

Food Policy, Climate Change,  
and the Tenuous Future of Food Security

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In 2011, a British military conference concluded that climate change posed a “grave and immediate to the health and security of the world.”<sup>1</sup> Years earlier, the Center for Naval Analyses, under instruction of the US defense agencies, released a report that put forth that climate change will evolve into the paramount threat to global security by exacerbating a number of volatile weather conditions.<sup>2</sup> In 2006, Royal economist Nicholas Stern put out a report that forecasted a 5 to 10 percent decrease in global Gross Domestic Product (by today’s levels) if temperatures are increased by over 5 degrees Celsius.<sup>3</sup> Stern later revisited his report with new data from the International Climate Change Partnership. With this new information, his estimates of destruction caused by climate change were expected to occur sooner and more violently. These works are not outliers among related studies, nor is there a dearth of research that all points to a similar conclusion: climate change is poised to present challenges to humanity’s fundamental way of life.

One of the lynchpins through which climate change will affect global well being is its impact on agriculture and food production by creating an unpredictable and or hostile environment. The reader may be unphased by this statement. Modern science has produced marvels and miracles of human ingenuity. Research in the fields of genetic engineering, agrochemicals, and fertilizers has increased production significantly in the past (i.e. the Green Revolution). While the advances in agricultural science cannot be denied, it is questionable whether these advances have actually led to “progress.” Nearly one billion people currently live in a chronic state of food insecurity while between five to six million children die annually from

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<sup>1</sup> “The Health and Security perspectives of Climate Change.” *BMJ*. BMJ Publishing Group. Web. 29 April. 2012.

<sup>2</sup> “National Security and the Threat of Climate Change.” *CNA*. Center for Naval Analyses. Web. 29 April. 2012.

<sup>3</sup> Stern, Nicholas. “Summary of Conclusions.” *NationalArchives*. Her Majesty’s Treasury. Web. 15 April 2012.

malnutrition.<sup>4</sup> While this occurs, most of the maize grown in the US's Midwest is for cattle consumption and a third of global food production for humans is wasted.<sup>5 6</sup> Such figures indicate that as of now, food policy and production clearly has substantial flaws which cause inefficiencies. This leads to a vital question: if today's agriculture cannot provide for humanity as of now... what will happen when climate change enters the playing field more visibly and violently.

The purpose of this paper is to answer a variation of the question that was just put forth: if macro food policy remains static while climate change dynamically alters environmental conditions, will the world be able to feed itself by 2050? The pertinence of such a question is hopefully self-evident. As the global population grows and demand on a resources across the board increases, large scale crop shortages, food unavailability and famine are not improbable. To the contrary, it seems to be likely. Understanding the causes and impacts of such scarcity is a step forward to combating it. Along the path of answering this question, this paper also aims to shed light on as to why it may not be possible to provide food security in the future and how to prevent such a grim future. As Sun Tzu said "if you know the enemy and know yourself, you need not fear the result of a hundred battles. If you know yourself but not the enemy, for every victory gained you will also suffer a defeat. If you know neither the enemy nor yourself, you will succumb in every battle." Knowledge of climate change potential threats is not enough... the

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<sup>4</sup> "925 million in chronic hunger worldwide." *FAO*. Food and Agriculture Organization of the United Nations. Web. 14 April 2012.

<sup>5</sup> "U.S. could feed 800 million people with grain that livestock eat, Cornell ecologist advises animal scientists Future water and energy shortages predicted to change face of American agriculture." *Cornell*. Cornell University. Web. 29 April. 2012.

<sup>6</sup> "Cutting food waste to feed the world." *FAO*. UN Food and Agriculture Media Centre. Web. 29 April. 2012.

global community must also understand its potential to persevere against climate change, as well as come to terms with the weaknesses of the modern food regime.

### *Contemporary Food Policy and Production*

Understanding how food is produced, distributed, and consumed today may help illuminate the benefits and failures of current practices while providing a trajectory of what this system will entail in the future. Today's agricultural system evolved from methods introduced during the Green Revolution, which began in 1943 with the work of Norman Borlaug and continued into the 1970s. Borlaug's intent was to increase agricultural production exponentially by pushing a "high input high output" philosophy, thus curbing starvation in the developing world (a phenomenon expected to be greatly exacerbated by the chaos of WWII and decolonialization).

After initial successes in India and Mexico, Green Revolution methods were adopted by, taught to or forced upon many farmers in developing nations. High production was expected to not only feed the world but bring the Global South's numerous farmers out of poverty. This appealed to many neoliberal macroeconomic policymakers who desired globalized free trade, greater productive per capita and an increased volume of tradable goods.<sup>7</sup> High input high output methods were streamlined and expanded upon in the Global North, especially in the US. Fordesque principles eventually were even applied to livestock, and Northern food production became heavily dominated by corporations and larger producers.<sup>8</sup> Small scale farming and the idyllic American family farm have been decimated by this transition as these producers do not have the critical mass or economic resources to compete against organizations that span the

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<sup>7</sup> Brandon, Josh. "THE GREEN REVOLUTION Revisited." *Canadian Dimension* 2008: 25,27,4. ProQuest Central; ProQuest Social Science Journals. Web. 29 Apr. 2012 .

<sup>8</sup> Patel, Raj. *Stuffed and Starved*. Melville House Publishing: Brooklyn 2010.

world over. The focus of agriculture thus has evolved (or devolved) from semi-subsistence farming (or growing for local market or direct supply chain) to capitalistic commodity production.

High input high output farming must be further expanded upon by the author to fully grasp the nuances of modern agricultural practices. This philosophy of agriculture is heavily reliant on artificial means of production as inputs. Such means include synthetic nitrogen based fertilizers (as well as other artificial varieties), insecticides, pesticides, and fossil fuel driven machinery.<sup>9 10</sup> High yield seeds (in some cases genetically modified ones) and extensive irrigation systems are also major components of this system. The idea is to utilize scientific means to milk every ounce of productivity out of a growing cycle by attempting to removing risk (i.e. pests) and increasing efficiency (i.e. crop vitality). These methods also enable producers to artificially push the boundaries of nature. For example, nutrient depleted soil can still be exploited through the use of fertilizers that create a synthetic vitality. Crops can also now be planted in more volatile area where agriculture has been previously unviable for farming thanks to the usage of artificially created seed strains that are engineered to jive with a particular climate.

High input high output operations tend to be defined by monocropping. Monocropping entails an entire agricultural production area being devoted to the harvesting of one particular commodity, such as corn. Within this area there is little or no genetic variability between the produce as the seeds are generally of the same strain... often purchased from a firm that

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<sup>9</sup> Kaufman, Frederick. "The Second Green Revolution." *Popular Science* 2011: 62,69,87-88. *ProQuest Central; ProQuest Social Science Journals*. Web. 29 Apr. 2012

<sup>10</sup> "International Assessment of Agricultural Science, Technology for Development." *Grida*. UN Environmental Program. Web. 21 April. 2012.

specializes in genetically modifying seeds. One may ask why this is done and perhaps the timeless proverb “never put all your eggs in one basket” comes to mind. While it may seem irrational to consolidate his or her risks, followers of this practice have their reasons. For one, large stretches of monocropped land that are all genetically programmed to resist a certain chemical or pesticide can be cheaply sprayed en masse and with less precision. Any other crops without said genes would likely wither from exposure to these chemicals.

Specializing in one commodity also enables producers to purchase equipment and machinery tailored specifically for that crop. Monocropped layouts increase the efficiency of these machines as just with spraying, actions can be done en masse. Harvesting a single commodity in bulk also facilitates packaging, selling and transporting goods, which cuts down on production costs and increases profits. Besides this, there is simply less varied demand for foodstuffs due to current human diets in conjunction with pressure from industrial and livestock sectors for more corn and soy.<sup>11</sup> Multinational Corporations (MNCs) and large ventures, which have come to dominate the agricultural market as previously mentioned, also have an incentive to produce in bulk in order to have greater market shares in a given market. With this comes the advantage of an economy of scale, as well as the power to affect prices through supply.

With a cursory understanding of what high input high output agro-economics entails, its impacts of the global food supply, the environment, and farmers (in a global context) must be analyzed. Its’ impact on the latter is especially alarming. As previously mentioned, the change to this system rapidly reduced the number of farmers in America, with less than 1 million persons

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<sup>11</sup> “Price Volatility in Food and Agricultural Markets: Policy Responses.” *FAO*. UN Food and Agriculture Organization. Web. 29 April. 2012.

claiming farming as an occupation farms today (down from 6.7 million in 1935).<sup>12</sup> An ironic phenomenon as the Green Revolution was supposed to make farming more economically viable. In developing nations (those mainly situated in South America, Central America, Asia, and Africa), small scale farmers' livelihoods have been greatly destabilized by the Green Revolution. However, unlike farmers in the US or other industrialized countries... these farmers often do not have the "luxury" of abandoning their way of life and hundreds or thousands of years of tradition. Their struggle is one of survival.

How did the Green Revolution and its progeny backfire for small scale farmers, making it more difficult for many of them? The foremost means is the very nature of the high input high output farming system. Inputs such as altered seeds, fertilizers, pesticides, water and equipment all require considerable layouts of capital... layouts which must be repeated again in the future. For the average small scale farmer that either subsists or makes a small profit from farmer, the transition to this system would likely require loans.<sup>13</sup> The reader may be thinking that it "takes money to make money" and that increased productivity would offset these loans. Verily, but only if these methods are practiced under ideal conditions or in some sort of hypothetical vacuum.

Developing nation, however, are not known for their ideal conditions in terms of economic or political stability. Even times of relative international stability many governments in the Global South are kicking to keep their heads above water.<sup>14</sup> In terms of climate, many nations in the Global South also are more apt to experience severe weather phenomenon. This means that it would not be out of the realm of possibility for a farmer to lose his or her crop, or see it severely damaged. Monocropping and lack of crop and genetic variation increases this risk.

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<sup>12</sup> "Demographics." *EPA*. Environmental Protection Agency. Web. 29 April. 2012.

<sup>13</sup> "Rural Poverty Report." *IFAD*. International Fund for Agriculture and Development. Web. 11 April. 2012.

<sup>14</sup> "National Security and the Threat of Climate Change." *CNA*. Center for Naval Analyses. Web. 29 April. 2012.

Should this occur, these farmers are not only faced with food insecurity, but mounting debt and a year's worth of profits. Unlike large scale operations, these farmers do not have an economy of scale which allows them to absorb shock.<sup>15</sup> In the next year money will have to be borrowed or laid out again for inputs (including seeds which cannot be saved if bought from most private companies). Should a harvest fail again, be it for natural disaster, illness, conflict or some other externality... the debt could become catastrophic and force the family to sell its land or worse. Suicide amongst Indian farmers, for example, is not a rare occurrence and is linked to this destructive cycle. Rather than face shame or burden their families with insurmountable debt, these people take their own lives.<sup>16</sup>

Debt does not necessarily have to result from outright crop failure. Crop prices may simply not be advantageous enough to farmers without subsidies to justify taking out loans. The global commodity market is volatile in nature due to globalization, neoliberal policies, and speculation.<sup>17</sup> While prices fluctuate, ex-dies machina-esque incidents such as food dumping can affect local food markets as well. These unexpected changes can destroy well drawn plans and render even the most arduous of toils futile. This is yet another danger that hangs over the heads of farmers, something which is out of their hands. It often doesn't help that in order to sell their goods abroad, small scale farmers in developing countries often have to sell their goods to a series of corporate middlemen. These intermediaries cut out part of a farmer's profits by

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<sup>15</sup> "Rural Poverty Report." IFAD. International Fund for Agriculture and Development. Web. 11 April. 2012.

<sup>16</sup> Patel, Raj. *Stuffed and Starved*. Melville House Publishing: Brooklyn 2010.

<sup>17</sup> "Price Volatility in Food and Agricultural Markets: Policy Responses." FAO. UN Food and Agriculture Organization. Web. 29 April. 2012.

purchasing at prices lower than the market price in order to render their own businesses economically viable, something which places farmers at an even greater disadvantage.<sup>18</sup>

Outside of these issues, there are other negative impacts on all small farmers as well. For one, poisoning is not uncommon. Pesticides, agrochemicals, and fertilizers can directly cause violent illness that might not be survivable in a top tier hospital (imagine how a farm worker might fare in rural Africa). Outside of this, water runoff can slowly poison farm families, leading to phenomena such as birth defects or contaminated water sources. The later is especially true in Punjab, India (the ground zero of India's Green Revolution) where a fifth of wells are contaminated with harmful synthetics.<sup>19</sup> Ironically, malnutrition is another problem that plagues developing farmers. These people are pushed to sell their produce as cash crops, only to have to purchase processed goods at higher prices in the end. A prime example of this would be Mexico where small scale farmers find themselves selling their goods only to be barely able to buy back processed and subpar tortillas.<sup>20</sup>

It would also be pigheaded to deny that the Green Revolution helped many people survive the famine which arose after WWII. However, Borlaug himself has admitted that his methods were a step in the right direction, but not a permanent or perfect solution.<sup>21</sup> The bastardization of Borlaug's methods to help impoverished farmers has now left many of the world's food producers in a more volatile situation. In 2010, when Haiti was struck with a devastating earthquake, the nation's devastated farmers refused aid from Monsanto, a company

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<sup>18</sup> Patel, Raj. *Stuffed and Starved*. Melville House Publishing: Brooklyn 2010.

<sup>19</sup> Garg, Balwant "Uranium, metals make Punjab toxic hotspot". *Timesofindia. The Times of India*. Web. 29 April. 2012.

<sup>20</sup> Patel, Raj. *Stuffed and Starved*. Melville House Publishing: Brooklyn 2010.

<sup>21</sup> "Iowans Who Fed the World- Norman Borlaug: Geneticist." *Agbioworld. AgBioWorld*. Web. April 29. 2012.

which is intricately tied to high input high output methods.<sup>22</sup> Why? They would rather start from the ground up then start down a path which would tie them to this method of farming. This is a testament to the failure of today's agricultural methods in ensuring the welfare of today's food producers.

