?NewsID=21429&Cr=climate&Cr1=change.
\textsuperscript{26} Frank McDonald, Global Green New Deal Needed to Save the Planet, IRISH TIMES, Mar. 18, 2009, at http://www.irishtimes.com/newspaper/opinion/2009/0318/1224243006437.html.
increasing risk of abrupt or irreversible climatic shifts.”27 The article goes on to quote experts as stating the following:

Temperature rises above two degrees 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.’28

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, producing just enough for individual consumption and making just enough money from their work to support their family and make a living wage, are largely romanticized notions of what once was – at least in the developed world. Rather than being limited to small-scale production necessary to feed only one’s family or community, agriculture has become one of the world’s largest industries. Agriculture employs nearly 1.3 billion people globally.29 In the U.S., the majority of farmed goods are produced by modern “farms that 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

27 Id.
28 Id.
29 Ellis, supra note 9, at 5.
tractor. They cover more acres and produce more crops with fewer workers than ever before.”

Modern large-scale family farms, defined as those with profits of at least $250,000 per year, make up only 7% of farms in the U.S., but account for almost 60% of all production, and receive over 54% of government agriculture subsidies. In 2004, revenues for livestock and dairy operations exceeded $120 billion, and revenues from crop production added another $116 billion in agricultural profits.

Agriculture as a major global industry is not in and of itself problematic for the environment. The danger agriculture presents stems from current farming practices and the resulting consequences for the ecosystem. The agricultural industry has developed around a model that focuses on maximizing profits rather than balancing growth in concert with environmentally sustainable practices. A primary example of the danger posed by current agricultural practices is apparent in the context of water. “In developing countries, agriculture uses 87 percent of total extracted water.” The developed world is no more efficient; for example, in the U.S., agriculture is responsible for 80% to 90% of consumptive water use. Worldwide, 70% to 90% of fresh water is used for agricultural irrigation.

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31 Id.
33 Ellis, supra note 9, at 5.
While agriculture is composed of many different practices, the primary activities that are 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, including the differences between the various GHGs, how human activities contribute to the accumulation of GHGs in the atmosphere, and the risks that these emissions pose for the environment.

B. The Science Behind Climate Change

Although there is a naturally occurring greenhouse effect necessary for life on earth to exist, humans are enhancing the natural warming cycle by adding chemicals that are not naturally occurring into the atmosphere. The addition of new chemicals, and increased quantities of naturally occurring chemicals, is causing increased warming. Rising temperatures accelerate evaporation rates, which in turn increases the atmospheric concentration of water vapor, resulting in further warming. This cycle has become known as the “enhanced greenhouse effect”; it is this effect that is responsible for much of the present, and future predictions of, harm to the environment.

This paper will focus on the primary GHGs – carbon dioxide, methane and nitrous oxide, rather than the “lesser GHGs”, which include sulfur hexafluoride, hydrofluorocarbons, perfluorocarbons, chlorofluorocarbons, and water vapor. The heat-trapping properties of the

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37 CLIMATE CHANGE: SCIENCE, STRATEGIES & SOLUTIONS 7 (Eileen Claussen, ed., Pew Center on Global Climate Change 2001).
three primary GHGs are “undisputed”, 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. 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.”

1. **Carbon Dioxide (CO2)**

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 the soil. 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. 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. “Trees grouped together in forests are even more efficient. Scientists estimate that the Earth’s forests currently store more than 75 percent of the planet's aboveground carbon. And the forests store almost that much of the planet's soil carbon.”

Carbon dioxide has been described as the most important of all GHGs because it is responsible for the largest proportion of “trace gases” in the atmosphere, and 60% of the enhanced greenhouse effect has been attributed to carbon dioxide. Atmospheric carbon dioxide

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41 *Id.*
42 *Id.*
43 *Id.*
44 Climate Change: Carbon Dioxide, BBC WEATHER CTR., at http://www.bbc.co.uk/climate/evidence/carbon_dioxide.shtml (last visited April 16, 2009) [hereinafter BBC WEATHER CTR C02].
comes from a variety of natural sources, including those described above, as well as volcanic eruptions and as waste produced by animal respiration.\textsuperscript{45} However, human activities, such as fossil fuel combustion, intensive tillage practices, and crop residue removal, have also become major sources of atmospheric concentrations of carbon dioxide.\textsuperscript{46} Modern, large scale agricultural activities are particularly damaging. These practices clear land of trees capable of absorbing carbon dioxide, release significant amounts of carbon dioxide previously stored in the land because of intensive tilling activities, and produce GHG emissions from the fossil fuels used as an energy source for farm equipment, irrigation pumps and even to dry grain.\textsuperscript{47} Additionally, carbon dioxide is emitted during the manufacture of fertilizer and pesticides used in agricultural practices.\textsuperscript{48}

With emissions of carbon dioxide continuing to increase, and an ecosystem less able to absorb as much carbon as it had in the past, scientists are predicting that, in the best case scenario, atmospheric concentrations of carbon dioxide will reach double the amount in existence prior to the Industrial Revolution by 2100; at worst, the level will double by 2045.\textsuperscript{49} Increased emissions of carbon dioxide result in higher atmospheric temperatures; in hotter climates, plants and the soil are less able to soak up carbon than in cooler climates, causing “permafrost to thaw, potentially releasing large quantities of methane.”\textsuperscript{50}

\textsuperscript{45} Id.
\textsuperscript{48} Id.
\textsuperscript{49} BBC WEATHER CTR C02. supra note 44.
2. Methane (CH₄)

Methane is an odorless, colorless gas that is also referred to as “marsh gas.” Methane is generated naturally by bacteria that break down organic matter,” and scientists estimate that it is 20 to 30 times more powerful than carbon dioxide. The “power” of GHGs is measured by using the Global Warming Potential (“GWP”), which 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. For methane, this means that the GWP of one ton is equal to 20 to 30 tons of carbon dioxide. And although the increase in carbon dioxide emissions since pre-industrial times is significant – around 31% – atmospheric concentrations of methane have doubled during the same period. Furthermore, human activities are responsible for “one and a half times as much methane as all natural sources.”

