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From Management to Sustainability: Strategies for Producers, Consumers, and Small Businesses

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Abstract

The effects of climate change and other stressors on the agricultural sector provide proof that the need to achieve agricultural sustainability is a legitimate issue that should be addressed immediately. The ultimate financial benefits to achieving sustainability are immense. This study investigated the causes of climate change and reported how it directly and indirectly affects the agricultural sector of the Southeastern Region of the United States. We concluded that crops vary with the different adaptation strategies and with the predicted rise in temperature and fluctuation in precipitation. It is essential for producers to monitor closely their previous growing seasons. Long term investments include plant breeding, rotating crops, building infrastructure, and mitigation systems. Climate awareness and its impacts on agriculture by consumers, producers, and policymakers are essential to develop adaptation strategies to mitigate the effects of climate change.

Keywords: Climate change, Management, Sustainable agriculture

1. Introduction

How does climate change impact the agricultural management and businesses? How will producers respond and perform under climate change? Are there methods that producers, consumers, and policymakers can use to combat the effects of climate change? Temperature increases, precipitation fluctuations, and decreases in the polar caps are all warning signs that climate change is altering our weather pattern in numerous ways (Rosenzweig & Casassa, 2007). The evolution of climate change and its impact on the agricultural sector in the United States has been documented for 171 years by the U.S. Department of Commerce (Vilsack, 2009). Since 1840, the Bureau of the Census (the "Agricultural Census") has gathered agricultural data from producers around the United States (Vilsack, 2009). Scientists, producers, and policymakers have applied this data to find that there is a direct link between agricultural yields and climate change (Howden, Soussana, Tubiello, Chhetri, Dunlop, & Meinke, 2007; Schlenker & Roberts, 2009). The Southeastern region, an area of favorable climate conditions, is a prime example of how climate change and other resulting factors are affecting the agricultural lands and produce yields (Franzluebbers, 2010). Since 1997, the Agricultural Census has illustrated a steady decline in the amount of land in acres used for farming in three Southern states (US Department of Agriculture). The decline in Southern agricultural land has caused cotton and tobacco yields, two Southern staple crops, to steadily decline as well (US Department of Agriculture). These declines have resulted in Southeastern producers being dependent on new technology and cultivation techniques to survive the effects of climate change.

Climate change has even been proven to play a role in politics, economics, and small businesses across the United States (Porter & Reinhardt, 2007). Almost every American farm produces enough food and fiber to feed about 160 people; and most of the United States depends on American grown produce (Prax, 2010). Thus, it is imperative that research and methods for attaining agricultural sustainability are established for the success of farmers and consumers who depend on American agriculture. In this review, we investigated the causes of climate change and reported how it directly and indirectly affects the agricultural sector of the Southeastern Region of the United States. To conduct this review, we first defined agricultural sustainability and identified

how important its success is to millions of people around the world. We then documented the transformation of climate change through the past decades by identifying the numerous stressors that can stimulate and inhibit its effects. Reviewing previous studies, modules, and statistical data also helped to identify past climate trends to envisage future weather forecasts. Finally, we presented crop yields from several decades and provided strategies for growth in order to achieve durable agricultural sustainability.

2. Literature Review

2.1 Agricultural Sustainability and its Importance on the Agricultural Sector

Agricultural sustainability is defined as the methods of cultivation that are designed to meet present and future societal needs for food and shelter so that the cost of producing these goods does not outweigh the overall net benefit (Tilman, Cassman, Matson, Naylor, & Polasky, 2002). Agricultural sustainability is achieved when farmers earn more in profits from selling produce than they spend during the season growing and cultivating the produce (Tillman et al., 2002). The world is virtually fed, housed, and maintained because of the various materials that natural ecosystems provide: food, fiber, shelter, and fuel (Daily, 2000; National Research Council, 1999; Tilman et al., 2002). Forty percent of the United States consists of agricultural lands that are the largest ecosystem and are immense to the world's vitality based on the output of food and other necessities that they provide (Franzluebbers, 2010; Tilman et al., 2002). In 2002, agriculture fed 6,000 million people (Tilman et al., 2002). As the global population is predicted to double by 2050, the demand for agricultural products is also expected to double to 12,000 million people (Alexandratos, 1999; Cassman, 1999; Cohen & Federoff, 1999; Tilman et al., 2002). Agriculture is not only a resource for food and shelter for billions of people around the world, but it is equally a large source of income for millions in the United States (Schmidhuber & Tubiello, 2007).