A reader from the Global North will likely have sympathy for these farmers, but wonder why the author has focused so much on their plight... there aren't many farmer left anymore, right? It is an obsolete and dying profession, no? While farmers may not be very visible in the Global North, there are 500 million small farms in the world that are home to over 2 billion people.<sup>23</sup> According to the Stern review, 22 percent of the world's population is occupied by agricultural and food production.<sup>24</sup> Their plight is one that must be taken very seriously. This is not to say that numbers should equate to the necessity to act or be the basis of the gravity of a situation. However, this indicates what a large percentage of the world's population is directly affected by the mere practice of high input high output methods.

Farmers are not alone in being negatively impacted by high input high output production methods. The natural environment itself has been severely degraded as a result of almost six decades of these practices in a multitude of ways. One major form of degradation is the release of carbon emissions and green house gases. Agricultural practices account for 14 percent of global green house emissions as of 2006.<sup>25</sup> One may be confused as plant life is meant to sequester carbon. While this may be true, immense amounts of fossil fuel use is need for high input high output agriculture. Energy is needed for machinery (during planting, watering,

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<sup>22</sup> Bell, Beverly. "Haitian Farmers Commit to Burning Monsanto Hybrid Seeds." *Huffingtonpost*. Huffington Post World. Web. 17 April. 2012.

<sup>23</sup> Hazell, Peter. "Five Big Questions About 500 Million Small Farms." *IFAD*. International Fund for Agricultural Development. Web. 29 April. 2012.

<sup>24</sup> Stern, Nicholas. "Summary of Conclusions." *NationalArchives*. Her Majesty's Treasury. Web. 15 April 2012.

<sup>25</sup> Stern, Nicholas. "Summary of Conclusions." *NationalArchives*. Her Majesty's Treasury. Web. 15 April 2012.

pumping water and harvesting), processing, transportation, packaging and storage (depending on the commodity). Fuels are also essential components of some fertilizers, as well as necessary for their production and the creation of agrochemicals. With this usage of energy being so widespread and costly, carbon sequestering from agricultural organisms cannot hope to compete.

On top of this, demand for new land in order to expand agricultural production requires the compromising of undeveloped land, as well as the destruction of forests such as the Amazon. Killing trees releases immense amounts of carbon into the atmosphere and deforestation accounts for 30 percent of green house gas emission.<sup>26</sup> The ecosystems of these new conquests are often devastated and cannot be easily restored, if it is at all possible. Destroyed ecosystems result in reduced biodiversity... thus weakening the variety of the world's biomass now and endangering its future by limiting genetic variation. These losses may be permanent, which means that humanity will have destroyed unique landscapes, countless animal lives, and precious scientific information that has been undiscovered in the natural world (i.e. medicines). This is an affront to not only human heritage, but the sacredness of life. Pragmatically speaking, the genetic, biological, and chemical information that exists in nature is a proverbial mother lode of useful and profitable knowledge.

Outside of farming, modern agriculture contributes to greenhouse gas emissions in another principle way: livestock. The cattle industry is cited to contribute more than a third of anthropogenic methane emissions.<sup>27</sup> As with farming produce, a high input high output system has been applied to cattle. Crammed together in Concentrated Animal Feeding Operations, or CAFOs, that can house thousands of animals, these cows' lives are streamlined from birth to

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<sup>26</sup> "Deforestation and Greenhouse Gas Emissions." *CFR*. Council on Foreign Relations. Web. April 29, 2012.

<sup>27</sup> "Livestock is a major threat to the environment." *FAO*. UN Food and Agriculture Organization. Web. 1 May, 2012.

violent death. These animals are feed a diet of grain, soy and corn which is foreign to their digestive system but fattens then up quickly. In conjunction with this, cows are injected with hormones, steroids and antibiotics to hasten their growth, alter their muscles and help them survive the harsh existence that a CAFO entails.<sup>28</sup> These “inputs” thus rush cows out of the womb and into a slaughterhouse at an unnatural pace while reducing risk.

While CAFOs paint a grim portrait of the beef industry, why is beef production and consumption so damaging to the environment? For one, new stretches of land is being opened up for pastures, thus also resulting in forest destruction. Cows themselves produce large amounts of methane during their digestive processes. Methane traps heat in the atmosphere at a rate twenty five times greater than that of carbon dioxide. This is an issue when there are more than 1.3 billion cows globally, a number which is unnaturally high and artificially created by human demand.<sup>29</sup>

Watering, environmental control and other mechanized processes such as processing cow carcasses into edible meat are also factors to be taken into account in terms of energy use. The emissions generated while feeding these animals is also not negligible. Outside of emissions, the feces these animals generate can often contaminate water sources via run off and wind... exposing people to potentially lethal bacteria. These animals are often caked in their own filth, which often sickens them and this illness could potentially pass on to whoever consumes parts of said cows down the line. The injections animals receive can lead to residual hormones and antibodies being passed on to humans and other animals. This process also upsets the natural

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<sup>28</sup> “Pew Commission on Industrial Farm Animal Production.” *Ncifap*. John Hopkins Bloomberg School of Health. Web. 13 April. 2012.

<sup>29</sup> The Gridded Livestock of the World FAO (2007). Predicted-2005 (adjusted to match FAOSTAT 2005 national totals). [http://www.fao.org/AG/AGAInfo/resources/en/glw/GLW\\_dens.html](http://www.fao.org/AG/AGAInfo/resources/en/glw/GLW_dens.html)

evolution of bacteria and bovine diseases. By killing so wholesale, stronger strains of these organisms will be weeded out and multiply, thus advancing the organisms' species by leaps and bounds. One day, out of the blue, humans may be faced with large scale destruction of herds. That may be a best case scenario. There is also the possibility that a zoonotic disease could evolve which could result in widespread human suffering or death. Such diseases and bacteria could also affect other animals. Altogether, these pollutants and illnesses pose a direct threat to environmental health.<sup>30</sup>

Soil erosion is another environmental sin of high input high output methods. Commoditizing food entails making the most profit from a resource and siphoning every drop of productivity of it. The environment, however, is a living being in the sense of being a macrocosm of ecosystems... and like any other living creature it has its breaking point. It is not uncommon for modern agricultural producers to now raise multiple harvests within one season, something which soil is not designed for. Even if this is not performed, monocropping can take a serious toll. Planting the same crop over and over for years means that the same nutrients are being depleted from the ground without any reprise for replenishment. This is highly unnatural and will render soil unviable. Generally this problem in the past has been solved with crop rotation, mixing different crops together, or letting fields lie fallow. However, such principles are at odds with today's system. Besides this, soil can actually become "addicted" to the aforementioned inputs, relying on them for essential nutrients and conditions like proper pH balance. This creates a number of complications if say a farmer can no longer afford to purchase inputs and must suddenly stop infusing them into his or her soil. Should a producer decide to

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<sup>30</sup> Pew Commission on Industrial Farm Animal Production." *Ncifap*. John Hopkins Bloomberg School of Health. Web. 13 April. 2012.

take a more natural route, the weaning off process may take years or up to a decade for the soil to detox.

Weakened soil consistency isn't the only vulnerability that is created by modern practices. The use of annuals also has a major role. Annuals are plants that have a life cycle of only one year or season. Why this damages soil is because a plant of such a short lifespan does not lay down roots that anchor down dirt. Rather, the process of planting and uprooting annuals every harvest can actually cause more damage by upsetting soil. Monocropping also leaves little room for grasses or trees to flourish, things which protect soil from wind damage and fulfill the role of anchor. The lack of these natural defenses combined with loosened soil and destructive practices means that windstorms or rainfall will result in massive erosion. Sixty percent of this soil will end up in rivers, streams and lakes.<sup>31</sup> As this soil is filled with agrochemicals and synthetics, humans can find themselves ingesting tainted water. Windswept soil can carry over 20 diseases which can affect humans... diseases such as anthrax and tuberculosis. This figure does not include bacterial and fungal infections which can occur.<sup>32</sup>

The extent of erosion in contemporary times is staggering in scale. Every year nearly \$40 billion dollars in productivity alone is lost in the US. In the world, this number is almost ten times greater, estimated at \$400 billion dollars. On top of this, there is almost \$45 billion in damages globally to environmental and public health caused by phenomenon such as sandstorms or the aforementioned pollutants or diseases. It is perplexing that any system based upon economic efficiency would tolerate such grievous losses to essential means of productions. However, the name of the game is exploitation. Just like gold miners of the past, one area is

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<sup>31</sup> "Slow, insidious' soil erosion threatens human health and welfare as well as the environment, Cornell study asserts." *Cornell*. Cornell University News. Web. 1 May. 2012.

<sup>32</sup> Ibid

reaped of productivity before the exploiter moves on. This partly explains the massive expansions into undeveloped territory and destruction of forests. However, what arable land there is limited and exploiting it will only further aggravate climate change.

In the past forty years (beginning approximately the same time the Green Revolution started becoming widespread), thirty percent of the world's arable land has become unproductive. Every year 10 million hectares of cropland is being lost to soil erosion alone, that's 37, 000 square miles.<sup>33</sup> In the US, erosion is claiming losses at a rate that is tenfold that of natural restoration rates. In China and India, nations with the world's largest populations and where food security is already an issue, these rates are between 30-40 percent.<sup>34</sup> China's issue with soil erosion, which resulted from anthropogenic causes such as industrialization and high input high output farming, has actually caused the Gobi Desert to expand rapidly at an unnatural pace. Even if farmland has not been rendered unviable by erosion, the expanded desert eats up farmland and makes farming impractical with sandstorms.<sup>35</sup> With a growing population of over 1.3 billion, this is not a threat to be taken lightly.

After years of abuse, the world's farmland is left in a precarious state. The chart below paints a portrait of where things stand. These figures alone are a testament to the need to transcend commodity farming and Green Revolution practices. If agricultural methods do not adapt, there will not be land on which to practice agriculture.

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<sup>33</sup> Ibid

<sup>34</sup> Ibid

<sup>35</sup> Guo, Jerry. "The Green Wall of China." *The Scientist* 21 (2007): 20-23. Digital.

Trends in Global Agricultural Land Degradation<sup>36</sup>

Improving Lands	10 percent
Stable, but slightly to moderately degraded	36 percent
Highly degraded land	25 percent
Moderately Degraded Land	8 percent
Bare Areas	18 percent
Water	2 percent

The soil which is most viable for food production, topsoil, is also the one which is being the most heavily impacted by erosion today. Topsoil (also classified as A Horizon) consists mainly of decomposing organisms, nutrients, living organisms (such as bacteria and insects) and plant-life. This mixture altogether creates a symbiotic relationship that is conducive to agriculture. It is a resource more valuable than oil or gold. It is a fundamental necessity for agriculture, which in term is vital to human civilization. This resource, contrary to popular belief, is neither abundant nor renewable after being heavily degraded. It would take 20 years of natural processes to recover from *one* rainstorm due to high input high output farming. To recover one inch of topsoil would require 500 years to naturally restore.<sup>37</sup> The fact that the world losses 75 billion tons of soil annually means that millennia would be needed to gain back what has been

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<sup>36</sup> "State of the World's Land and Water Resources for Food and Agriculture." *FAO*. UN Food and Agriculture Organization. Web. 29 April. 2012.

<sup>37</sup> "Harney Silt Loam." *USDA*. US Department of Agriculture. Web. 29 April. 2012.

lost.<sup>38</sup> As the world's food demands cannot wait millennia... caution must be taken with that arable land is left.

Current proponents of the modern agricultural system and the Green Revolution, including many development professionals and neoliberal economists, may argue that the increase in food production justifies and the prevention of famine justifies the drawbacks entailed by these agricultural systems. It is true that these systems have led to major increases in agricultural productions. Between 1961 and 2008, the increase in foodstuffs is about three fold.<sup>39</sup> One report also states that the average person in a developing nation consumes 25 percent more calories.<sup>40</sup>

While the author commends the advances in agricultural science that have occurred in recent decades, he is skeptical that today's practices have genuinely and sustainably benefited humanity or persons in developing nations. Increases in caloric intake, for example, do not equate to proper nutrition. On the contrary, people in developing nations and developed nations (mainly those who are of lower economic classes) now have diets with little variety and that are overwhelmingly composed of carbohydrates, starches or fats. While caloric intakes might be being met for some, malnutrition is rampant... affecting nearly a billion persons.<sup>41</sup> Even in wealthier countries people are coaxed into choosing a more substandard diet that plays into what producers can supply. Minorities and the less well off in industrialized nations often reside in food deserts in which convenience stores and fast food establishments serve as their main providers of sustenance... sustenance which usually is devoid of proper nutrients, prepackaged,

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<sup>38</sup> Lichtfouse, Eric; Navarette, Mireille; and Philippe Debaeke. "Sustainable Agriculture." New York: Springer Sciences, 2009. Pp 785.

<sup>39</sup> "Production Indices." *FAOSTAT*. Food and Agriculture Administration Statistics. Web. 29 April. 2012.

<sup>40</sup> "Transforming Agriculture." *IFPRI*. International Food Policy Research Institute. Web. 29 April. 2012.

<sup>41</sup> "State of Food Insecurity in the World 2010." *FAO*. UN Food and Agriculture Administration. Web. 29 April. 2012.

and heavily processed.<sup>42</sup> Those who do have a greater income often resort to fast food for convenience, and when they do purchase food at supermarkets they are faced with substantially higher prices for fresh food that is unprepared. Humans require a diverse diet which corn, grain and soy cannot aptly provide though. In Britain, the average person actually ate a healthier diet of greater variation in the Roman era than today!<sup>43</sup> This phenomenon can be partially attributed to monocropping and the processing of food en masse. While one may see a range of variety at supermarkets and retail locations... this is only a well played charade to masked that most goods come from a select number of corporations and contain many of the same ingredients (corn and soy).

Outside of nutritional deficiency, modern methods have also hit the metaphorical wall.<sup>44</sup> Despite rapid gains in the past, there is only so far that inputs can push the boundaries of natural processes. The law of diminishing returns is now applicable. In recent years, what gains have been made are due to opening up new cropland, not technological advances. If scientific breakthroughs were on the horizon, there would be no need to expand so viciously. This science is also unsustainable and will ravage farmland and the environment as a whole. Thus, how advanced is it really? These methods should've been nothing more than a temporary fix to until more sustainable and wholesome methods were discovered and implemented. The latter never would be though as the current agricultural system is simply too profitable to MNCs and those involved in the neoliberal trade regime.