Methane released from the sea floor approximately 55 million years ago caused global temperatures to rise “by 4-8 degrees Celsius,” and it took the earth almost 100,000 years to

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52 Methane, U.S. ENVTL. PROT. AGENCY, at http://www.epa.gov/methane/ (last visited Apr. 17, 2009). See also BBC WEATHER CTR C02, supra note 44.
53 SCIENCE DAILY, supra note 51.
54 BBC WEATHER CTR C02, supra note 44.
55 “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.” Emissions of Greenhouse Gases in the United States 2003, ENERGY INFORMATION ADMIN., at http://www.eia.doe.gov/oiaf/1605/archive/gg04rpt/units.html (last modified Dec. 28, 2004).
57 Id.
58 SCIENCE DAILY, supra note 51.
return to a “normal state.” At present, methane is accredited as the source of 20% of the enhanced greenhouse effect. While the majority of methane is emitted through livestock digestive processes, there are many other causes of methane releases, including both anthropogenic and natural sources. Natural sources of methane emissions “include wetlands, gas hydrates, permafrost, termites, oceans, freshwater bodies, non-wetland soils, and other sources such as wildfires.” However, the natural sources of emissions are being overwhelmed by emissions from human-related activities. Some 60% of global methane emissions are attributed to anthropogenic sources, including fossil fuel combustion, animal husbandry, rice farming, burning of biomass and waste management.

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. When methane is released into the atmosphere it reacts with oxygen and forms carbon dioxide, which can cause marine dysoxia. Marine dysoxia kills oxygen-using animals, which could cause the extinction of many species of animals living in the ocean. 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, headed a team

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60 BBC WEATHER CTR C02, *supra* note 44.
61 Branosky, *supra* note 47.
63 *Id. See also* CLIMATE CHANGE 2001: WORKING GROUP I: THE SCIENTIFIC BASIS, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (Cambridge Univ. Press 2001), at http://www.ipcc.ch/ipccreports/tar/wg1/127.htm (click on “4.2.1.1 Methane (CH4)”)[hereinafter IPCC 2001].
64 EPA, *supra* note 55. *See also* IPCC 2001, *supra* note 63.
65 SCIENCE DAILY, *supra* note 51.
66 *Id.*
67 *Id.*
of scientists who explored the consequences of the last major methane release on Earth some 635 million years ago, which was far more substantial than the release 55 million years ago discussed above. Professor Kennedy and the other scientists concluded that a sudden release of methane previously trapped in ice sheets resulted in an extreme change in the climate, setting off a chain of events that caused substantial global warming and marked the end of the Earth’s last “snowball ice age.” Describing why an event that occurred more than 600 million years is relevant today, Professor Kennedy stated:

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”] 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.

In other words, the methane released from ice sheets approximately 635 million years ago, 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

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68 Id.
69 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.
70 NSF CRC PROJECT ON GAS HYDRATES, at http://sag1.chem.pitt.edu/clathrate/ (last visited May 1, 2009). “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 10^3 years.” Id.
71 SCIENCE DAILY, supra note 51.
sheets and release the methane. The potential result of another abrupt release of methane into the atmosphere is a rise in global temperatures so significant that existing forms of plant and animal life could no longer be sustained.

3. Nitrous Oxide (N2O)

The final primary gas that contributes to climate change, and the most powerful of the three GHGs, is nitrous oxide. Most commonly known as “laughing gas”, nitrous oxide is colourless and non-flammable.\(^\text{72}\) It is generated by microbial reactions in water and soil.\(^\text{73}\) Nitrous oxide remains in the atmosphere for as long as 150 years,\(^\text{74}\) and “the GWP [for NO2 is] 310, making it a far more potent gas than CH4 or CO2.”\(^\text{75}\) In other words, 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.”\(^\text{76}\)

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.\(^\text{77}\) Even with this variety of natural sources, experts attribute the 8.8% increase in atmospheric concentrations of nitrous oxide since industrialization

\(^{72}\) Causes of Global Warming, ECOBRIDGE, at http://www.ecobridge.org/content/g_cse.htm (last visited Apr. 17, 2009).


\(^{74}\) Climate Change: Nitrous Oxide, BBC WEATHER CENTER, at http://www.bbc.co.uk/climate/evidence/nitrous_oxide.shtml (last visited March 27, 2009) [hereinafter BBC WEATHER CENTER N2O].

\(^{75}\) Branosky, supra note 47.

\(^{76}\) Climate Change: Earth Gases- Nitrous Oxide, BBC WEATHER CENTER, at http://www.bbc.co.uk/weather/features/gases_nitrousoxide.shtml (last visited April 14, 2009) [hereinafter BBC WEATHER CENTER CC].

The primary anthropogenic source of the increase in nitrous oxide emissions is the use of nitrogen fertilizers. Globally, the production of fertilizer deposits 55 Teragrams (Tg) of nitrogen into the soil annually. “Nitrogen fertiliser 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 fertilisers leach into groundwater, nitrous oxide goes into the atmosphere.” 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. “All in all, land conversion is leading to the release of around half a million tonnes a year of nitrogen in the form of nitrous oxide.” The primary risk of harm related to nitrous oxide emissions is the potency of the gas and length of time it takes to be removed from the earth’s atmosphere, making it a substantial contributor to the enhanced greenhouse effect.