The United States is the world's largest producer and exporter of agricultural produce (Ashenfelter & Storchmann, 2006; Auffhammer, Ramanathan, & Vincent, 2006; Darwin, 1999; Dechenes & Greenstone, 2007; Kelly, Kolstad, & Mitchell, 2006; Mendelsohn, Nordhaus, & Shaw, 1994; Schlenker, Hanemann, & Fisher, 2006; Schlenker & Roberts, 2009; Timmins, 2006). In the 2007 Agricultural Census, over 2.2 million farms were reported in the United States (Vilsack, 2009). More than 400 million acres of land was utilized for cultivation during the 2006 growing season and producers earned nearly three billion dollars in agricultural sales (Vilsack, 2009).

The Southern states of Alabama, Georgia, Florida, South Carolina, and Tennessee had 44.3 million acres of cultivable land for farming and more than 249,000 farms during the 2006 growing season. More than two million farmers in the United States depended on the income they received from their agricultural yields in 2006 (Vilsack, 2009). In addition to the more than two millions farmers in the United States, billions of people around the world rely on the export of these agricultural goods every year (Vilsack, 2009). Ensuring that the agricultural sector achieves sustainability in the future is essential for the livelihoods of more than two million U.S. farmers and the billions of people who depend on their produce. Awareness of climate change is the first step to modifying and mitigating damages to achieve agricultural sustainability. Temperature rise in recent decades has been the main concern of most studies because of its direct influence on agricultural sectors, every environmental and human ecosystem (Rosenzweig & Casassa, 2007).

2.2 Climate Change

Weather and high temperatures have always been a major factor on the environment (Hultman, Hassenzahl, & Rayner, 2010). The concern over chemical pollutants and their effects on the environment led to the gradual development of risk assessment studies in the 1980's (Carson, 1964; Hultman et al., 2010). Evidence of climate change began to rapidly accumulate as scientist observed regional temperature increases, precipitation fluctuations, and increases in glacial lakes but decreases in mountain snow caps (Rosenzweig & Casassa, 2007). These studies led scientist to conclude that climate change scenarios had a direct impact on the length and yields of produce each year (Wall & Smit 2005). In 2009, many farmers around the world had to adjust to extreme high temperatures, droughts, and floods (Baragona, 2009). High-income countries have not been impacted as negatively as lower-income countries (Tol, 2010). Low-income countries tend to be impacted more negatively because of their locations in tropical zones and their lack of resources to combat the growing temperatures (Tol, 2010).

In the United States, annual temperatures have risen from 1955 to 2005 with the greatest warming recorded in Alaska and substantial warming in the Southeastern United States (Field & Mortsch, 2007). The Southeastern United States has favorable climate conditions that include mild winters and hot summers with lots of rain (Franzluebbers, 2010). Spring and summer temperatures have risen and the onset of Spring warming occurs

earlier each year (Field & Mortsch, 2007). Since the 1950's, Scientist have observed a 10 to 15 percent decline in Arctic sea-ice, glaciers have diminished, and mountain snow cover in the Northern Hemisphere has decreased by 10 percent (Rosenzweig & Casassa, 2007). Global warming is expected to increase 0.2 degrees Celsius each decade reaching an increase of four degrees Celsius by 2100 (Hultman et al., 2010). Increased temperatures could possibly mean increases in precipitation, longer periods of increased heat waves, greater risks of flooding, changes in hurricane trends, and more severe storms with El Nino patterns (Rosenzweig & Casassa, 2007).

2.3 Stressors and Inhibitors of Climate Change

The gradual transformation of climate change is a result of numerous natural and unnatural stressors on the environment (Howden et al., 2007). As temperatures have increased, carbon dioxide ("CO2") concentrations in the environment have also risen, causing scientist to probe this correlation (Wall & Smit, 2005). Increased levels of greenhouse gas emissions, sulphate aerosols, and possible external forces have also led scientist to conclude that humans have an impact on recent climate change (Field & Mortsch, 2007).