While global food supply has risen, there are over 1.02 billion people who live in a state of food insecurity currently. This “bottom billion” lives on roughly or just under 1 USD a day, of

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<sup>42</sup> Patel, Raj. *Stuffed and Starved*. Melville House Publishing: Brooklyn 2010.

<sup>43</sup> “Britons Healthier in Medieval Times.” *Telegraph*. Telegraph News. 28 April. 2012.

<sup>44</sup> Dyer, Gwynne. “Climate Wars.” Melbourne: Scribe Publications, 2008.

which 90 percent is spent on food.<sup>45</sup> This is a precarious state to live in due to volatile food markets and the number of risks that people in the developing world face without insurance or a strong social safety net (i.e. illness, natural disasters, job loss and conflict to name a few). Right above them are another billion who could quickly join this pool if food prices were to spike or some of the aforementioned risks were to occur. This tier's income is between 1-2 USD a day, an income that is neither reassuring nor ideal.<sup>46</sup>

While food production may be at an all time high, the statistics the author has just relayed indicate a grave error in food policy and distribution. Our agricultural system treats food as a commodity... and thus that is what it has evolved into in the eyes of policymakers and producers. However, food is not a commodity... it is a right and a necessity for human existence. For this reason, we must ask if it should simply be left to capitalist forces that seek to maximize profits and efficiency.

As food evolved into a major and viable export commodity over the latter half of the 20<sup>th</sup> century, it came under the dominion of global neoliberal trade policies. Neoliberalism is defined by *lassiez faire* ideals that tout low government involvement, deregulation, free trade without tariffs, the mineralization of subsidies, and privatization of industry. Developing nations, in order to fully integrate into the global marketplace and receive financial aid, must adopt these principles. Doing so, however, can actually weaken developing nations severely. As a result of this, we see a number of harmful phenomena. In the general economic sense, there have been a number of cuts to social programs and reduced government spending in the Global South. This undermines social safety nets (i.e. food aid, subsidies, debt and emergency relief services),

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<sup>45</sup> Collier, Paul. "The Bottom Billion." Oxford: Oxford University Press, 2008.

<sup>46</sup> "International Assessment of Agricultural Science, Technology for Development." *Grida*. UN Environmental Program. Web. 21 April. 2012.

something which is a necessity in areas prone to food insecurity.<sup>47</sup> It also retards advancements in human capital such as job training and primary education... things which can empower impoverished persons and help mitigate the risks they face.

In terms of food security and production, many developing nations are now at the whim of developed nations. Legally states can't easily refuse imports into their nations, something which may affect local prices. This can be a catastrophe for agricultural workers and farmers, especially in nations where agricultural production is a major component of GDP. This action is known as food dumping, and even in the form of aid it can compromise overall food security while benefiting private corporations and agribusinesses. Developed nations (who are generally the perpetrators of food dumping) have the advantage of stronger economies and cheaper commodities, making this phenomenon neocolonial in the sense that Western nations are selling cheaper goods to former colonies in a manner which exploits and damages the latter.

As neoliberal trade mechanisms overpower local production in developing nations, citizens of these states become increasingly dependent on international goods for consumption. While these products can be cheaper at times, due to the volatility of the agricultural markets this is not always the case. The fact that in the previous decade food prices more than doubled between 2000 and 2010 gives testament to this.<sup>48</sup> Weakened local production may be unable to properly alleviate situations where food prices spike or if trade is somehow disrupted in its diminished capacity. This too compounds the potential for food insecurity and greatly complicates the global food market. High food prices are often tolerated by governments as they are believed to encourage agricultural investment and bring prosperity to farmers, prosperity

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<sup>47</sup> Stiglitz, Joseph. "Challenging the Washington Consensus - An Interview with Lindsey Schoenfelder." New York: The Brown Journal of World Affairs, Winter/Spring 2003, Vol IX, Issue 2. Pp 33-40

<sup>48</sup> "FAO Food Price Index." *FAO*. Food and Agriculture Organization of the United Nations. Web. 29 April. 2012.

which will allow them to lower prices in the future. This means that even if people are hurt in the short term, inaction can be “justified” as it is for the greater good. However, the 2008-2009 food crisis was shown to have negatively impacted GDP growth (actually reversing it in some cases) in developing nations.<sup>49</sup> How can a nation or people be expected to improve when starvation and hunger are rampant? One must also not forget that these high prices cannot be relied on and that inaction could be in vain, assuming that is if the economic benefits were not simply hypothetical

In the interest of furthering the criticism of the aforementioned stance some major policymakers toy with (as well as expanding the critique of modern food trade), it should be noted that high prices are more apt to aid large corporations than private farmers. For one, there is little transparency in the global agricultural market. Food no longer goes from farm to fork. Instead there are MNCs, middle men, speculators, processors and distributors.<sup>50</sup> Any unilateral action by one of these parties affects the profits of another, and while these respective entities may not be competing with each other, there is little incentive to compromise profits or share information to solely benefit another business (especially when competing peers could use information to their own advantage). It is unlikely a major trading firm is going to stop and consider its impact on a particular Kenyan villager. It is also unlikely that someone operating a rural Chinese farm will have access to all the information that will allow him or her to understand all the nuances of the companies he or she deals with. Farmers in the developing market also do not have consistent or reliable access to information on prices or projected prices... meaning that it is very easy for them to get cheated and not benefit from high prices. One must not forget that with the modern system farmers now sell the majority of their crops.

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<sup>49</sup> Stern, Nicholas. “Summary of Conclusions.” *NationalArchives*. Her Majesty’s Treasury. Web. 15 April 2012.

<sup>50</sup> Patel, Raj. *Stuffed and Starved*. Melville House Publishing: Brooklyn 2010.

This means that these people could be potentially compelled to buy processed food at prices higher than what their own crops were sold for.

It is not a coincidence that the regions that contain the greatest number of food insecure persons are also among the top 3 for importing foodstuffs. These regions include Sub-Saharan Africa and developing Asia.<sup>51</sup> Ironically, the most vital and consumed foodstuffs (grain, maize and soy) are also the most unstable (in terms of price). While meat prices have stayed relatively stable, between 2006 to 2009, these staples fluctuated dangerously with cereals maxing out at 265 on the FAO index (up from approximately 122 in 2006).<sup>52</sup> The global market is simply too interdependent and... global, to put it simply. A MNC based in the US could have a tangible impact on a farmer in Africa. While a nation cannot easily ban imports, prohibitions of food exports are now becoming a tool for concerned politicians. India, China, and Russia, all major players in agricultural production, have all halted wheat exports in the last 5 years. This action caused major disruptions in the global food market and thus greatly undermined the food security of more vulnerable nations.<sup>53</sup> It can also create paranoia... something which may affect prices, something which is in part affected by financial players' trust in a market, and cause other nations to do likewise. It would be difficult to tell these nations to do otherwise. While damaging to other peoples, these actions do have the right and duty to protect their own citizens. In India and China, with such large populations, the threat of a food crisis is not one to be taken lightly.

Unfortunately dependency on foreign trade and food dumping are only one facet of the world's complex food market. Another issue is that of speculation. Food, as aforementioned, is

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<sup>51</sup> "State of Food and Agriculture 2010-2011." *FAO*. UN Food and Agriculture Administration. Web. 27 April. 2012.

<sup>52</sup> "FAO Food Price Index." *FAO*. UN Food and Agriculture Index. Web. April 8. 2012.

<sup>53</sup> "Price Volatility in Food and Agricultural Markets: Policy Responses." *FAO*. UN Food and Agriculture Organization. Web. 29 April. 2012.

now a commodity. As a commodity it is shared, traded, and invested in like any other good. It has devolved into a means to make a profit, just like debt, property or even iPods. Yet, as one sees with the fickleness of the stock market or even the recent housing bubble, speculation brings with it a measure of risk for reward. Even the most socially conscious businessperson may miscalculate and cause unintended mishaps (i.e. food prices rising or falling drastically), something which could be disastrous when it comes to sustenance.

However, not all businesses operate in an ethical or conscious fashion. Instead, profits can overshadow other considerations. Markets can be cornered, monopolies established, and prices inflated to maximize profit intake. All of these actions can hurt innocent persons who are at the mercy of the prices these corporations and global trade create. One might wonder what sort of power private enterprises can hold in the global economy, or should hold.

The author does not wish to portray food production corporations as some sort of evil entity that would serve as the antagonist in a 80s action film or espionage novel. However, it cannot be denied that major ethical controversies surround many of the top global food conglomerates. Nestle, for example, has been caught in both Africa and Latin America using women dressed as nurses to push Nestle baby formula to mothers who were still breastfeeding.<sup>54</sup> As a result many children became ill as these mothers couldn't afford a constant stream of this formula or because it was simply unsound in medical terms to stop breastfeeding. Chaquita Brands International's predecessors created Banana Republics in Central America that entailed installing a puppet dictator who could ensure a beneficial atmosphere for fruit production. Strikes and protests against this company often were often met with lethal military reactions. Even today

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<sup>54</sup> "Food: The Formula Flap." *Time*. Time Magazine. Web. 23April. 2012.

MNCs have undue influence in the region.<sup>55</sup> Cargill, another major producer, has had numerous large scale recalls due to contamination, and even sold Iraq chemically treated wheat in 1970 that caused the deaths of 96 people.<sup>56</sup>

While many companies operate ethically and in a manner that is beneficial to their consumers, this is not always the case. With the 2008-2009 food crisis, a UN report concluded that with there were a multitude of forces at play, a considerable deal of the food spike which caused the crisis could be traced back to speculation.<sup>57</sup> In the end, the name of the game is profit. The purpose of relaying this information is to illustrate the dangers that come with placing a human necessity so freely in the hands of those who wish to profit from it. Food is not a DVD player or leather couch. It is the basis of human life and civilization.

Another issue which arises from the current global food market is that of allocation. With capitalist philosophy, resources are utilized by private entities in a way which maximizes profits and efficiency. However, this does not always ensure that optimal social utility is being reached. For example, thirty percent of US corn production is being sold to produce ethanol and other biofuels. While this is profitable for corn producers, it also takes away valuable foodstuffs from human consumption. The beef industry also siphons off a considerable amount of produce. If one were to use the crops grown annually in the US alone that diverted to feed cattle, one could provide sustenance to nearly 800 million people every year (in 1997, which means that the

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<sup>55</sup> Acker, Alison. (1989). *Honduras: The Making of a Banana Republic*. South End Press: Cambridge.

<sup>56</sup> Broehl, Wayne G., Jr. (1998). *Cargill: Going Global*. University Press of New England- Hanover: New Hampshire. Pages 167-171.

<sup>57</sup> "Price Volatility in Food and Agricultural Markets: Policy Responses." *FAO*. UN Food and Agriculture Organization. Web. 29 April. 2012.

number is grander now due to higher beef demand).<sup>58</sup> This is a staggering number and an opportunity cost too high to bear for the taste of beef. The cited figure is almost ninety percent of the population of Africa. Imagine what security that foodstuff could do or if the land used to produce it were utilized in alternative way, perhaps to producing more varied or land efficient crops.

Outside of this, the current climate of food production and consumption is extremely wasteful. The fact that food has been so thoroughly commoditized changed the eyes of many Western consumers, to whom many see it as cheap or expendable. Food is simply taken for granted and as a result purchases are more apt to go expired or unfinished. Restaurants and grocery stores also often dispose of perishable produce and meat which is not longer fresh or high quality as they view it as too subpar for their consumers. The fact that a great deal of food is now transported between countries and countries doesn't help with this phenomenon. Overall, a UN study has indicated that between a third and half of the world's food production goes to waste, largely due to the habits of Western consumers.<sup>59</sup>

High input high output agricultural methods and the neoliberal food regime pride themselves on high efficiency, using production statistics as a response to criticism. However, even if these claims were more soundly based, it would not justify the evils that are caused... simply because they are not needed. Inequitable distribution, waste and speculation... these are the culprits behind much of the food insecurity today, not a lack of production. While the author

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<sup>58</sup> "U.S. could feed 800 million people with grain that livestock eat, Cornell ecologist advises animal scientists Future water and energy shortages predicted to change face of American agriculture." Cornell. Cornell University College of Agriculture and Life Sciences. Web. 29 April. 2012.

<sup>59</sup> "Cutting food waste to feed the world." *FAO*. UN Food and Agriculture Media Centre. Web. 29 April. 2012.

is not advocating for a communist or socialist overhaul of the current food regime, raping the environment and entrusting in flawed economic policies so blindly is clearly not the solution to food insecurity.

It is disheartening to think that such a precarious portrait of food security has been painted without even discussing climate change yet. It would be quite elementary for one to write a piece on how anthropogenic alone causes will endanger food security. Environmental degradation, pollution, the destruction of genetic variation, wastefulness, risky practices, greed and poor allocation are a knife held over the welfare future generations. Yet there is hope. These factors are all the result of human error and within humanity's power to rectify through improved laws, practices and policies. If dynamic action is taken perhaps damage to the Earth can be mitigated, food security can be improved, and preparations for the coming storm of climate change can be made. Yet without any external factors, our own inane practices will cause irreparable damage to the environment and the global way of life.