**Part 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 surface, and GHG emissions

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78 BBC WEATHER CENTER CC, *supra* note 76.
79 BBC WEATHER CENTER CC, *supra* note 76.
81 BBC WEATHER CENTER CC, *supra* note 76.
82 BBC WEATHER CENTER CC, *supra* note 76.
84 *Id.*
attributed to agricultural production increased 17% globally between 1990 and 2005. With such a large and rapidly growing industry, agriculture represents one of the largest threats to the environment and, at the same time, one of the biggest opportunities to reduce atmospheric concentrations of the primary GHGs, thereby significantly reducing 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 transport, industry, energy supply, agriculture and forestry, buildings, and waste sectors; the results confirm that agriculture provides one of the largest opportunities for curbing global GHG emissions. The potential environmental savings by 2030 for the agriculture and forestry sector are estimated to be 6 billion tons CO2 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).

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.

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85 Ellis, supra note 9, at 5.
86 Adam, supra note 16.
87 These sectors, and the calculated potential savings figure, were combined in the article and not for the purposes of this paper.
88 Id.
1. Deforestation and Harmful Land Use Practices

Deforestation is the process of changing forested lands into non-forested land uses, and is directly caused by the removal of trees from an area without reciprocal reforestation efforts.\(^8\)

“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.”\(^9\) According to the National Geographic Society, rainforests still cover approximately 30% of the earth’s surface, but each year deforestation results in the loss of forest cover the size of Panama.\(^1\) At present rates of deforestation, the world could lose all of its rainforests in one hundred years.\(^2\)

Forests are important to the ecosystem because they provide habitats for wildlife,\(^3\) influence regional climate and weather patterns, protect top soil, foster medicinal conservation, recharge aquifers, and serve as storage for organic carbon.\(^4\) Forests are able to extract carbon dioxide from the atmosphere, and in so doing contribute to the stability of the environment.\(^5\) Without the sun-blocking cover of trees, normally moist soils dry out and are depleted of the nutrients necessary for carbon capture.\(^6\) The absence of tree cover and increased ground temperatures also leads to more extreme temperature changes between the day and night, which further harms plants and animals.\(^7\) 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.

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9 Id.
11 Id.
12 Seventy percent of Earth’s land animals and plants live in forests. . . .” Id.
14 Gervet, supra note 89.
15 NAT’L GEOGRAPHIC, supra note 91.
16 Id.
In summary, forests are critical to fighting global warming because of their ability to absorb “the greenhouse gases that fuel global warming.” For example, for each two cubic meters of wood growth, forests can capture around one ton of carbon from the atmosphere. “Fewer forests means [sic] larger amounts of greenhouse gases entering the atmosphere—and increased speed and severity of global warming.” Approximately six billion tons of carbon dioxide – representing one quarter of all GHGs – are released on an annual basis due to deforestation.

The primary reason forests are cleared is agriculture; land is cleared to grow crops and to provide grazing pastures for animals. Not only is deforestation harmful to the environment because of the damage to land resulting from a lack of trees, but also because of the methods used to deforest the land. Many of the common methods of clearing forests render the land useless for years beyond the period of time that the land is actually used for an alternative purpose, such as crop farming. One of the most common, and destructive, methods of removing trees is through a practice known as 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. 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.

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98 Id.
99 Id.
101 NAT’L GEOGRAPHIC, supra note 91.
102 UN FAO Kyoto Protocol, supra note 100.
103 NAT’L GEOGRAPHIC, supra note 91. See also Pimentel, supra note 16; Butler, supra note 16; Livestock Policy, supra note 16.
crops. Most cleared areas are never restored to secondary forest bush and instead remain permanently deforested. The use of slash and burn farming and the resulting permanent deforestation has become a major contributor to carbon emissions and global climate change. It is not only the method of farming, but the scope of the practice that contributes to environmental degradation. It is estimated that 200 to 500 million people around the world use the slash and burn method. The breadth of the practice is responsible for contributing “as much as 25 percent to global warming.”

The incineration of fossil fuels and deforestation – in particular, deforestation in the tropics – combined with the resulting land use changes, represent as much as 33% of total anthropogenic carbon dioxide emissions. For a more concrete example of present harms exacted as a result of deforestation, scientist James Randerson spearheaded a six year study that focused on the connection between deforestation, droughts and global warming. Randerson and his colleges 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.” To reach this conclusion, satellite images showing climate and fire patterns were analyzed. By studying these images, Randerson discovered that the use of fire to clear forested lands and remove organic soil increased substantially during dry

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105 Id.
106 Id.
109 IPCC 2007, supra note 20.
111 Id.
112 Id.
years, resulting in the release of “huge amounts” of carbon dioxide. 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, “but carbon emissions from deforestation were 30 times greater – exceeding emissions from fossil fuel burning.” 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”, and that an increased frequency of droughts makes the carbon stored in forests even more vulnerable.

2. Crop Farming

The Australian Department of Climate Change (the Department) summarized the results of the country’s 2006 National Greenhouse Accounts, which provides detailed information on emissions of GHGs in the economic sectors and in States and Territories, as well as a general overview that the government submitted to the UNFCCC and the initial report under the Kyoto Protocol. In this summary, the Department identified agricultural practices and how, and to what degree, they impact the ecosystem. The summary is useful because it provides an overview of the various types of crop farming practices used by countries around the world; because the practices and impacts identified are not unique to Australia, this analysis provides a good framework for considering how crop farming can be environmentally harmful if not practiced in a sustainable and eco-friendly manner.