Carbon dioxide levels measure global warming caused by greenhouse gas emissions (Horowitz & Gottlieb, 2010). The burning of fossil fuels account for 80 percent of all U.S. emissions (Horowitz & Gottlieb, 2010). Past greenhouse gas emissions have contributed to 0.1 degrees Celsius of global warming every decade (Howden et al., 2007). The emissions of greenhouse gases are continuing to increase because they can be emitted through numerous ways (Horowitz & Gottlieb, 2010). The decomposition of manure emits greenhouse gases, primarily from cow and sheep manure (Horowitz & Gottlieb, 2010). Increases of CO2 in the atmosphere from the release of greenhouse gases may have different effects on climate change. Farmers emit CO2 when they use gasoline or diesel fuel in vehicles and machinery to cultivate land (Horowitz & Gottlieb, 2010). For instance, a North Carolina farmer estimated that she uses 400 liters of fuel per day to pick cotton (Baragona, 2009).

Consumers and urbanization are two important stressors of climate change that are not predominately recognized as the problem. In the 1950's U.S. scientist Charles Keeling monitored atmospheric CO2 and produced what is known as the "Keeling Curve" (Kolbert, 2006; Pralle, 2009). The Keeling curve demonstrated an alarming trend of increased CO2 emissions over the last half century and negated prior studies that predicted CO2 being absorbed by earth's vegetation and the ocean (Pralle, 2009). Keeling's studies ultimately verified that humans were also contributing to the problem (Abatzoglou, 2007; Pralle, 2009).

As climate change impacts each region of the United States differently, humans tend to migrate and relocate to different areas (Howden et al., 2007). Businesses become inclined to establish subsidiary offices near growing populations, and new infrastructure soon follows in land that were once occupied by animals (Howden et al., 2007). Employee migrations will expand into these new areas and the cycle of urbanization is created (Howden et al., 2007). Scientist looked at the role that urbanization and climate change can have on the environment, particularly soil (Nelson et al., 2009). Buildings absorb heat from the sun and can quickly be cooled off by rain (Nelson et al., 2009). However, the runoff from the rain flows into the soil and can impact the nutrients that are absorbed by the soil (Nelson et al., 2009). Additionally, recent studies have predicted that climate change will have an impact on land suitability for farming and potential agricultural yields (Schmidhuber & Tubiello, 2007).

2.4 The Effects of Climate Change

Climate tends to respond slowly to increases of greenhouse gases in the atmosphere while the aggregate impact on agricultural and economic societies happens abruptly (Tol, 2010). Initial warming and the increase of carbon dioxide in the atmosphere could have positive results for agriculture in the Southeastern United States. More carbon dioxide reduces "water stress" and allows for the faster growth of plants to take place during the photosynthesis process (Long, Ainsworth, Leakey, Noesberger, & Ort, 2006; Tol, 2010). However, the Carbon cycle can be negatively affected by climate change that can prevent soil from retaining both carbon and moisture (Franzluebber, 2010). Cool and dry environments are the most favorable conditions for soil retention of carbon, as opposed to the warm and moist temperatures of the Southeastern Region (Franzluebbers, 2010). The turning point of climate change on agricultural yields occurs when temperatures exceed the 1-2 degree Celsius range and the incremental effects begin to aggregate (Tol, 2010). As temperatures exceed the 2 degree Celsius range the environment becomes more susceptible to wildfires, severe tropical storm and seasonal shifts (Marlon et al., 2008). Increases in wildfires in the western states of the U.S. are reflected in all parts of the nation by earlier Spring and summer temperatures and earlier Spring snowmelt (Marlon et al., 2008). The devastation caused by Hurricane Katrina in New Orleans and along the Gulf Coast of the U.S. is evidence of the effects of warming oceans as a result of climate change (Pralle, 2009).

3. Farmland and Agricultural Yields

As mentioned previously, the effects of climate change on agricultural yields have been documented for 171 years through the Agricultural Census (Vilsack, 2009). The Agricultural Census is the principal source for facts and statistics about the United States' agricultural production (Vilsack, 2009). Since 1982, the Agricultural Census has collected data from producers in five year cycles with years ending in 2 and 7. Before 1982 the Agricultural Census was primarily conducted in years ending in 4 and 9 (Vilsack, 2009). Throughout this 5 year census, producers can evaluate change in yields, scientists can study agricultural systems, and methods to increase yield production are formulated (Vilsack, 2009). Farmland and agricultural yields collected from the Agricultural Census include data from all 50 states, Puerto Rico, Guam, the U.S. Virgin Islands, the Commonwealth of Northern Mariana Islands, and the American Samoa (Vilsack, 2009). Farms in the census included all placed that produced $1,000 or more in agricultural products (Vilsack, 2009). To reduce the number of items to the crops most specific to this review, we closely examined those crops that were dominant among producers in the Southeastern Region.