#### *Climate Change and Its Implications for Food Security*

As a senator, President Obama was quoted saying: "All across the world, in every kind of environment and region known to man, increasingly dangerous weather patterns and devastating storms are abruptly putting an end to the long-running debate over whether or not climate change is real. Not only is it real, it's here, and its effects are giving rise to a frighteningly new global phenomenon: the man-made natural disaster." In modern parlance, climate change has become a blanket term for rising global temperatures (i.e. global warming), semi-permanent changes in the functioning of the climate, and the results of these dynamics (all of which are attributed to anthropogenic actions such as the emitting of greenhouse gases). There have been some claims

that recent dynamic alterations in Earth's climate are due overwhelmingly to natural causes. However, relevant scientists who support this belief are in a very slim minority. A preponderance of scientific studies give support to the anthropogenic school of thought that humans are altering the world's basic climate functions and the Intergovernmental Panel on Climate Change places the likelihood of this as over 90 percent.<sup>60</sup>

Climate change can be attributed to the greenhouse effect. This occurs when solar radiation is trapped within the lower atmosphere of the Earth by particles of water vapor, carbon dioxide, ozone, and methane which refract, absorb and reemit this radiation. This prevents it from returning to Earth's higher atmosphere and space, leading to a heating effect. This process is natural and it is what has enabled life on this planet. However, human industry and activity has led to abnormal amounts of these particles into the atmosphere (especially carbon dioxide and methane), thus exacerbating the natural heating mechanisms of the Earth. As a result of this, the phenomenon of global warming has occurred, with the mean global temperature rising between 0.6-1 degrees from the natural baseline thus far according to NASA.<sup>61</sup>

Global warming brings with it a host of concerns and issues. The process affects a number of feedback mechanisms that will lead to self perpetuation of abnormalities. Rising ocean temperatures will release copious amounts of water vapor into the atmosphere, something which will serve as a greenhouse gas and exacerbate global warming. Melting permafrost and glaciers will also result in a similar phenomenon by unleashing trapped gasses such as methane. Drought and sweltering heat reigned down upon biomass from significantly higher temperatures

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<sup>60</sup> Stern, Nicholas. "Summary of Conclusions." *NationalArchives*. Her Majesty's Treasury. Web. 15 April. 2012.

<sup>61</sup> "GISS Surface Temperature Analysis." *NASA*. National Aeronautics and Space Administration. Web. 15 April. 2012.

can cause fires or simply kill organic life... organisms which sequester enormous amounts of carbon and methane.

These corrupted mechanisms and rising temperatures can drastically alter the Earth's climate. Abnormal water vapor levels and high temperatures are the perfect ingredients for violent and severe weather. Weather patterns would migrate, something which can drastically alter a region's precipitation. Sea levels are rising and are expected to increase drastically as the Earth's glaciers disappear... a phenomenon that will affect currents, add to the strength of storms, and cause pandemic flooding and inundation for coastal nations.<sup>62</sup> The Earth's weather will be largely unpredictable and meteorological models will be rendered obsolete as the basic assumptions concerning global weather patterns will no longer be valid. Infrastructure and ways of life built around specific climate conditions will be shook to their foundations. The nuances and specific affects of climate change will be analyzed in greater detail as the author relates it to agriculture. The impact of climate change on agriculture will completely alter the face of the modern regime, limit global production capacity, and contribute to an unprecedented food crisis... one which humanity is already headed for under its own volition. Alone, it presents an unparalleled challenge unlike any the global community has faced before. Combining its effect with the current dysfunctional state of agriculture is tantamount to throwing thermite into a burning building.

The principal mechanism through which climate change will impact agriculture (and already has begun too) is unreliable weather patterns. These will manifest themselves dangerously in a number of ways. For one, as aforementioned, human understanding of weather patterns will be fundamentally challenged. The mystery that is the natural world is still greatly

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<sup>62</sup> "National Security and the Threat of Climate Change." *CNA*. Center for Naval Analyses. Web. 29 April. 2012.

unknown, even in our Information Age. When natural mechanisms are rendered unnatural by anthropomorphic influences, scientists will be back at the proverbial drawing board. Lack of forecasts will severely limit the ability of agricultural producers to plan ahead or adapt to sudden threats such as a short term drought or storm. The volatility of prices will also increase as it will become extremely difficult to ascertain the fruitfulness of a coming growing season. The interconnectedness of the global food market means that even if production is predictable and stable in one region, an area that is more tenuous can skew prices if there were say a drought or hurricane.

This uncertainty has major implications for policymakers as well. An anomalous phenomenon such as heavy floods can turn a nation's state of food security from "feast" to "famine," something which a developing nation may not be able to divert resources to prepare for if it is not an immediate threat on the horizon. Food policy is, like any other policy, subject to bureaucratic lag... meaning that policymakers may not be able to draft laws or enact decrees in a timely manner or on information that is still relevant as the environment will be so dynamic. Uncertainty also creates fear and anxiety. Imagine for a moment that you are an impoverished farmer in a developing nation. Your economic security is delicate at best. Not only must you face the prospect of poor prices for your good, the economic instability of your nation, and high input high output agricultural risks, but anomalous weather events or even long term droughts which are no longer out of place. How does one prepare for such things when one is already living hand to mouth? What sort of life is it to live with the knife of hunger hanging over you constantly? Fear can quickly turn into panic, and a panicking population is hard to govern. Policymakers too will face their own emotional challenges and the pressure of having to make decisions that will

be affected by a multitude of externalities not within their control. For states with limited resources, zero sum decision, sacrifices, and tradeoffs are also on the horizon.

There are more tangible manifestations besides fear and uncertainty. Climate change is set to upset the basic hydrological cycle, leading to hotter and longer periods without rain.<sup>63</sup> Unstable weather patterns are not optimal for biomass or agricultural production. Infrequent precipitation can kill organisms if the intervals between rain and dry spells are spaced too far apart. If not lethal, dehydration can dwarf growth or diminish nutritional quality. Discoloration and diminished aesthetic value are another side effect as well. Ironically, after a dry spell precipitation can also kill organisms. Rain-showers that unleash pent up moisture can damage produce upon with the impact of water droplets, over-water organism, uproot plants, or cause disastrous floods. Too much moisture on the ground or puddles can also be a breeding ground for fungus and other destructive organisms. Poor aeration can also cause root rot, a condition which occurs when roots do not have access to a necessary amount of air, thereby smothering them. Floods or even moderately strong rain showers can exacerbate soil erosion, as well as dry spells which dry out soil and kill necessary microorganisms. It would be hard for produce to flourish in subpar soil.

The aforementioned mechanisms are defined by mild or moderate weather. Yet despite being minor in strength, because they are fundamental to agriculture, changes to them can have major or catastrophic consequences. This is an important lesson in the quest to understand the threat of climate change. It is not necessary catastrophic hurricanes which should be the chief object of our attention, but interruptions in everyday natural functions.

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<sup>63</sup> Stern, Nicholas. "Summary of Conclusions." *NationalArchives*. Her Majesty's Treasury. Web. 15 April 2012.

Altogether, it is easy to see how difficult these conditions would be for agricultural producers. Agricultural production is already a risky business and lifestyle due to natural fluctuations and the nature of the global economy. Now, those risks will increase exponentially, especially for small scale farmers. One may say that producers could always use artificial means of watering and irrigation to mitigate dry spells. While this may be true to an extent, potable and clean water sources will become increasingly strained due to overexploitation and the effects of climate change (an issue which will be covered in greater depth later in the text). The equipment needed for such operations may not be easily available for small farming operations. Even if this solution could be implemented, it will not stop extreme rainfall from damaging crops. Watering can also only mitigate heat spikes to an extent before withering or damage occurs. Even if an organism is saved from such a fate, it will not reach its optimal state in terms of size or nutritional quality. The general public is apt to forget that agricultural produce are living organisms that, just like humans, can only take so much stress.

For areas or farmland that cannot easily be hydrated, there is not only the risk of crop failure, but fires. In 2010, unnatural temperature spikes in Russia led to widespread devastation and crop loss totaling over 15 billion.<sup>64</sup> 56,000 human lives were lost and it was even feared that such pervasive fires might set off some of Russia's nuclear arsenal as some of its depots were located within the paths of fires. After this incident, Russian leader Putin greatly amended his nation's policy towards global warming. NASA predicts such wildfires to increase substantially in coming decades as a result of rising temperatures that will render biomass vulnerable to

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<sup>64</sup> “Natural Variability Main Culprit of Deadly Russian Heat Wave That Killed Thousands.” *NOAA*. National Oceanic and Atmospheric Administration. Web. 29 April. 2012.

ignition.<sup>65</sup> Such events will ironically serve to exacerbate climate change by releasing carbon into the atmosphere and destroying sequestering organism. Biodiversity and wildlife will also be adversely impacted.

Another major concern with these fires is no matter how much one farmer or landowner tends to his or her own crops, fires can spread from adjacent lots or areas. Even if fires can be put out, in a wheat field for example, extinguishing methods can be extremely damaging as well (chemicals, dumping smothering amounts of water, and the movement of equipment)... even if there is a change to tame a large scale fire. Regions used to lower temperatures and a consistent amount of moisture will be greatly susceptible to such phenomenon as the vegetation and practices are not naturally suited for such conditions.

A dry spell can evolve into a drought if rains are postponed over a long enough period of time. Not only is the aforementioned hydrological cycle going to be rather unreliable, but whole weather bands will migrate, meaning that one region may experience weather conditions characteristic of another. Soil will die, produce will be killed by thirst, and even if rain comes it may not be received by eroded or depleted soils. Dust storms can sweep up dead soil, smothering plants by depositing soil, dust, and sand, thus creating sand drifts of various sizes.

Not only can dust storms occur, but a "Dust Bowl" type scenario could reoccur with a vengeance. The Dust Bowl occurred in both the US and Canada during the 30's as a result of exploitive agriculture practices. Said methods destroyed natural anchoring vegetation and leached the health from top soil. When combined with a severe drought, these conditions led to region wide disastrous dust storms that removed up to 75 percent of topsoil in certain regions,

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<sup>65</sup> "Wildfires: A Symptom of Climate Change." NASA. National Aeronautics and Space Administration. Web. 29 April. 2012.

destroyed harvests, killed, and led to widespread migrations over period of almost a decade.<sup>66</sup> Everyday life was altered beyond recognition in some cases. With today's exploitive practices combined with the adverse conditions climate change is likely to bring, it would not be far-fetched to say that another Dust Bowl can occur. On the contrary, multiple ones may occur simultaneously in different nations or continents.

In arid climates such as Sub-Saharan Africa or Sub-Gobi China, a drought could have disastrous results on communities that already have a difficult time subsiding. Whole regional harvests could be annihilated, leading to widespread food insecurity. Mass migration, starvation, conflict, and panic could quickly ensue. In struggling, failing or failed states without access to emergency resources, the consequences of a drought can be especially dire. One can see this with the Horn of Africa crisis that began in 2011. Not only were the nations of the Horn reliant on international aid, but rebel and terrorist groups greatly influenced the distribution of said aid. This helped empower these groups while civilians were left to starve or suffer.

Droughts also have severe economic consequences. Focusing on survival and the necessity of providing economic aid can prevent or dampen economic growth. Private citizens and business entities cannot hope to flourish in such a survivalist atmosphere. The only economic boon is to those who practice graft and would nefariously increase their prices in order to profit of the desperate. Outside of this, one must remember again that a production collapse in one geographical area can send reverberations around the global food market due to the globalized nature of the modern food regime. In total, drought can bring famine, economic stagnation, force mass migrations, and cause semi-permanent soil degradation. If it is a phenomenon that can barely be tackled today, what about forty years from now with a more

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<sup>66</sup> "About the Dust Bowl." *Illinois*. University of Illinois. Web. 29 April. 2012.

degraded Earth, volatile climate, and a larger population of nearly two billion more persons (many of whom will be born into developing nations)? Africa will be ground zero for the coming waves of droughts. Already one third of the African population resides in a drought prone region, and over half of disasters on the continent are climate related. Growing deserts, unstable governments, susceptibility to drought, increasing population... to the author, this appears to be a weal recipe for disaster and a humanitarian catastrophe.

Sadly, there are even more complexities to throw into the proverbial pot. As promised, the future of water security will be discussed. It is a matter which deserves a great deal of attention and alone is a threat to global security and health. However, due to the confines of this paper it will be surveyed in order to relate it to agricultural issues. Today's agricultural methods are very water intensive, relying on artificial means of hydration beyond the natural hydrological cycle to boost productivity. As of now, such water usage is unsustainable. Twenty to forty years from now, it will not be possible without siphoning off water for humans... or at all.<sup>67</sup> As water is a necessity for agricultural, industrial processes, and basic human life, the gravity of compromised water security in terms of both economics and global health is hopefully self-evident.

One means through which climate change will endanger water security is by catalyzing the growth of bacteria, microorganisms, and disease.<sup>68</sup> Heat is a godsend for such organisms which generally dwell in water or moist areas. As temperatures rise, water sources will no longer be potable due to large concentrations of these potentially lethal creatures. A warming climate also means that microorganisms can travel to new areas where the ecosystem is not designed for

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<sup>67</sup> Stern, Nicholas. "Summary of Conclusions." *NationalArchives*. Her Majesty's Treasury. Web. 15 April 2012.

<sup>68</sup> *Ibid.*

their presence. Humans also lack immunity to microorganisms that they have not been acclimated to. Diseases such as "Montezuma's Revenge" come to mind, illnesses that affect transnational travelers that consume water and food local to the nation that they are visiting. With this contamination, a great deal of water will be deemed undrinkable for humans, meaning that populations will have to tap into alternative sources. This will bleed water from agricultural production, if human needs are deemed to be a priority that is. Water that is contaminated will likely be unsuitable for agricultural use as well. It would be folly for producers to water their goods with microorganisms which could be lethal to consumers. Besides this, such life forms could be detrimental to plant life as well. However, even if crops are not intentionally exposed to these contaminants, one cannot stop them from being spread by rainwater or entering water sources (unless purification methods were utilized). In sooth, a great deal of food today is processed and decontaminated through means such as irradiation, thus mitigating the threat microorganisms pose. However, with this comes the risk of expediting the evolutionary processes of these organisms, making them immune to treatments. There is also the problem of fresh fruits and vegetables that are not processed and could easily serve as a host or Petri dish.