113 Id.
114 Id.
115 Id.
The first category of crop farming is extensive agriculture, which is a farming practice that uses minor amounts of labor and money in comparison to the size of the land being farmed. Extensive agriculture is dependent on the fertility of the soil, the climate and an available water supply. The Department identified direct impacts to the physical land and ecosystem resulting from this method of agriculture: “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.”

The second category of crop farming is intensive agriculture, which relies on a significant amount of labor and money relative to the size of the land being farmed. 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. The physical and ecosystem impacts of this type of farming include: “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] CO₂ . . .” 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 CO₂ concentrations).”

\[119\] Id.
\[120\] Austl. DoCC- GHG Emissions, supra note 117.
\[122\] Id.
\[123\] Austl. DoCC- GHG Emissions, supra note 117.
In addition to extensive and intensive farming practices, the use of machinery, and products such as harmful fertilizers and pesticides, the choice of crop that a farmer grows can have a significant impact on the environment. One crop that contributes substantially to the increase in atmospheric levels of GHGs is rice. Flooding fields to farm rice produces the perfect environment for bacteria to grow and thrive.\textsuperscript{124} The bacteria living in the flooded fields produce methane by decomposing manure and other organic matter, and then emitting the methane through the plants themselves or into the atmosphere.\textsuperscript{125} 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.”\textsuperscript{126} Wassmann’s interview was conducted shortly after the late April to early May 2007 IPCC meeting in Bangkok, Thailand. During this meeting the IPCC released a report concluding “that rice production was a main cause of rising methane emissions in the 20th century.”\textsuperscript{127}

3. Livestock Farming

Even with all of the problems that crop farming can have on 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.\textsuperscript{128} In the Continental U.S., 50\% of the total land area is covered by grasslands and forests used as grazing pastures for livestock.\textsuperscript{129} The majority of this land is used as permanent pastures, although a considerable

\begin{footnotesize}
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\textsuperscript{124} & \textsc{Associated Press, Experts: Rice Farming Huge Source of Methane Emissions}, \textsc{FOX News}, May 2, 2007, at http://www.foxnews.com/story/0,2933,269478,00.html.  \\
\textsuperscript{125} & \textit{Id}.  \\
\textsuperscript{126} & \textit{Id}.  \\
\textsuperscript{127} & \textit{Id}.  \\
\textsuperscript{128} & \textsc{FAO Livestock, supra} note 12.  \\
\textsuperscript{129} & \textsc{James R. Gillespie, Modern Livestock \& Poultry Production} 9 (Delmar Thompson Learning, 7th ed. 2004).  \\
\end{tabular}
\end{footnotesize}
Livestock farming is perhaps the most significant agricultural practice if measured by its contribution to climate change. The livestock sector alone accounts for 40% of the total agricultural Gross Domestic Product (GDP). Farming 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. Livestock farming is also a major cause of deforestation due to the clearing of land to create grazing pastures. Approximately 70% of land in the Amazon has been deforested for the purpose of livestock grazing. And the amount of crops produced exclusively for animal consumption is staggering. For example, about 900 pounds of vegetation are consumed every month by the average cow.

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, as well as 64% of ammonia emissions (which contribute to acid rain). Scientists estimate that animal husbandry may be responsible for the release of more than 500 million tons of methane into the atmosphere annually. “The world's 1.3 billion cattle and other ruminant livestock emit about 60 million tons of the total, or 12 percent of all the methane released into the atmosphere. The

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130 FAO Livestock, supra note 12.
131 Ellis, supra note 9, at 12.
132 FAO Livestock, supra note 12. See also Ellis, supra note 9, at 12.
133 FAO Livestock, supra note 12.
134 Id.
136 FAO Livestock, supra note 12.
137 Interview with Jeremy Rifkin, supra note 135.
burning of forests, grasslands, and agricultural wastes releases an additional 50 to 100 million tons of methane.”\footnote{138}

Another problem associated with current livestock agriculture is how energy inefficient current practices are. Even though “the ratio of energy use to agricultural output[] has fallen by about 50 percent since 1978”\footnote{139} the amount of energy required to produce one calorie of meat far outweighs the caloric value realized. As a basis for comparison, one calorie of energy expended to grow corn results in four calories of edible food – a 1:4 ratio.\footnote{140} 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.\footnote{141} Another good indication of the environmental harm resulting from existing livestock agricultural practices is the amount of water consumed. Although estimates about the amount of water needed to produce one kilogram of beef cattle vary, the range is anywhere from 3,682 liters of water up to as many as 100,000 liters.\footnote{142} Compare this to the 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.\footnote{143} Given the existing water shortages in the more arid regions of the world, and the predicted increase in size and number of such regions as a result of global warming, regulating agricultural practices presents a substantial opportunity for both climate change mitigation and adaptation in the area of water conservation. Unfortunately, such approaches have not been seriously considered or adopted in the few existing mechanisms adopted to address climate change.

\footnote{138}{Id.}
\footnote{140}{DRAFT Report, supra note 34.}
\footnote{141}{Id.}
\footnote{142}{Id.}
\footnote{143}{Id.}
Part III: Current Mechanisms for Combating Climate Change

Most national and international 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 to no emphasis on agriculture. This section will examine the only legally binding, international, multilateral treaty addressing climate change – the Kyoto Protocol to the UNFCCC, regional mechanisms put in place to carry out the goals of Kyoto, as well as proposed mechanisms such as legislation in the United States and the Copenhagen Climate Change Conference scheduled for December 2009. There is a significant amount of scholarship devoted to how the 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, which was 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. One of the first major, concerted international environmental actions taken to address this risk was the UNFCCC. One hundred and eighty six (186) countries are Parties to the UNFCCC, including the U.S. and the European Community (EC). Parties to the Convention committed to stabilize their emissions of GHGs by the year 2000 to levels existing in 1990. The next major international environmental mechanism enacted to build on these goals and go one step further was the Kyoto Protocol.