Agriculture is extremely sensitive to climate change and its subsequent effects (Howden et al., 2007). The El Nino Southern Oscillation system has caused warmer ocean temperatures, cycles of drought, flooding events, extreme hurricanes (e.g., Hurricane Katrina that impacted many Southern states), and a variation in agricultural yields (Howden et al., 2007). Expected higher temperatures and increased rain will mean longer growing seasons and an offset of numerous other problems (Howden et al., 2007). Longer growing seasons could adversely affect crops in the Southeastern region where it is already warm with increases in soil evaporation and the threat of severe droughts (Field & Mortsch, 2007). Experiments have shown that higher CO2 concentrations in the atmosphere may be more beneficial for wheat, rice, and soybeans versus crops such as maize and sorghum (Schmidhuber & Tubiello, 2007). Unpredictable extreme weather could cause fluctuations in crops as higher risks for landslides and damage to soil caused by erosion may arise (Schmidhuber & Tubiello, 2007). Hotter, longer days will cause higher crop yields in colder northern climates and lower crop yields in southern climates (Field & Mortsch, 2007; Schwartz, 2007). Heavy precipitation will lead to soil erosion and waterlogging of soil (Field & Mortsch, 2007; Schwartz, 2007). In contrast, future droughts will result in land degradation, lower crop yields, and increased wildfires (Field & Mortsch, 2007; Schwartz, 2007).

Changes in climate, precipitation, and greenhouse gas emissions have brought tremendous changes to land suitability and crop yields for producers in the Southeastern United States (Schmidhuber & Tubiello, 2007). Forty-one percent of the world's corn and thirty-eight percent of the world's soybeans are produced in the U.S. (Schlenker & Roberts, 2009). The Southeastern Region is a big producer of warmer-weather crops including soybeans, cotton, tobacco and corn (Schlenker & Roberts, 2009). In the 2007 Census, Tennessee ranked fourth in the U.S. for tobacco and fortieth in the Universe for soybeans and Georgia ranked fourth in the nation for its production of cotton and sixth for tobacco (Vilsack, 2009). Studies have shown that an increase in temperature exceeding 29 degrees Celsius for corn, soybeans**,** and cotton can be detrimental to their yields (Schlenker & Roberts, 2009). In 2009, scientists met in Copenhagen, Denmark to assess global warming challenges. Many scientists forecast that farmers would have to adjust to the extreme temperatures based on the varying trends of yields through the analysis of the last three Censuses (Baragona, 2009).

The data recovered from the last three Censuses provide staggering figures that illustrates that the agricultural community is being negatively impacted as the intensity of climate change continues to develop. While the number of farms has increased by approximately 10,000 from 1997 to 2007, the amount of land that has been applied solely for farming has decreased by thirty million acres. As a result of this massive decrease in cultivable land, more than 300,000 acres has been converted to irrigated land and the amount of land being irrigated from 2002 to 2007 climbed. These results are not a direct indication that climate change is the sole reason of this agricultural decline however it is a major factor that can lead to many detrimental effects on the soil, precipitation, and carbon levels. Farmers across the U.S. have seen an overall decrease in most agricultural yields except for cotton (Table 1).

(Insert Table 1 about here)

4. Farmland and Agricultural Yields in the Southeastern Region

The facts of the farmers in the U.S. and the producers in the Southeastern Region have experienced similar decreases in farmland (Table 2). Tennessee experienced the largest decrease in its number of farms with a reduction of more than 10,000 farms. Land in the Southeastern region decreased by more than three million acres across the Southeastern Region alone. These striking figures may not isolate climate change as the culprit, however they do indicate that something drastic has affected the agricultural sector over the past twenty years.

The effects of climate change and other stressors on the agricultural sector provide proof that the need to achieve agricultural sustainability is a legitimate issue that should be addressed immediately (Wall & Smit, 2005).