Livestock are also endangered by this phenomenon. Given that livestock already receive inhumane treatment, are caked in their own feces, and compacted together in dirty CAFOs... disease and bacteria could spread through a herd or facility with ease.<sup>69</sup> This could not only be lethal to livestock, but the illnesses these organisms cause can be zootrophic in nature. Many meat products are the conglomeration of a number of animals. One burger can easily have parts

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<sup>69</sup> "Pew Commission on Industrial Farm Animal Production." *Ncifap*. John Hopkins Bloomberg School of Health. Web. 13 April. 2012.

of a hundred or a thousand cows.<sup>70</sup> Because of this, the threat of livestock serving as a human disease vector is compounded exponentially if even a single bovine was compromised. Adding to this danger is that with greater heat, microorganisms will reproduce more quickly, thereby unnaturally advancing evolutionary mechanisms. This will make the threat of a "superbug" or organism that can't be easily countered more probable. The greater solar radiation levels which are causing climate change will also play a part with the threat of microorganisms. Life on Earth is designed for a specific amount of radiation. Anything above these limits can be lethal or cause genetic damage (which is why skin cancer rates have been increasing). If humans are being impacted by this abnormal radiation (i.e. skin cancers)... imagine the effects on microscopic life forms. These organisms will experience a great deal of genetic mutations, and the mortality rate caused by radiation will also jump their evolutionary processes even further. Thus, the Earth can expect to be faced with much more advanced, stronger, and genetically diverse microorganisms... creatures which already pose a threat to human health and of which there are gaps of knowledge. These organisms will have easy access to all life on Earth and can likely cause immense damage before even being understood. The global ecosystem is very delicate, but also perfect in design. It is a series of checks and balances meant to make life viable on Earth. Interrupting this system can have dire consequences, even if it is just with the smallest of life forms.

Organisms could not be the only contaminant in water sources due to climate change. As regions in higher latitudes have begun to experience greater temperatures, permafrost has started to melt. Permafrost is a type of soil which has existed under the freezing point of water for more

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<sup>70</sup> *Food Inc.* Robert Kenner. Magnolia Pictures, 2008. DVD.

than two years. As a result, this soil traps a great deal of gases, liquids, and minerals. Methane is one of the substances that permafrost sequesters. As it melts, permafrost will release methane not in a gaseous state as one may expect... but as a liquid. This liquid will seep into lakes, rivers, and other water sources. For the Nordic nations, Canada, and Russia, this could be a major threat to human life and ecological health as methane is poisonous.<sup>71</sup> This contamination may be localized and the methane may eventually reach a gaseous state, however this is a risk that should not be taken. This is especially true with Russia, which is a major player in the global agricultural market and has taken protectionist action in the past at the expense of other nations' food security.

Salt water is also poised to threaten the integrity of fresh water supplies. As the polar ice caps and glaciers melt, sea levels are expected to rise 2 meters by 2100.<sup>72</sup> Storm surges and floods could enable brackish water to adjacent fresh water deposits, thereby increasing salinity levels. If this occurs too frequently or if the occurrence is drastic enough, coastal fresh water sources could be rendered unusable. On a side note, rising sea levels present a number of other threats. Inundation has the potential to swallow up coastal farms, rice paddies, and essential river deltas. Vietnam's low lying Mekong river delta, for example, could be swallowed up or contaminated by brackish water.<sup>73</sup> This is not a negligible occurrence when considering that half of Vietnam's rice is produced in via the Mekong. Aside from issues on food security, such effects on production would leave export based economies helpless and undermine the production of an essential staple. Agricultural land that is not immediately swallowed up will have to face

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<sup>71</sup> Stranahan, Susan. "Melting Arctic Ocean Raises Threat of 'Methane Time Bomb'." *Yale*. Yale University-Environment 360. Web. 29 April. 2012.

<sup>72</sup> Pfeffer, W.T.; Harper, J.T.; and S. O'Neel. (2008). "Kinematic Constraints on Glacier Contributions to 21st-Century Sea-Level Rise." *Science* 321: 1340–3.

<sup>73</sup> "Scientists Race to Save the World's Rice Bowl from Climate Change." *National Geographic*. National Geographic. Web. 21 April. 2012.

exposure to aforementioned storm surges, something which can be catastrophic for harvests. Rising sea levels will also cause major demographic shifts out of coastal cities and according to the Stern Review almost 5% of the global population will face displacement.<sup>74</sup> The fact is that many "megacities" in developing nations exist in coastal areas to facilitate trade. This would mean that more rural land will be developed for human habitation and that citizens of many developing nations will be unable to rely on urban industrial occupations as an escape or for economic opportunities. When these cities become flooded, the impact on environmental health is not negligible as the invasive water will lap up debris, chemicals, fuel, and even human waste. A storm surge could easily dump sewage laden water into a fresh water lake or on a coastal farmer's crops. None of this is beneficial to agriculture, economics, or humanity in general.

Bluntly put, in the future water security will be jeopardized by the fact that there will simply be much less fresh water as a whole in many regions of the world. Higher temperature will inevitably lead to greater evaporation while keeping water vapor from precipitating. Circa 2050, the IPCC expects this to lead to a decrease in precipitation return between 7-20 percent in North America, 9-17 percent in East Asia, 7-20 percent in South Asia (India), 10-40 percent in the Sahara, and 10-40 percent in Southern Europe/Mediterranean region. Globally, a 10-15 percent decrease can be expected over the Earth's landmass.<sup>75</sup> As a result of this, rain fed water sources would dry up or become greatly depleted. If not, the water cycles which drive rivers will be interrupted, meaning that water supplies can become unreliable and seasonal variations such as floods that bring silt will be less frequent. Decreased precipitation would inevitably affect soil moisture as well, making it unsuitable for produce and necessary microorganisms. In Sub-

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<sup>74</sup> Stern, Nicholas. "Summary of Conclusions." *NationalArchives*. Her Majesty's Treasury. Web. 15 April 2012.

<sup>75</sup> "Intergovernmental Panel on Climate Change-2007." *IPCC*. Intergovernmental Panel on Climate Change. Web. 14 April. 2012.

Saharan Africa this will likely lead to a fifty percent decline in water fed agriculture yields... by 2020.<sup>76</sup> This is less than eight years from now and before the most potent effects of climate change have come to play. Imagine what productions will come to embody by 2050, or even 2070 when decreases in precipitation are predicted to be considerably higher.

As temperatures rise, the Earth's glaciers will face collapse. By 2050, glacier volume across the world will be depleted by 60 percent. This change will be in many regions irreversible or would take centuries to repair. During warm seasons, glaciers naturally melt to a set extent, releasing massive amounts of water that can be utilized for human consumption. Normally glaciers reform and replenish during cooler seasons, however, climate change is preventing this by disturbing the hydrological cycle that allows moisture to return to the higher altitudes where glaciers inhabit. Higher temperatures also inhibit refreezing mechanisms. As a result, glaciers will erode to the point of either becoming extinct or an unviable water source.

When one hears glaciers, one is probably apt to think of rural landscapes in the Northern Hemisphere or the Arctic Circle... places irrelevant to the functioning of the vast majority of the world. This is not the case. Glaciers feed major water sources in Asia, South America, and North America. The city of Toronto in Canada, for example, actually receives nearly 80 percent of its water supply from glaciers. Hundreds of millions of Chinese and Indian rural dwellers rely solely on glaciers in the Himalayas and connected mountain ranges for agricultural production and their own water intake. 37 percent of Indian irrigated agriculture is primarily reliant of glacier water for viability.<sup>77</sup> Should these particular glaciers collapse, these people and the people that their produce sustains will be left to face famine and food insecurity. To make matters worse, a

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<sup>76</sup> Stern, Nicholas. "Summary of Conclusions." *NationalArchives*. Her Majesty's Treasury. Web. 15 April 2012.

<sup>77</sup> "Climate Change and Global Glacier Decline." *WWF*. World Wildlife Fund. Web. 15 April. 2012.

number of Indian cities, not just rural communities, rely on glacier fed water sources as a main source of freshwater. As a result, a number of enormous urban centers will face collapse. Nearly a quarter of the Chinese population will be affected, which is a figure of nearly 330 million people. In the future, India alone can expect over half a billion people left with water shortages by the degradation of the Himalayan glaciers.<sup>78</sup> Even if the global temperature were to raise one more degree, the cities of Lima and Quito might face collapse while the 40 percent of agriculture in the Andean mountain valleys that is glacier fed would be annihilated.<sup>79</sup>

In the world's most populous nations we can expect with certainty agricultural catastrophe and forced demographic shifts. These shifts will leave countless people jobless and homeless in an overpopulated nation which is still developing economically. This collapse will not be short term as with a natural disaster or drought... it will be permanent and irreversible. Climate refugees for this reason, as well as because of aforementioned factors, will not be uncommon. One conservative study done with information that underestimated the effects of climate change predicted that by 2050 up to 200 million people will be on the move every year due to natural degradation and the effects of climate change.<sup>80</sup> This would be the same as if the population of the United States was rendered homeless, impoverished, on the move, and sometimes unwelcomed, these "climate refugees" will be particularly vulnerable to food insecurity and in large groups can affect the food security of the communities they interact with. Overall, with a change in 3 degrees Celsius, 1-5 billion people will face frequent or permanent water shortages.<sup>81</sup> Skeptics of the threat of climate change may argue that some populations will

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<sup>78</sup> "Climate Change and Global Glacier Decline." *WWF*. World Wildlife Fund. Web. 15 April. 2012.

<sup>79</sup> Stern, Nicholas. "Summary of Conclusions." *National Archives*. Her Majesty's Treasury. Web. 15 April 2012.

<sup>80</sup> Myers, N., and Kent, J. (1995). "Environmental exodus: an emergent crisis in the global arena." Washington, DC: The Climate Institute.

<sup>81</sup> Stern, Nicholas. "Summary of Conclusions." *National Archives*. Her Majesty's Treasury. Web. 15 April 2012.

receive greater more water as a result of the changing climate. This is true. However, with the caveat that said water increases will come in the form of extreme rainfall and floods. Said water will also be unreliable, often unnecessary, and unaccepted by an ecosystem that is geared to only a certain amount of moisture.

The analysis will now move away from water related problems in order to continue providing a more comprehensive picture of the threat of climate change while driving home the immensity of this threat. Previously the author discussed how climate change would enable microorganisms to evolve, migrate, and flourish in regions unnaturally for its existence. This phenomenon is not limited to microorganisms however. Pests and invasive plant life will also capitalize off of rising temperatures. Migrant weather bands will enable exotic weeds and animals to travel to regions where there may not be natural mechanisms to counter their presence. As a result, a foreign insects or plants could reproduce and spread unchecked, thereby upsetting ecosystems and possibly killing crops.<sup>82</sup>

Countermeasures such as insecticides or chemical weed killers may be ineffective against newcomers against which they are not tailored. While perhaps not an existential threat to a harvest, such instances would definitely leech away at productivity. There is a possibility though that a foreign organism could wreak major and irrevocable havoc although, and thus this phenomenon is something that is not negligible. Outside of this, chemical treatments are already jumping the evolution of insects and invasive vegetation. Vegetation has even adapted to resist the popular weed killer *Roundup*, creating “super-weeds” that are hardy and threaten crops.<sup>83</sup> Climate change could exacerbate this mechanism through radiation caused mutations and

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<sup>82</sup> “Climate Change Impacts on Pest Animals and Weeds.” *MLA*. Meat and Livestock Australia-Government of Australia. Web. 29 April. 2012.

<sup>83</sup> “Farmers cope with Roundup Resistent Weeds.” *NYTimes*. New York Times. Web. 30 April. 2012.

weeding out weaker specimens. On a side note this radiation could kill or negatively mutate produce... produce which may have been genetically modified and will react unpredictably to radiation. There is a change climate change will kill off some of these pests as well. However, this is unlikely as pests are by nature resilient and hard to eradicate. To the contrary, symbiotic organisms are more apt to be killed off. With a 3 degrees Celsius increase, between 15-40 percent of all terrain species will face extinction.<sup>84 85</sup> Some of these species may be vital to countering pests. Regardless, with such an inhospitable climate predicted for the future, empowering one of the fundamental obstacles to viable agriculture is a ruinous path.

Storms and extreme weather are the last direct implication of climate change this analysis will cover. Concerning storms, as aforementioned, the hydrological cycle will be upset. Combined with higher temperatures and greater concentrations of water vapor, one has the perfect ingredients for unnaturally strong storms and hurricanes. Not only will these storms be greater in volatility, but in frequency as well. The potential damage of such storms has been stated to be comparable to Weapons of Mass Destruction.<sup>86</sup> This is a threat not only to human life and economic growth, but crops which cannot be sheltered against cutting winds, floods, and smothering rains. Thus, whole harvests can be wiped out unexpectedly in a matter of days. Tornados will also fall under the umbra of these changes. Persons in developing nations will bear the brunt of this cost, people already vulnerable and lacking strong infrastructure.<sup>87</sup>

Those who are resistant to taking action on climate change argue that the phenomenon can actually provide agricultural benefits to regions of the world, especially those in the Global

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<sup>84</sup> Malcolm, J.R., C.R. Liu, R.P. Neilson, et al. (2006): Global warming and extinctions of endemic species from biodiversity hotspots, *Conservation Biology* **20**: 538 – 548

<sup>85</sup> Stern, Nicholas. "Summary of Conclusions." *NationalArchives*. Her Majesty's Treasury. Web. 15 April 2012.

<sup>86</sup> "National Security and the Threat of Climate Change." *CNA*. Center for Naval Analyses. Web. 29 April. 2012.

<sup>87</sup> Busby, Joshua W., *Climate Change and National Security: An Agenda for Action*, Council on Foreign Relations (November 2007).

North (Canada, Russia, and northern sections of the US). This would be done through higher temperature and concentrations of carbon in the atmosphere that would spur plant growth. While higher carbon concentration can be beneficial to plant life, the research which has indicated this was conducted in a controlled environment.<sup>88</sup> The ravages of climate change are apt to negate any gains carbon fertilization may cause. Research on the subject also indicates that low fertilization by higher carbon concentrations is more likely to occur, in which case there is no tangible added benefit. As for higher temperatures, these would not be consistent or reliable while abnormal temperatures themselves by nature could actually be damaging to produce. Fires, severe weather, and fluctuating water cycles would also render any added benefits from temperature increases null and void. The Stern review predicts that if low fertilization occurs, there can be a 12 percent decrease in cereal productions from today's levels.<sup>89</sup> Perhaps small gains will be made here and there, but compared to the damage climate change will wreak on the majority of the world, these increases would be trivial and negligible.