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145 Id.
146 Id.
The Kyoto Protocol was adopted in 1997 in Kyoto, Japan, and entered into force in December of 2005. The goal of the Kyoto Protocol is to achieve “stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.” Kyoto goes beyond the UNFCCC by requiring developed nations to reduce emissions of GHGs from 1990 levels by 5% by 2012. To achieve a 5% cut in global emissions of the six key GHGs by the period 2008-2012, it was determined that States should reduce emissions by the following percentages: Switzerland, most of Central and Eastern Europe and the European Union (EU) by 8%; the U.S. by 7%; Canada, Hungary, Japan and Poland by 6%; Russia, New Zealand and Ukraine need not achieve a reduction, but must stabilize their emissions during this period; and, emissions may be increased by 1% in Norway, by as much as 8% in Australia, and by up to 10% in Iceland. Although 5% 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.”

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 paper, along with sulphur hexafluoride, (2) reduce hydrofluorocarbons and perfluorocarbons produced by industrialized countries, and (3) establish

147 Kyoto Protocol, UN FRAMEWORK CONVENTION ON CLIMATE CHANGE at http://unfccc.int/kyoto_protocol/items/2830.php (last visited Apr. 16, 2009) [hereinafter UNFCCC Kyoto].
149 EUROPA- Kyoto and CC, supra note144.
151 Id.
general commitments for all other nations. To satisfy these objectives, countries are permitted to design a plan that works best for their particular State, and allows for the use of mechanisms such as Emissions Trading, Clean Development Mechanism (CDM), and Joint Implementation, which are intended to provide developed nations with economic incentives to satisfy the GHG emissions limits.

The attention given to agriculture in the Kyoto Protocol is on par with the Protocol’s discussion of 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. Any plan developed in accordance with Article 10 “would” take into account agriculture, forestry and waste management, in addition to industry, energy and transport. Additionally, the Protocol recognizes the importance of forests as natural carbon sinks and, under the flexible mechanisms, provides 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 be traded.”

Kyoto’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. Kyoto explicitly calls on Parties to incorporate agriculture into any climate change mitigation plan, and also emphasizes the potential benefits for the environment and economy that can be

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152 UNFCCC Kyoto, supra note 147.
153 Id.
155 Id. at art. 10(b).
156 UN FAO Kyoto Protocol, supra note 100.
achieved by adopting mechanisms protective of natural resources. However, the Kyoto 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. The flexibility of the Kyoto Protocol also means that the agreement can serve as a model for countries that have not signed on as Parties, but are signatories to the UNFCCC and have committed to reducing GHG emissions.

Unfortunately, the mechanisms adopted by most countries have instead relied almost exclusively on regulating industry, transportation and electricity. The same criticism of existing mechanisms can be made for proposed climate change plans, the majority of which fail to fully appreciate the extent to which agriculture provides an opportunity to mitigate climate change. Absent a more holistic international mechanism, this is unlikely to change anytime in the near future. The regulation of the above mentioned sectors, viewed by the public as the regulation of big business, receives less opposition than the regulation of agriculture, viewed by many as the regulation of individuals – a far more difficult political battle.

B. The European Union’s Climate Change Program & the United Kingdom’s Climate Change Act

Although the EU and its Member States only ratified the Kyoto Protocol in May 2002, 157 by 2000 they realized that progressive actions were needed to achieve the emissions reductions goals set forth in Kyoto. In response, the European Commission launched the European Climate Change Programme (ECCP). 158 Prior to the creation of the ECCP, the primary initiatives identified by the Commission as necessary for improving energy efficiency included: electricity

157 EUROPAC- Kyoto Protocol, supra note 150.
from renewable sources, “voluntary commitments” by auto makers to cut carbon dioxide emissions by one quarter, and proposals for a tax on energy products. The ECCP was created as a mechanism for implementing the Kyoto Protocol and its goal was to pinpoint all elements that are necessary for the EU to develop an effective strategy for implementing Kyoto. The first working group of the ECCP addressed flexible mechanisms, focusing almost exclusively on carbon trading systems.

The second phase of the ECCP (2002-2003) resulted in a more comprehensive set of measures, yet all concern the energy, transport and electric sectors. Specifically, the report identifies the following measures as having been completed by the Commission: 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. The second phase also included working groups to address agriculture, sinks and agricultural soils, and forestry issues. Each of these working groups produced a detailed report addressing the problems associated with the various agricultural practices, as well as actions that could be taken to mitigate the harm.

In October 2005 the Commission launched the Second ECCP (ECCP II). 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.\textsuperscript{165} 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, costal zones and tourism; human health; agriculture and forestry; biodiversity; regional planning and infrastructure; urban planning; development cooperation; insurance industry; and national strategies for adaptation.\textsuperscript{166}

Even with such broad efforts, most environmental regulations and adaptation policies are implemented at the individual State level, limiting the influence regional initiatives can have. At present, the United Kingdom (UK) is the only Member of the EU “to have a legally binding long-term framework to cut carbon emissions.”\textsuperscript{167} The legally binding measures require a 26\% reduction in carbon dioxide emissions by 2020 and a 50\% reduction by 2050.\textsuperscript{168} The primary requirements under the Act are that the government: publish five annual carbon budgets beginning in 2008; create a committee on climate change that will advise it on establishing carbon budgets and on the balance between domestic emissions reductions and the use of carbon credits; and, conduct a climate change risk assessment.\textsuperscript{169} 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.\textsuperscript{170} However, the Act does not discuss the regulation of agriculture and land use is

\textsuperscript{165} Id.
\textsuperscript{166} European Climate Change Programme II: Impacts and Adaptation, EUROPA, at http://ec.europa.eu/environment/climat/eccp_impacts.htm (last visited April 1, 2009).
\textsuperscript{169} Id.
\textsuperscript{170} Id.
mentioned only as part of the definition of “UK removals”. Thus, the only legally binding mechanism for reducing emissions in the EU – the UK Climate Change Act – is both narrow in its scope, because its focus is limited to reducing carbon dioxide emissions, and in its breadth, because agriculture and land use are not included as regulated sectors in the mitigation policies.