The analysis will now focus on the predications for a particular region to showcase in depth the perilous state of food insecurity in the future. Sub-Saharan Africa will be an optimal place for this due to its current tenuous state of food insecurity, issues with the current agricultural regime, and the particularly unique relationship the region will have with climate change. Every nation in Sub-Saharan Africa is either in an alert or high risk classification on the Failed State index.<sup>90</sup> It is home to some of the most corrupt nations in the world according to Transparency International, as well as to some of the lowest scoring countries on the Human

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<sup>88</sup> Stern, Nicholas. "Summary of Conclusions." *NationalArchives*. Her Majesty's Treasury. Web. 15 April 2012.

<sup>89</sup> Ibid.

<sup>90</sup> "Failed State Index." *Foreign Policy*. Foreign Policy Magazine. Web. 19 April. 2012.

Development Index.<sup>91 92</sup> The Horn of Africa, which is located on the Eastern coast of the nation, is spotted with ungoverned areas where terrorists have taken refuge and even become local authorities. Religious fervor is high, contributing to conflicts between Christians, Muslims, and animists at times, such as in Sudan where a sickening genocide is still occurring. Most African nations are the result of historical colonial borders, which means that a *mélange* of races and cultures have been thrust together... races and cultures that can be insular and may not easily mesh with outsiders. As a result, one can see significant racial and religious tension in many Sub-Saharan nations.<sup>93</sup> Resources are sometimes distributed based on this categorization, resulting in minorities being discriminated against and receiving limited government support (an issue when climate change and food insecurity is poised to severely limit the availability of resources). As for the region's climate, a great deal of it is desert or semi-arid, which is a natural challenge to agriculture. A majority of the region, though, is dominated by a tropical climate, which is heavily reliant of precipitation to be habitable.

The reader is now more familiar with the political, economic, and physical landscape of Sub-Saharan Africa. It is inherently not a weal location for civilization and is already a few steps from widespread political collapse. Nevertheless, it is home to hundreds of millions who should be commended for their perseverance. Climate change will ironically hit this, the most vulnerable, region the hardest. By 2080, temperatures in Sub-Saharan Africa could rise 7 degrees as a result of its unique landscape.<sup>94</sup> A seven degree increase in a desert or semi-arid region could render patches of land totally uninhabitable or useless for agricultural growth. The increase in potential fires, as well as reduction in biodiversity also is not negligible. Over time, this heat

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<sup>91</sup> "Corruption by Territory." *Transparency*. Transparency International. Web. 20 April. 2012.

<sup>92</sup> "Indices and Data." *UNDP*. United Nations Development Program. Web. 20 April. 2012.

<sup>93</sup> National Security and the Threat of Climate Change." *CNA*. Center for Naval Analyses. Web. 29 April. 2012.

<sup>94</sup> Stern, Nicholas. "Summary of Conclusions." *NationalArchives*. Her Majesty's Treasury. Web. 15 April 2012.

and changing weather bands are expected to expand the Sahara at an unnatural rate, driving into areas more hospitable for human civilization. Changing weather bands will have a major on Africa. As aforementioned, tropical climates are heavily reliant on precipitation to be sustained. If this precipitation is to become unreliable, inconsistent, or substantially reduced than tropical sub-regions could face dynamic transitions or collapse... thereby devolving into more semi-arid climates. Semi-arid climates may simply turn into deserts. As a result, one can expect to see whole communities forced to migrate to more hospitable places and cities (where there is diminished ability to produce food). Said persons will be climate refugees and will likely enter a state of food insecurity without a livelihood.

The change in precipitation would also have a direct impact on agricultural production. Water sources will evaporate or become compromised by water born diseases. Concerning the latter point, by 2080 67 million Africans will face malaria, cholera, and other deadly ailments.<sup>95</sup> Both phenomena will be particularly destructive to nomadic peoples that herd as they may find stretches of land without any water holes or their herds decimated by disease. Outside of this, rain fed agriculture is expected to decline by fifty percent at the very least.<sup>96</sup> As a result, agriculture would decline by a third in Africa as a whole. This may occur while population demands create a 100 percent increase in food production.

The consequences for Sub-Saharan Africa could be catastrophic. Governments in this region are already strained, unstable, and impoverished. In many cases, any attempt to relieve food insecurity or address a climate change crisis will be partially contingent on foreign aid, something which cannot always be counted on or is delivered in an expedient manner.

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<sup>95</sup> Stern, Nicholas. "Summary of Conclusions." *NationalArchives*. Her Majesty's Treasury. Web. 15 April 2012.

<sup>96</sup> Ibid

Catastrophes, however, could also simply cause government collapse by destroying vital infrastructure or draining economic resources. At the very least, the government's reach could be undermined in rural areas. Persistent crises might raise discontent, leading to revolts, sedition, and outright revolution. This lawlessness and chaos will only further food insecurity by impeding distribution and increasing economic risks. The weal breeding ground for terrorists will also become a reality. Imagine the chaos of Sudan and the Horn of Africa... but spread regionally. This chaos has caused lethal famine even with international support. If such conditions become pandemic, how can relief be distributed effectively? How can the African Union aid members when most of the nations are already undergoing their own crises. Thus, there is an overwhelming threat not only to human security and agriculture, but international stability and efforts in the War on Terror. Not only will there be breeding grounds, but the chaos of these conditions will likely catalyze religious fervor and resentment towards the prosperous West. This fervor may lead to resource conflicts between different religious groups, and it would be folly to think that resource distribution won't be affected by racial concerns. That is what Africa could be destined for if action is not taken. The author wishes to emphasize that this is just one of many possible paths that Africa could travel down. The people of Africa are ferrous and able to determine their own path. The Arab Spring, the division of Sudan, and countless grassroots accountability and democracy movements are a testimony to their will to prosper. These may just be harbingers of future popular movements that could affect enormous reforms. The author will also discuss grassroots activities to increase food security later in this text that illustrate ingenuity and self-determination in Africa. The scenarios the author presents are what will happen if action is not taken. The "ball is in their court" to use a colloquialism, and it is quite possible for

dynamic change to occur. Who would've thought in 1930 that most of Africa would be free of colonial rule by the 1960's?

The Stern Review concluded that while the aforementioned challenges to agriculture from climate change are significant and destructive as lone actors, in tandem together these forces will synergize and interact in a way that cannot be predictable. As a result, Stern predicts total collapse of agriculture in select regions, famine for hundreds of millions, and yield drops of more than a third in Africa (as previously stated). These predictions, though, are conservative and based on data which underestimated the effects of climate change. This Review also did not factor in the long term destruction that the current agricultural regime will wreak upon global food security. Despite this, the picture that Stern paints is still a dire and gloomy portrait of the future.

The author believes that even Stern's forecasts are optimistic. Let us review some pertinent facts. Currently, there are nearly a billion persons who live under one dollar (USD) a day and are food insecure. Another billion people live under two dollars (USD) a day, and can easily become food insecure with economic fluctuations and food price spikes. By 2050, there will be nearly two billion more persons added to the Earth, many of whom will enter one of these categories (in the last two decades Africa accounted for over half of the world's population growth and will reach nearly two billion people by 2050), as well as create strain on food and economic resources.<sup>97</sup> Feeding this global population will require a nearly 120 percent increase

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<sup>97</sup> "Population Projections-2006 Revision." *UN*. UN Department of Economic and Social Affairs. Web. 19 April. 2012.

in food production.<sup>98</sup> In conjunction with this, a great deal of more food will be set for biofuels, industrial usage, and to meet growing demands for beef.

As this occurs, if modern agricultural practices persist, erosion, environmental degradation, anthropogenic desertification, water depletion, and pollution can all be expected to occur. As a result, a preponderance of agricultural land will become either unviable or yield harvests with reduced efficiency. Already there has been considerable damage to productive assets which cannot be reversed. Permitting this system to persist could serve to impoverish farmers and drag agriculture even further into a commodity driven market with limited regards for social welfare. The joblessness and volatile food prices which arise from this market hurt not just those with tenuous economic welfare (the bottom two billion of the world), but speculators as well. The interests of major private entities may also prevent resources from being allocated optimally for social needs and even if this system were to produce enough food to feed humanity humanely, there are demands from cattle companies and biofuel producers to contend with.

Climate change could serve as the final nail in the coffin of the future of food security. GDP will shrink considerably and the development gains of the 50 years in the Global South will be largely undone... leaving hundreds of millions of people without any means of breadwinning. As this occurs, unreliable precipitation and extreme weather events will destroy harvests, weaken the health of produce, and force small impoverished farm holders to abandon their trade. With food security in such jeopardy, this is unacceptable. Humanity will need every farmer and every farm to stabilize global food supply. Whole weather bands will migrate, pests and invasive plant life will flourish in open up regions, and the amount of land suitable for agriculture will be

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<sup>98</sup> "Charting Growth in Food Demand." *IAState*. Iowa State Center for Agriculture and Rural Development. Web. 14 April. 2012.

diminished by erosion, unnatural temperatures, flooding, desertification, and rising sea levels. To top this, water, the essential compound for life on this planet, will become scarcer, non-potable, unreliable, and the cause of disastrous inundations and floods.

The author extrapolates from this confluence of factors a near total collapse of civilization in the Global South. Climate changes economic impacts, food price fluctuations, and overpopulation will force those who live between one and two USD a day into a state of insecurity that will rival that of the bottom billion's. Thrown into this maelstrom would also be more than 400 million more persons in India and nearly 1 billion more persons in Africa by 2050.<sup>99</sup> By 2030 alone Asia's population, the region where the largest number of food insecure persons reside, is expected to hit 5.2 billion. Thus, we see populations expanding in the regions that will be the hardest hit and the least adapted to food insecurity. It would not be unreasonable to expect over 3 billion persons in a state of food insecurity as a result of this... nearly a third of the global population. However, this is a conservative estimate, perhaps even low-balling. Each new IPCC publication brings increasingly more dire predictions of the future and illustrates that climate change is starting to act with greater speed than expected. If food security is affected as the author has predicted in the Global South, death from starvation and malnutrition, famine, mass migration, conflict over resources, and state collapse would all be symptoms. Economic growth could cease or falter as people and governments will be struggling to just get by. Terrorists and militants flourish in failed states, creating kleptocracies that distribute food in exchange for power.<sup>100</sup> One should picture Sudan, but across a number of states and even regions.

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<sup>99</sup> "Population estimates." *UN*. United Nations Department of Economic and Social Affairs. Web. 29 April. 2012.

<sup>100</sup> "National Security and the Threat of Climate Change." *CNA*. Center for Naval Analyses. Web. 29 April. 2012.

By 2050, current estimates predict global temperatures to surpass 4 degrees Celsius. After this threshold, it is unknown what could occur. An ice age or thermal cooling being triggered by a shutdown of thermohaline circulation (or heat bearing oceanic currents) could be devastating to agriculture in the northern hemisphere by creating abnormally cool temperatures that would render large scale plant growth unviable. Already drastic changes in oceanic temperatures and currents have shocked the scientific community.<sup>101</sup> <sup>102</sup> There is also the “runaway climate hypothesis that once positive feedback mechanisms (such as permafrost GHG sequestration) collapse, the climate will irreversibly and suddenly evolve into conditions which are unviable to life as we know it. NASA scientists have observed such phenomena on other planets such as Venus.<sup>103</sup> The possibility of a calthrate gun occurring cannot be discounted either. This occurs when rising sea temperatures unleash underwater methane deposits. As a result of this a number of possibilities could happen. Oceans can be rendered anoxic, or devoid of oxygen, thus killing most marine life and therefore fisheries created for human consumption. Air itself could become flammable. This phenomenon is suspected of being a possible cause for previous extinctions in Earth’s past; either by emitting poisonous fumes or forcing global cooling/warming that is lethal to vegetation.<sup>104</sup> In sooth, these events may be less likely to occur and are as of not wholly understood. Nevertheless, the possibility of an existential threat cannot be ignored. Such threats must also be discussed to appreciate the gravity with which climate change can affect

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<sup>101</sup> “Thermohaline circulation changes.” GIRDA. United Nations Environmental Program. Web. 29 April. 2012.

<sup>102</sup> Byden, Harry; Longworth, Hannah; and Stuart Cunningham. “Slowing of the Atlantic meridional overturning circulation at 25° N.” *Nature* 438, pages 655-657 (1 December 2005).

<sup>103</sup> Rasool, I.; De Bergh, C.; De Bergh, C. “The Runaway Greenhouse and the Accumulation of CO<sub>2</sub> in the Venus Atmosphere.” *Nature*, Volume 226, Issue 5250, pp. 1037-1039 (1970).

<sup>104</sup> “CCSP, 2008: Abrupt Climate Change. A report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research.” *ClimateScience*. US Geological Survey. Web. 29 April. 2012.

civilization. Humanity believes it has conquered and tamed nature... but such hubris could ultimately be its downfall. In total, to answer the thesis question: by 2050 the global population will be unable to be properly fed *if* food policies remain static.

The author does not wish to seem to be on the fringe in his beliefs of the dangers of climate change. No, climate change may not likely present an apocalyptic scenario in the future. It very well may not present an existential threat to humanity as a whole... but it will likely present one to those who subsist on one or two dollars a day. Civilization cannot endure such chaos and instability. Agriculture and food production is the basis of civilization and of human life. With every great leap forward in agricultural methods have come major social, economic, and political advances. Its critical nature cannot be underestimated. Policy makers and the public have become distracted by the phenomenon of global terrorism. Yet compare the damage terrorists have done in the last fifteen years to what food yields decreasing by a third in Africa or a calthrate gun will entail. The large scale disruptions in agricultural production the author has predicted, as well as the dynamic impact climate change will have, present a greater danger than terrorism. Even today, starvation kills exponentially more persons than terrorism or military conflict. Because of the magnitude of this threat, dynamic action needs to be taken to mitigate climate change, adapt to it, and remedy the ailing food regime. This issue must become one of the pertinent topics of discussion not only for policy makers, but the general public. This is a “manmade” problem. It is not too late to unmake it.

### *A Blueprint for Change*

It is easy to raise the call for arms, but less so to actually formulate a plan for action. One might expect that solutions to the complicated enigma that was just presented might be difficult

to discern... or are simply nonexistent. It is true, even with the most energetic, timely, and fastidious of preparations, the coming storm will be a difficult one to weather. Yet there are a number of steps that can be taken to guarantee a hopeful future for our posterity. Some of these measures will be surprisingly simple and may bring a number of economic benefits. Others will require sacrifice. Yet this is not a game or a discussion for those who are inflexible. The welfare of billions is at stake, something which much supersedes economical philosophies, partisan politics, and the profits of private organizations.

The way in which mainstream global agriculture is conducted must be overhauled. High input high output agriculture cannot be sustained as is. There will simply not be enough water or fossil fuels required for its practice, not to mention the environmental and economic issues it causes. Agricultural producers must instead utilize organic methods and capitalize off of new knowledge of natural processes. The author will proceed to design a reworked framework for agricultural practices.

Diversity is the name of the game in this new system. Instead of monocropped fields of corn rows, one can instead picture a patchwork of crops mixed together with arbors and local plants. Even within each crop species there will be variation, with different genetic strains and breeds being utilized. The purpose of this is multifold. Greater variation within crops will enable a larger gene pool, something which will better prepare the species for evolution and surviving the hardships of climate change. Genetic variation is also shields against pest, disease, and normal hardships experienced during growing seasons. Having a number of crops is beneficial in that it allows for crop rotation and better replenishment of the soil that is being exploited. Each species requires particular nutrients from the soil it is planted in. By switching which crop is planted in a particular field each growing season prevents these nutrients from being exhausted,

something which would weaken or kill the soil. After two or three rotations a patch could then be left to lie fallow and regenerate for a growing season or seasons. However, other sections of land which are not lying fallow could still be utilized, allowing producers to continue their operations.

This technique may seem medieval or archaic. Verily, it was perfected in Europe during the Middle Ages. European extensively practiced it until the 20<sup>th</sup> century. Why? For the express purpose of preserving land. European serfs and lords were tied to the land they were born with. It was the basis of their livelihood, and as such it was preserved and treated delicately. In a time of soil erosion and widespread destruction of forests and virgin territory, this technique is needed now more than ever. The Mesoamerican Empires practiced the concept of *milpa*, which involved rotating beans, squash, and corn. The process enabled considerably populous empires to have balanced diets based on an environmentally sustainable agricultural system.

It also has other benefits. “The Rotation Effect” created by this system boosts production by 9-24 percent when compared to monocropped yields.<sup>105</sup> <sup>106</sup> It also disrupts pests and bacteria from entrenching as they cannot rely on a crop being in one particular place year after year.<sup>107</sup> Thus, not only is there an increase in soil health, but considerably large yield boosts without the need for inputs. Economically, diversifying crops allows for the diversification of risk. High risk may lead to high reward, but sustainability and consistency is something on which someone can build stable foundations for a business... whether it is a life for one’s family or a large scale MNC.

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<sup>105</sup> Hollis, Paul L. "Profitability Key to Crop Rotations;" *Southeast Farm Press* 31.14 (2004): 3-. *Environmental Sciences and Pollution Management; ProQuest Central; ProQuest Natural Science Collection; ProQuest Social Science Journals*. Web. 29 Apr. 2012.

<sup>106</sup> "The Rotation Effect for Corn Yields." UMN. University of Minnesota Extension. April 29. 2012.

<sup>107</sup> "Crop Rotations for Increased Productivity." *NDSU*. North Dakota State University. April 29. 2012.

There are downsides to the crop rotation method. Diversifying crops reduces a small farmer's ability to sell in bulk or capitalize off a particular harvest. This can be mitigated by community organizations and farmers' networks that can pool resources and crops together. However, crop rotation can be harder to manage and implement, requiring a certain degree of knowledge and experience to be successful. Diverse crops also decrease the efficiency of machines that are designed for monocropped fields. In terms of small farmers, again farmers can coordinate through organizations to share different machines to help mitigate this downside. Though more manual labor might be needed, this can bring fringe benefits to communities as more jobs will be created. Greater productivity, stability, and less need for inputs would negate these extra costs in production easily.

What crops would dominate this new food regime? Corn, most assuredly would not be a top contender. Despite its prevalence today, from a nutritional standpoint corn is not a suitable staple food. On the contrary, historically when it has served as a staple it has led to "pellagra," or a vitamin deficiency disease that can cause ataxia and skin lesions.<sup>108 109</sup> Traditionally, when it has succeeded as a major dietary component it was after being soaked in alkali water mixed with lime and ash. Otherwise it simply lacks essential vitamins, amino acids, and nutrients. In its stead, production should center on varied wheat strains, beans, potatoes, soy (if environmental concerns can be mitigated), and fortified rice. Potatoes yield almost three and a half more per acre than corn in terms of weight... and the whole vegetable can be used, whereas with corn only the kernels are generally consumed. Despite this one sees almost 84 times as much land being

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<sup>108</sup> "Pellagra." *NIH*. National Institute of Health. Web. 1 May. 2012.

<sup>109</sup> Rajakumar, K (2000). "Pellagra in the United States: A Historical Perspective". *Southern Medical Journal* 98 (3): 272-277.

utilized for corn.<sup>110</sup> One may argue that potatoes are simply starches. This is not true. Sweet potatoes, for example, are one of the more nutrient rich vegetables and contain vitamins, fiber, carbohydrates, protein, and beta carotene.<sup>111</sup> The skin of other potatoes is rich in minerals and can be beneficial to the human heart besides serving as a source of carbohydrates. Regardless, this is an optimal example of how land is not being properly appropriated.

The proposed system has other merits as well. The use of trees and local plant life within crops has been noted for increasing productivity immensely. While the exact causes are still being ascertained, it is likely that such organisms help contribute to agriculture by creating a healthy ecosystem and naturally fertilizing cropland. Trees help anchor down soil and shelter crops from wind, rain, and other natural phenomenon as well. A UN report has discovered an 83 percent boost in production among farms in 57 developing countries when agroecological methods were utilized. In 20 different African counties a 113 increase in productivity occurred, which is over a two fold increase. Coinciding with these increases were major reductions in dependency of artificial inputs, especially insecticides.<sup>112</sup> In terms of durability, organic and agroecological systems are more able to withstand events such as hurricanes. This trait will be needed as climate related disasters increase in volatility and frequency. Organic farming as a whole affects greater resilience. For example, organic harvests generally have a 70-90 over inorganic harvests during droughts. In terms of future conditions, this will also be desirable.

With organic practices, crop rotation, and the incorporation of natural systems comes a baseline increase in biodiversity of a least 30 percent, as well as more organisms. Insects such as

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<sup>110</sup> "Crop production-2011." *USDA*. US Department of Agriculture. Web. 1 May. 2012.

<sup>111</sup> "USDA Nutrient Database for Standard Release 18." *USDA*. US Department of Agriculture. 1 May. 2012.

<sup>112</sup> "Eco-Farming can double food production in 10 years, UN report says." *OHCHR*. UN Human Rights. Web. 1 May. 2012.

spiders and other predators such as praying mantises provide natural and free defenses to pests... defenses that do no risk chemical contamination or soil erosion. These organisms can also be artificially introduced to certain regions. One might be wary to believe that such creatures are enough to justify the discontinuation of pesticides. It would not be wrong to hold such a view. Education would also be needed to make this system viable. In actuality, 90 percent of pest issues are due to human error that can be avoided. If workshops, training, and information can be provided to producers and small farmers... pesticides can be eliminated or labeled as overkill. As a result, producers will find themselves no longer needing to purchase a costly input which is damaging to soil and speeding up the evolution of pests. Greater investments should also be funneled into researching green pesticides such as neem, a naturally procured compound which acts as a repellent.<sup>113</sup> There are also bacterial toxins such bacillus thuringiensis which only kill pests that feed on crops.<sup>114</sup> These sorts of eco-friendly pesticides can complement the aforementioned measures as a failsafe or can provide peace of mind for those who trust in more in pesticides.

Some critics of organic methods state that organic production requires a greater amount of land due to crops loss and reduced yields. In truth, the studies on organic farming have found yields ranging 80 percent to 96 and 97 percent of what conventional methods generally produce.<sup>115</sup> If the worst case estimate should prove true, a twenty percent decrease is not negligible. However, it would not come without decreased production costs, a reduction in economic risks, and greater harvest durability (which is a vital perk if climate change proves to

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<sup>113</sup> "Material Fact Sheets -Neem." Cornell. Cornell University Resource Guide For Organic Insect and Disease Management. 29 April. 2012.

<sup>114</sup> "Material Fact Sheets -BT." Cornell. Cornell University Resource Guide For Organic Insect and Disease Management. 29 April. 2012.

<sup>115</sup> "Can Organic Crops Feed Us All?" *Worldwatch*. World Watch Institute. Web. 18 April. 2012.

be extremely volatile. These factors would help justify the trade off of a lower yield. Yet the three studies were focused on Western agriculture, and in the developing world agroecological methods have been shown to nearly double yields as previously mentioned.

A 2007 review conducted at Cambridge University of 293 pieces of agricultural literature indicated that the general consensus was that the world can be fed organically without having to increase land cover for agricultural purposes.<sup>116</sup> Even if this were not true, the fact is the current system is already requiring new lands to be opened up! The Amazon rainforest may be wiped off the map because of inorganic high input methods raping the environment. Organic farming actually has the potential to restore lands and incorporate ecosystems into the global economy. At the very least it is less likely to degrade soil consistency or productivity any further. As indicated, it also has the potential to be more productive, job creating, cheaper, durable, reliable, and environmentally sound. These are the systems the world will need in the coming days, not one which is volatile, expensive, and exploitive of nature and people.

Critics of organic methods also overlook the fact that huge tracks of land are being appropriated to generate animal fodder. This cannot be continued. As aforementioned, Africa could be fed with all the American crops that go to feeding bovines alone. The author proposes that the beef industry be phased down. This would entail gradually scaling down the beef industry's massive scope through regulatory means as well as transitioning from CAFOs to pasture fed livestock and sustainable cattle farms. Although beef is highly consumed and is becoming a more desirable product in industrializing nations, it is naturally a luxury and should remain as such. Arbitrary eating habits cannot be entertained at the expense of enough food to feed continents. Beef should be taxed by the governments wherever beef consumption is

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<sup>116</sup> *Ibid.*

determined to be too environmentally destructive in order to reflect its carbon cost and subsidies should be removed from all but grass fed industries (which are generally more humane and less damaging to the environment). The market then will adjust itself accordingly, resulting in less beef at a higher price. The beef industry's opportunity cost and the direct impact on the environment is simply too high to justify its existence as is.

Proponents of the beef industry may argue that beef is a staple now and a major source of protein. While this is true, status quo does not justify perpetuation when there are alternative possibilities. More emphasis should be placed on poultry, eggs, and milk as primary sources of protein. Milk and egg protein is actually of a higher quality than beef, meaning that a greater amount is utilized by the human body. In Mali, small community fish ponds have had marked improvements in providing sustainable, consistent, and cheap sources of protein to impoverished persons. Produce itself can serve as a viable source as well. Rice and beans consumed together form a complex protein, while staples such as black beans themselves contain substantial amounts of the compound. Today, soy serves as a substitute for meat for many vegetarians and vegans, and a number of higher protein strains of grains and cereals exist. This produce can be texturized and processed into a number of different products that would appeal to consumers (i.e. black bean burgers). Overall, it makes little sense to use land to cultivate food to serve as fodder for bovines that are then consumed for protein when vegetables and fruits can themselves be consumed for protein. From a nutritional standpoint, relying on one source of protein is not optimal. Varied intake from red meat, poultry, produce, dairy, and fish is instead the diet that should be promoted for human health.

In developing nations, freeing up land for human consumption would likely be received with warm reception as beef is still a luxury for many persons. In industrializing nations where

Western eating habits are starting to be adapted, as future food insecurity becomes more tenuous many people and policymakers will likely choose to increase stability rather than entertain these desires. As for Western nations, these changes to the beef industry may be a hard sell as it loved by many consumers and the backbone of number of MNCs. This is why it should be phased out gradually; giving consumers and customers time to amend their practices. However, those who oppose pork barrel spending in the US will likely approve of over 16 billion in savings each year that would be incurred if subsidies to CAFO industries were cut.<sup>117</sup> The fact also remains that shrinking the beef industry is a necessity that cannot be avoided. Every track of land must be used efficiently. Allocating enough land that could feed a continent to the cattle industry is the exact opposite of this

The same principal should apply to biofuels. In terms of corn based ethanol, taking corn away from human consumption will serve to make the market more volatile and drive up the crop's price. Producing ethanol from corn is also rather inefficient in terms of land and material. Biomass, sugar, and crops harvested for the specific purpose of fuel are more suitable alternatives for the present and near future until second generation biofuels are further developed as they require less energy and land to produce. Sweet potatoes and cassava have also been noted as more efficient biofuel sources with current technology.<sup>118</sup> The economic interests of corn producers will have to play second fiddle to the necessities of the future. The inability to monocrop in the future, however, should help mitigate this by forcing the diversification of crops and thus risk.

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<sup>117</sup> Becker, Geoffrey S. *Farm Commodity Programs: A Short Primer*. Congressional Research Service. 20 June 2012.

<sup>118</sup> "Potential of Sweet Potatoes and Sweet Sorghum as Advanced Biofuel Crops for Low Input Production on Small Farms." *KSU*. Kentucky State University. April 29. 2012.

One may ask where genetic modification comes into play with this new regime. Unfortunately there is no clear cut answer to as to whether this technology should be utilized. Genetically modified organisms are marvels of modern technology, enabling scientists to imbue plants with traits which will allow them to weather droughts and extreme climate conditions with greater ease. These organisms have also been altered to withstand certain pests and the application of pesticides. Yet these altered crops have intellectual property laws which prevent saving seeds, something which gives companies great control over life itself. Some agriculturalists argue that GMOs are the key to future agriculture by enabling farmers to plant crops which can be designed to outlast the ravages of a dynamic climate.