The failure of the UK Climate Change Act to include provisions regulating agricultural activities is likely due to the same reason that agriculture has not been successfully integrated into international mechanisms – politics. 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 holistic approach, which, while better for the environment, would have likely increased political opposition to the Act.

C. Proposed Climate Change Legislation in the U.S.

On March 30 of this year the House Energy and Commerce Committee introduced a new climate change bill. The “American Clean Energy and Security Act of 2009” (the Act) 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. The Act 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. The second objective

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174 TIMES ONLINE, supra note 174.
175 Id.
of the Act is a focus on adaptation, which marks a significant change from prior climate change bills proposed before the U.S. Congress. The Act proposes various measures to help state and local governments develop initiatives to address the unavoidable consequences of climate change. 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. In its current form, the Act is divided into six primary parts, which are then divided into multiple subtitles and sections, as illustrated below.

<table>
<thead>
<tr>
<th>Title No.</th>
<th>Title Name</th>
<th>Subtitles/Parts</th>
</tr>
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| I        | Clean Energy                    | A- Renewable Electricity Standard  
B- Carbon Capture and Sequestration  
C- Clean Transportation  
D- State Energy and Environment Development Funds  
E- Smart Grid Advancement  
F- Transmission Planning  
G- Federal Purchases of Electricity Generated by Renewable Energy  
H- Technical Corrections to Energy Laws |
| II       | Energy Efficiency               | A- Building Energy Efficiency Programs  
B- Lighting and Appliance Energy Efficiency Programs  
C- Transportation Efficiency  
D- Utilities Energy Efficiency  
E- Industrial Energy Efficiency Programs  
F- Improvements in Energy Savings Performance Contracting  
G- Public Institutions |
| III      | Reducing Global Warming Pollution | A- Reducing Global Warming Pollution |
| VII      | Global Warming Pollution Reduction Program | A- Global Warming Pollution Reduction Goals and Targets  
B- Designation and Registration of Greenhouse Gases  
C- Program Rules  
D- Offsets  
E- Supplemental Emissions Reductions from Reduced |


177 Id.

178 Id.

What is noticeably absent from the Act – apparent by looking only at the Table of Contents – are any requirements on the agricultural industry. Rather than incorporating the regulation of agriculture into the legislation, the Act continues to focus almost exclusively on the industry, transport and electric sectors. Within the text of the 648 page Act, neither “farming” nor “livestock” are mentioned at all; agriculture is discussed only *four times*, and none of the references concern the regulation of the agricultural industry or requirements to institute sustainable farming practices.

The first reference to agriculture is within Section 701 (“Findings and Purpose”) and notes that “damage to plants, forests, lands, and waters” is a source of GHG emissions. The second reference can be found in Section 705 (“Scientific Review”). Section 705(a)(1) 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. Subsection (C)(4)(H) requires the consideration of “agriculture and forest systems, including effects on

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180 *Id.* at 329-333.
181 *Id.* at 329.
potential growing season, distribution, and yield” as a part of the scientific analysis conducted pursuant to Section 705(a).182 The next mention of agriculture is in Section 422183 (“Workforce Training and Education in Clean Energy, Energy Efficiency, Climate Change Mitigation, and Sustainable Environmental Practices.”).184 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.185 The final reference to agriculture in the Act is in Section 455 (“National Climate Change Vulnerability Assessments.”).186 Again, the focus on agriculture is limited to a required assessment of local measures being taken to adapt to climate change impacts on farming.187

In fact, 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 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.”188

Section 741 (“Environmental Considerations”) then 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 so that native species of plants and animals, and

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182 Id. at 333.
183 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.
184 ACES Act, supra note 173 at 566.
185 Id.
186 Id. at 582.
187 Id.
188 Id. at 329.
biodiversity, are protected.\textsuperscript{189} Conditions for applying offsets for reduction of deforestation nationally are discussed in Section 743 (“International Offset Credits”).\textsuperscript{190} 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.\textsuperscript{191}

The failure to approach climate change mitigation in the U.S. from a more holistic perspective could be based on a number of factors, such as the relatively small percentage of CO2 equivalent GHG emissions in the U.S. that come from agriculture versus industry, electricity and transportation.\textsuperscript{192} However, this is unlikely to be the primary reason for a lack of regulation because, despite having fewer GHG emissions nationally than international figures, a regulation of agricultural activities – defining agriculture by this paper’s standards – still offers the potential of reducing as much as one-quarter of all anthropogenic GHG emissions in the U.S.\textsuperscript{193} The more likely explanation is politics. The Farm Lobby is one of the most powerful special interest groups in the U.S. and has been described by an expert and insider 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

\textsuperscript{189} Id. at 422.
\textsuperscript{190} Id. at 431.
\textsuperscript{191} Id. at 436-48.
\textsuperscript{193} \textit{Agriculture, supra} note 192; \textit{Land Use, supra} note 192.
about 1 percent of the population.” Agricultural interests have been described as a “wheel of fortune” for farmers, lobbyists and representatives from farm-states. Or, as stated by former Senator Peter Fitzgerald, who had been a 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.”

**Part IV: Proposed solutions**

Even though the regulation of agriculture will require tough political negotiations, there are less divisive ways to incorporate agriculture into climate change mitigation and adaptation plans. This section will provide suggestions for actions that can be taken, both on national and international levels, to increase the role of agriculture in climate change mechanisms.

A. National Proposals

This section will explore how individual countries can improve their climate change mitigation policies by making a range of proposals that, if adopted, would result in a more holistic approach to climate change mitigation. The suggested mechanisms will range from options that are more limited and focus on regulation in only one area, to more comprehensive plans that would affect all agricultural practices. Because the U.S. has historically been the largest global emitter of GHGs and still remains the largest polluter per capita, and because the U.S. is the only Western, industrialized nation to be a member of the UNFCCC but not have

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195 *Id.*
196 *Id.*
198 *Id.*
ratified the Kyoto Protocol,199 this section will use focus on the changes that the U.S could, and should, make. However, most suggestions and policies for reform in the U.S. could be implemented by other nations around the world.

Beginning with the least comprehensive measure, yet one that would still help reduce agricultural emissions of GHGs, the U.S. could alter federal farm subsidies and instead offer subsidies for more environmentally friendly agricultural practices, such as organic farming. Agricultural subsidies provided to U.S. farmers are a huge burden on taxpayers;200 present substantial problems for international trade;201 and, contribute to environmental degradation.202 In only a five year period, between 2001 to 2006, the U.S. handed out over $95 billion in agricultural subsidies.203 Of this amount, over 90% of subsidies are provided to farmers who grow five crops – wheat, soybeans, rice, corn and cotton.204 A yearlong report conducted by three journalists with the Washington Post identified more than $15 billion in “wasteful, unnecessary and redundant spending.”205 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,

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202 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 200.
204 Edwards, supra note 200.
205 Morgan et al., supra note 203.
• the majority of subsidies were provided to large farms, accelerating the demise of small farming operations that cannot remain competitive.\textsuperscript{206}

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.\textsuperscript{207}

Altering federal farm subsidies could be accomplished in several ways, including: reducing or eliminating subsidies for farms that make profits in excess of X dollars 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. In late February of this year President Obama announced the proposed federal budget, which included proposals for reforming agricultural subsidies.\textsuperscript{208} President Obama’s proposals focused largely on the first three methods for altering subsidies mentioned above – limiting subsidies given regardless of market conditions or whether the land is actively used for agricultural practices, eliminating subsidies to farmers with sales in excess of $500,000 annually, and reducing the overall cap on subsidy payments.\textsuperscript{209} The proposed measures would have resulted in nearly $10 billion in savings over the next ten years,\textsuperscript{210} but were so broadly worded that even members of the

\textsuperscript{206} Id.
\textsuperscript{207} “Southern Rural Development Initiative found that less than 1 percent of agriculture subsidy payments between 2001 and 2003 went to Blacks, Native Americans and Asian Americans.” Jessica Hoffman, \textit{Farm Subsidies Overwhelmingly Support White Farmers}, at http://www.organicconsumers.org/articles/article_16762.cfm (Jan. 2009).
\textsuperscript{209} Herszenhorn, supra note 208.
\textsuperscript{210} Id.
Democratic Party opposed the measures and the proposed changes to agricultural subsidies were dropped from the budget.\textsuperscript{211}

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. However, it is also possible that his attempts at regulation failed because they were viewed by those with agricultural interests as eliminating benefits, rather than offering 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”\textsuperscript{212} and has the potential to “lower input costs, decrease reliance on nonrenewable resources, capture high-value markets and premium prices, and boost farm income.”\textsuperscript{213} Further, organic agriculture enables ecosystems to better adapt to the impacts of climate change and has substantial potential for reducing agricultural GHG emissions.\textsuperscript{214}

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However, organic farming receives far less government assistance than non-organic farming, despite being recognized as a solution to environmentally destructive large-scale farming practices.

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 methods of farming. 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” because this method of 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.”

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. Organic farming can reduce GHG emissions through: the reduced consumption of fossil fuels used for energy; an overall reduction in emissions of the primary GHGs; soils that are

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215 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, at http://www.fas.org/sgp/crs/misc/RL31595.pdf.


less vulnerable to erosion; and, an increase of carbon stocks and carbon sinks.\(^{218}\) In the U.S. alone, studies have shown that the energy input required for organic farming is 28% to 32% less than the energy required for conventional farming.\(^{219}\) “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.”\(^{220}\)

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.\(^{221}\) 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 does.”\(^{222}\)

Although 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 – both of which expedite the agricultural process, thereby reducing costs, such arguments are unsubstantiated. 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 20–90 percent increases in production.”\(^{223}\) A University of Michigan research scientist, Catherine Badgley, has stated that “a global shift to

\(^{218}\) Niggli et al., supra note 214 at 8-10.
\(^{219}\) Id.
\(^{220}\) Id.
\(^{221}\) Id.
\(^{222}\) Id.
\(^{223}\) Id.
organic farming could produce enough calories to feed the entire human population and potentially 75 percent more calories than are produced now.” Furthermore, even if organic goods remain more expensive in the developed world, this concern could be ameliorated by shifting at least some agricultural subsidies away from wheat, soybeans, rice, corn and cotton, and towards organic goods. This solution has the potential to alleviate the increased costs of the goods for the consumer while protecting farmers’ profits.