The author is hesitant to condone the utilization of GMOs. GMOs have had noted negative effects of human gastrointestinal system and there is the possibility of causing allergic reactions. The fact GMOs are often created by private corporations also means that there is a profit driven motive behind them. As demonstrated, the commoditization of food has not boded well for those in developing nations, often creating indebtedness. The implications of fiddling with genetics are not fully known, and how these organisms will fare against the abnormal conditions of climate change is another mystery. The mélange of unnatural conditions may cause the tampered genes of GMOs to react in a way in which natural crops do not. The threat of cross polinization also means that if GMOs had a compromised genetic composition, it could be passed to other natural crops. There are also a number of ethical and philosophical considerations. Many persons with religious convictions believe GMOs violate the concept of divine creation and the sanctity of life. As a result, persons in the Global South may reject GMO seeds and produce... even in desperate scenarios (i.e. Haitian farmers burning Monsanto seeds).

Due to these risks, perhaps it would be prudent to crossbreed natural varieties of seeds to gain the desired result or as close as possible to said results. There is also the option of creating an artificial environment which could mimic the conditions of climate change in which crops could be cultivated and the strongest strains saved. The process could be repeated in a variety of scenarios until an “uber-strain” is created. GMO research should not be abandoned though. Although it has risks, strains should be prepared for a last ditch effort if agriculture becomes too adverse to natural strains. Perhaps in the years to come genetic modification will become less risky and it will become possible to grow them in a confined area. Regardless, research on GMOs or improved natural strains should be done with public financing. The whole world will need access to the best tool for the job of feeding the world... viable seeds. Agriculturalists discuss the marvels of new machines, chemicals, pesticides, and fertilizers... but in the end this is all useless without seeds that can survive the coming storm.

The “margins” cannot be neglected in this blueprint for action. Across the world, communities, organizations, and individuals are pioneering or preserving effective means of agriculture. For example, indigenous farmers in Peru viably farm hundreds of varieties of potatoes... potatoes with such genetic value that corporations have tried to steal and patent them. Cuba, as a result of fuel shortages after the collapse of the Soviet Union, adapted low input Organoponicos to help supplement vegetable and fruit production. These urban plots are numerous, efficient, organic, and produce food inexpensively. The Cuban government has even backed them by providing citizens with land, seeds, and valuable research. While these systems have not been a panacea to all of Cuba’s agriculture, this is a weal example of the numerous

fringe practices that can be adapted.<sup>119</sup> In Africa, urban agriculture has become a major force and is starting to be promoted by governments such as the Democratic Republic of the Congo, where 800 hectares are being allotted which can feed nearly 80,000 people.<sup>120</sup> Such setups allow for the maximum utilization of land, cities to have access to fresh vegetables, and enables urban dwellers to grow their own producer (thus giving them more control over their lives). Such setups have a lower carbon footprint and are advantageous in nations with poor roads.

Not all margins are based on minimalism or traditional ideology. Companies such as RENERGY Foods, for example, are in the process of engineering agricultural bio-domes in Canada that increase the efficiency of solar radiation, save water, and protect crops from external forces (diseases, pests, storms, harmful temperatures, and fires).<sup>121</sup> The bio-domes are fully recyclable, have fire control systems, and are becoming increasingly financially viable. Shades can also be installed to reduce temperatures and solar radiation from hurting crops. Constructing these systems in volatile areas may be a means of increasing production per acre to a historic high while preserving the feasibility of agriculture. Food could even be grown during winter months in order to offset poor harvests and ensure a stable supply of food. No, the whole world's food production could not be converted to this system, but by utilizing it agriculture can remain in the areas that will be hardest hit by climate change and be practiced in areas where it has never been practiced before (deserts, high altitude countries, and even cities). Developers should incorporate these systems into their agricultural projects. These professionals seek to adapt poorer nations to climate change, increase production, and decrease economic risks to farmers. Here is their solution: community owned bio-domes which can shelter large amounts of produce.

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<sup>119</sup> Koont, Sinan. "The Urban Agriculture of Havana." *Monthly Review* 60.8 (2009): 44-63. *ProQuest Central; ProQuest Social Science Journals*. Web. 29 April. 2012.

<sup>120</sup> "Urban farming against hunger." *FAO*. *FAO Newsroom*. Web. 18 April. 2012.

<sup>121</sup> "RENERGY announces prototype ETFE Pillow." *RENERGYfoods*. *Renergy*. 20 April. 2012.

Projects and systems like this need to be further researched and funded. No matter how unusual or futuristic a solution may appear, policymakers cannot be confined by their prejudices. The author again emphasizes that this is not a game of half measures that can be won by playing conventionally. To the margins we must look.

Modifications must be made to the macroeconomic system and economic philosophy if any of these changes are to have any affect. The Washington Consensus and neoliberal principles such as the elimination of subsidies and no utilization of trade barriers must no longer be forced on any nation or touted as a universal truth. Yes, neoliberal principles work in some economies, but it cannot be grafted artificially on a nation's economy. This has been attempted for over 50 years... and still this world has over a billion hungry people. In Mali, the government did the exact opposite of what neoliberal doctrine prescribes for economic woes. It instead subsidized its farmers monetarily and with agricultural inputs. The results helped cure a massive famine and provide better food security for more of Mali's population.<sup>122</sup> The concept of a globalized and interconnected economy based of free trade is something to aspire too... but it may not be realistic in this day of age in terms of food. A majority of the world's nations cannot hope to compete with those of the Global North in an open market. Globalized markets enable too much fluctuation and allow for ripple effects emanated from one nation to be felt the world over as well. A better option would be for nations to organize and trade significantly more on a regional level. The African Union, ASEAN, the EU and related organizations must work together to coordinate regional food security and trade. For economically developing nations, forming regional blocks can be empowering in the global market, enabling nations that would pale in comparison to superpowers to make coercive demands. Logistically, it is much easier to

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<sup>122</sup> Dewbre, J. and A. Borot de Battisti (2008), "Agricultural Progress in Cameroon, Ghana and Mali: Why It Happened and How to Sustain It", OECD Food, Agriculture and Fisheries Working Papers, No. 9, OECD Publishing.

coordinate needs and trade volume on a regional, rather than global, basis. Such cooperation would help lay down future relationships and mechanisms for dealing with food security crises and climate change.<sup>123</sup>

The author is not suggesting an elimination of globalized trade, but instead a partial disintegration and a diversification of food sources. To the contrary, the current trade regime has brought benefits to the world. However, DVD players and coltan are not wheat or corn. Food prices cannot be the result of market mechanisms or speculation. In conjunction with this transition, an IGO should be established to help monitor global food prices that possesses the ability to influence trade, distribute food aid, and release or hoard food in order to affect prices. Nations may not like giving up sovereignty; however in the current food trade regime nations of the Global South really do not have any. At least with this proposed situation the regime will be geared towards stabilizing prices in favor of citizens (though producers' needs can also be taken into account by regulatory bodies).

On the topic of sovereignty, the concept of food sovereignty, or the right of communities to determine their own food policy, production, and consumption in order to obtain a healthy and sustainable diet, can also be taken into consideration in the new improved food regime. Coined by the agricultural movement Via Campesina in Mali during February 2007, its proponents profess the following:

“Food sovereignty is the right of peoples to define their own food and agriculture; to protect and regulate domestic agricultural production and trade in order to achieve sustainable development objectives; to determine the extent to which they want to be self reliant; to restrict the dumping of products in their markets; and to provide local fisheries-based communities the priority in managing the use of and the rights to aquatic resources. Food sovereignty does not

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<sup>123</sup> Busby, Joshua W., *Climate Change and National Security: An Agenda for Action*, Council on Foreign Relations (November 2007).

negate trade, but rather, it promotes the formulation of trade policies and practices that serve the rights of peoples to safe, healthy and ecologically sustainable production.<sup>124</sup>

This philosophy has its merits. Self sufficiency and empowering the world's many small-scale farmers can help insulate nations against climate challenges and the risks of neoliberal trade by increasing and bolstering domestic production. Espousing these rights can also help evolve the mentality of the current food regime from one of capitalization and production to one that focuses on sustainability, feeding populations, and entitlements... a mindset which will be necessary in the coming decades. Outside of pragmatism, why should communities surrender control over a necessity to other nations or corporations? Food, agriculture, and communing with nature have a great deal of cultural significance... which should these cultural values be sacrificed for an arbitrary economic system which is failing to yield significant benefits? Via Campesina's philosophy should be taken with a grain of salt, however. Transitions to total self sufficiency in the past have sometimes caused widespread famine. Some nations may also not benefit from reducing trade as they may have a strong comparative advantage in producing non-agricultural goods. The author again emphasizes that globalized trade must be amended, not eliminated. However, as this is not simply an economic problem, but a social one as well, the author believes that the sentiments and ideas Via Campesina professes can help garner respect and legitimacy for farmers (an often underprivileged group). Farming is one of humanity's oldest and most vital professions... we cannot lose sight of this even in our age of enhanced reality glasses and iPads.

What is the price of adapting against climate change and amending the global food regime? The Stern review concluded that the costs of inaction greatly outweigh the costs of mitigating and adapting to climate change as a whole. However, these costs may actually yield

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<sup>124</sup> "Declaration of Nyéléni." *Viacampesina*. Via Campesina. Web. 23 April. 2012.

significant gains in global GDP (perhaps up to 6 percent annually) through the funding of green energy, energy efficiency, climate proof development, and next generation infrastructure.<sup>125</sup>

Busby similarly concluded that there are many ways to adapt to climate change that would provide positive economic externalities, so called “no regrets” adaptations that will serve functions outside of just mitigating climate change.<sup>126</sup> Efficiency, new investment opportunities, public works projects, and international development... it would be hard to argue that adaptation and mitigation poses insurmountable economic hurdles. To the contrary, the author would very much desire to own a green technology firm in the coming years.

Concerning the authors proposed evolution of the global food regime, the economic consequences of alteration will also be predominantly benevolent. Massive savings would be incurred by the discontinuation of high input methods, savings which can be passed onto consumers. There will be drastically less need to acquire new cropland, while the cropland being utilized may see marked improvements in quality and productivity. Major opportunities will be opened up for investment, research, new products, and agricultural infrastructure being built. Greater food security in the Global South and more stable livelihoods for the world’s billions of small farmers will have enormous macroeconomic benefits... allowing for self improvement, family savings, greater purchasing power, and a healthier economic atmosphere in general as there is a diminished risk of starvation or loss of occupation. Global health will improve wherever populations rely heavily on corn, red meat, and nutrient deficient food thanks to an influx of diverse crops. This may lead to decreases in public health costs overall (less malnutrition, obesity, and heart disease).

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<sup>125</sup> Stern, Nicholas. “Summary of Conclusions.” *NationalArchives*. Her Majesty’s Treasury. Web. 15 April 2012.

<sup>126</sup> Busby, Joshua W., *Climate Change and National Security: An Agenda for Action*, Council on Foreign Relations (November 2007).

Overall, it would appear that the author's system would be more than economically viable and instead be *more* profitable in a macroeconomic sense than the current regime. There are some downsides to this system. Transitioning to this new model will require national government and IGO subsidies, as well as oversight and technical knowledge. Agricultural and food related MNCs will need to make major alterations to business models and find sources of revenue eliminated. Again this system can be transitioned in gradually and with government aid. There will also be new schemes to invest in. Nevertheless, there will likely be backlash from lobbyists within the current food regime, especially on the part of the corn industry in America. The author asks if pandering to lobbyists is worth jeopardizing the global food regime when the proposed changes may actually bring *greater* prosperity. The world can be fed sustainably and in a more wholesome manner if the right adjustments are made... and for those who are concerned, a buck can also be made. Some private entities may see some reduced profits, hopefully just initially. However, the author would hope that global stability and the lives of impoverished children weigh more than private interests.

### *Conclusion*

The author has presented a colossal challenge to the reader. The global food supply is in ominous jeopardy, not only from a changing climate, but agricultural practices which have been ingrained into the world economy over the latter half of the previous century. If these two forces are allowed to synergize, the effects will be cataclysmic. Large portions of the world's arable land will be rendered permanently unfit for agriculture and food prices will vacillate in an almost schizophrenic manner. Approximately three billion people will be thrust into a state of food insecurity... and hundreds of millions will perish, many of whom will be infants and youths. The author does not wish to appear as a doomsayer, but ironically these predictions are optimistic as

the perils of climate change can wreak greater havoc than imagined. If the current food regime is allowed to persist, the global population will not be able to be fed by 2050. Instead, humanity is faced with a dystopian future. Regions of the developing world will resemble something out of a *Mad Max* movie or *the Hunger Games*... economic collapse, nomadic lifestyles, starvation, fear, crime, and failed governance.

Avoiding this future is not a herculean feat. Nor would it require drastic sacrifices. Sustainably and organically produced food traded in a semi-regulated market is quite capable of feeding the world and providing enormous socioeconomic benefits. Achieving this system, while requiring coordination and some financial backing, has the potential to bring the world a step closer towards a utopian system and is not an insurmountable challenge. While there may still be challenges posed by climate change, the world will be in a more optimal position to pass through the future gauntlet. Even without the threat of climate change, the author's proposed system has the ability to alleviate many of today's economic, developmental, and social woes. As such, the author challenges policymakers to make the choices that are not only ethical, but pragmatic. Inaction and barreling down the destructive course we as a world are on cannot be justified. Lives, livelihoods, the sanctity of the environment, and civilizations are at stake. Narrow-mindedness, hubris, anthropocentrism, and special interests cannot be allowed to overshadow the need to take action. This is the time for full measures, dynamic action, and transcending arbitrary economic philosophies. If the people of today do not take action, the blood of hundreds of millions will be on their hands, at the very least. This is not wild speculation; it is the future unless action is taken. There is no middle ground. If we as a race commit whole heartedly, we will reap the benefits of our actions. Any other path and the human race will have caused its own downfall. The severity of this crisis cannot be underestimated, so the author pleads with you,

reader, to do your part. Advocate, adjust your eating habits, educate yourself, and educate others. The information is out there and if the worst happens, ignorance cannot be pled in the future. Let us not let apathy get the best of us. Let us instead, as a race, take steps to rise and be proud that we took actions to better ourselves and our posterity. To let this disaster transpire when it is within our power to stop it would be a permanent blemish on the human race and spirit. As the Persian poet Rumi said "Ask all of yourself." Let us determine our own fate through our own volition, and let it be a good one. The author thanks the reader for his or her time.