Yet another approach is to tie agricultural subsidies directly to GHG emissions. Again, instead of eliminating subsidies, making federal money for farmers contingent on reducing GHG emissions would be a way to incentivize farmers to improve current practices. Rather than attaching the subsidy only to the type of crop grown, receipt of federal monies would also 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 who adopt more environmentally friendly agricultural practices. Emissions levels could be established that would provide minimum, median and maximum benefits for the environment, and 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 – primarily, emissions of methane produced by livestock – and requires that these emissions be reported. The EPA is also exploring options for ways to make the

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224 Id.
reporting of nitrous oxide and methane emissions resulting from fertilizer use economically feasible and reliable.\(^{226}\) If the EPA already possesses such information and capabilities, then a move from reporting requirements to establishing more 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 – for example, the Clean Air Act – and subject larger farms (defined by the existing definition used for large family-farms) to the same emissions standards that other industries and facilities are required to satisfy. Or, instead of using existing regulations, agricultural practices could be included in the cap and trade program, though to a greater degree than what is proposed in the American Clean Energy and Security Act of 2009. Under the Act, deforestation is the only activity related to agriculture that is incorporated into the cap and trade scheme. Rather than limiting the agricultural activities that fall within a cap and trade program, all agricultural practices could be regulated, providing an additional economic incentive– the ability to trade additional credits in the market – for farmers to switch to more environmentally friendly farming practices.\(^{227}\) 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 percent of current U.S. carbon-dioxide emissions. . . . Many of the farming practices and land use changes involved in achieving these reductions have multiple

\(^{226}\) Id.

\(^{227}\) 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 simply 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, or 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.
benefits, including improving soil, water and air quality; increasing wildlife habitat; and providing additional recreational opportunities.”

Considering other options for changes at the national level, comprehensive legislation regulating the agricultural industry, or GHG emissions from any source, could be enacted. In the U.S., the American Clean Energy and Security Act of 2009 is a step in the right direction. However, in its current draft form, the Act 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 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. Title VII already contains a provision concerning deforestation, and therefore 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, in particular, livestock farming, could be required to meet the emissions requirements that are

228 Climate Change 101: Technological Solutions, PEW CTR. ON GLOBAL CLIMATE CHANGE, at http://www.pewclimate.org/docUploads/101_Tech.pdf (last visited Apr. 17, 2009). See also Paustian et al., AGRICULTURE’S ROLE IN GREENHOUSE GAS MITIGATION (Pew Ctr. on Global Climate Change 2006).
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, to encourage the reforestation of marginalized farm lands.

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. With the Kyoto Protocol set to expire in 2012, world leaders have been involved in a series of meetings that will culminate in December of this year at the UN Climate Change Conference in Copenhagen. The goal of the Copenhagen Conference is ambitious; the organizing governments want 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. With respect to climate change mitigation, the most important advance that could be made – with respect to agriculture and a global reduction in GHG emissions – is to incorporate requirements on the reduction of emissions related to agricultural practices into the post-Kyoto climate change protocol.

Mitigation actions in the agriculture sector present strong potential co-benefits for climate change adaptation, primarily, the improvement of ecosystem resilience, and for sustainable development, including food security, a reduction in poverty among the 70% of impoverished

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229 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.” Climate Change and Agriculture: Challenges and Opportunities for Mitigation, at http://en.cop15.dk/blogs/view+blog?blogid=908 (March 20, 2009).
persons living in rural areas, and for environmental services.\textsuperscript{231} Soil carbon sequestration offers the potential benefit of reducing agricultural emissions of carbon dioxide by some 89\%, and 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.\textsuperscript{232} “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.”\textsuperscript{233} Because carbon is one of the main ingredients in organic matter, there is a strong correlation between increased production and the mitigation of, and adaptation to, climate change through soil carbon sequestration.\textsuperscript{234} Furthermore, the science in this area is well enough developed that there is a good understanding of what 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.”\textsuperscript{235}

To ensure that agriculture is incorporated into the post-Kyoto mechanism, it is important that issues related to agriculture and climate change are discussed in the Copenhagen preparatory sessions. Inclusion in the preparatory sessions increases the chance that agriculture and climate change will be placed on the agenda for the December conference; being noted as an official component of the agenda is the best way to ensure that agriculture mitigation is incorporated into the next international climate change treaty. In the months leading up to the Copenhagen Conference, there are three scheduled UN meetings on climate change, beginning with the late March to early April conference in Bonn, Germany, followed by a second session in Bonn

\textsuperscript{231} Muller, supra note 230.
\textsuperscript{232} Id.
\textsuperscript{233} Id.
\textsuperscript{234} Id.
\textsuperscript{235} Id.
scheduled for June 1-12, and a final meeting in Bangkok, Thailand, from September 28 to October 9. For the first Bonn session, there was only a small amount of the agenda reserved to discuss issues related to deforestation, and even less time reserved for general agricultural issues. However, workshops on both issues – agriculture’s contribution to climate change and GHG emissions resulting from deforestation – have been scheduled. Therefore, 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.

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

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236 Countdown to Copenhagen, UN Framework Convention on Climate Change, at http://unfccc.int/2860.php (last visited April 2, 2009).
238 Stern, supra note 50.
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 key GHGs, the regulation of agriculture – accomplished either through initiatives adopted by individual States to encourage more sustainable agricultural practices, or through international mechanisms requiring reductions of emissions resulting from agricultural activities – 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, cap and trade programs can be designed to incentivize farmers to utilize more sustainable practices that emit few GHGs, governments can use new or existing (if available) laws to regulate emissions from agricultural practices, and the international community can incorporate emissions from agricultural practices into any binding mechanism established at the Copenhagen Conference. 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.