(Insert Table 2 about here)

4.1 Adaptation Strategies

In the early 1890's Svante Arrhenius, a Swedish scientist, warned about the "'enhanced' greenhouse effect caused by carbon dioxide in the atmosphere" (Abatzoglou, 2007; Pralle, 2009). More than a century later, scientists and policymakers are now beginning to implement international change (Pralle, 2009). The increasing likelihood of climate change trends urge adaptation among producers, agribusinesses, consumers and policymakers. (Howden et al., 2007). Adaptation includes all measures of altering agricultural practices, responses to decision making, and changes in social and building structures that can affect the environment (Adger et al., 2007; Howden et al., 2007). There are many long and short term options for producers to adapt to the changing climate trends (Howden et al., 2007). In the followings, we discuss the various adaptation options from the standpoints of producers, consumers, small businesses, and governments in turn.

4.2 Producers

There have been a plethora of studies and scientific conclusions on the future of climate change and its effect on the environment. However, change can only be accomplished if producers are conscious of this information. The Southeastern Region is known for its hot summers and climate change is predicted to increase these temperatures (Fransluebbers, 2010). Southeaster producers can achieve short-term adaptation practices by simply taking into account local climate trends (Howden et al., 2007). For instance, producers who are most affected by precipitation fluctuations can mitigate these damages by building shelterbeds, an elevated cultivation system, to avoid soil erosion and conserve water (Wall & Smit, 2005). Diversifying crops by planting crops that are more suitable to warmer temperatures can also offset decreases in yields (Wall & Smit, 2005). Producers have also begun staggering their seeding to prepare for the longer growing season, mapping harvesting dates to plant crops later in the growing season (Wall & Smit, 2005). Another immediate change that Southeastern producers can implement is changing the way they cultivate to reduce CO2 emissions. Since soil retains carbon better in cooler, dry environments, it may be economically essential for Southeastern producers to apply organic carbon (Franzluebbers, 2010). This will allow the soil's surface, the area that receives fertilizer, pesticides, and rainfall, a better chance to regulate its natural cycle (Franzluebbers, 2010). Producers can adopt other cultivation methods to reduce fuel usage and improve their overall expected yields (Horowitz & Gottlieb, 2010). Natural gas is a main ingredient in fertilizer (Baragona, 2009). Since manure emits CO2, producers can reduce their use of fertilizer by applying it over time rather than at the beginning of the growing season (Horowitz & Gottlieb, 2010).

Most long term strategies include incorporating knowledge from short term studies. Long-term adaptation strategies consist of radically altering cultivation methods in anticipation of future sustainability. Producers may not find it economically wise to invest in long-term climate adaptation strategies that have not been validated through science (Howden et al., 2007). However, the ultimate financial benefits to achieving sustainability are immense. Long term investments include plant breeding, rotating crops, building infrastructure, and mitigation systems (Howden et al., 2007). Crops vary with the different adaptation strategies and with the predicted rise in temperature and fluctuation in precipitation, it is wise for all producers to monitor closely their previous growing seasons (Field & Mortsch, 2007; Howden et al., 2007). Crop Rotation is a technique that includes a close observation of the soil. Producers are changing the locations of where crops are grown (Schlenker & Robert, 2009). This helps to diversify the nutrients absorbed by the soil and places crops in more suitable locations for greater yields (Schlenker & Robert, 2009). This method takes accuracy and close analysis for it to be economically beneficial (Schlenker & Robert, 2009).

4.3 Consumers

Consumers are strongly linked to releasing carbon emissions in their homes and through personal behaviors outside the home such as driving vehicles (Wells, Ponting, & Peattie, 2010). Factors that influence consumer behaviors are "demographics, attitudes, knowledge, goals, emotions, and circumstances" (Wells et al., 2010). Consumer behavior is shaped by values and their acceptance and awareness of the consequences of their actions (Wells et al., 2010). Similar to producers who must first become aware of their impact on climate change, most consumers do not know how their behavior is impacting the environment (Wells et al., 2010). A 2006 Pew Research Center poll showed that about 19% of U.S. respondents were 'worried about global warming' and a shocking 47% said that they were either 'worried a little' or 'not worried about it at all' (Gallup, 2008; Pew, 2006; Pralle, 2009). In 2007, 41% of U.S. respondents said that they were 'worried a great deal' about global

warming, however these numbers dropped to 37% and 34% in 2008 and 2009 respectively (Gallup, 2008, 2009; Pralle, 2009). A latent public concern about global warming is the first issue that must be addressed in order to adopt adaptation strategies (Pralle, 2009).

"Sustainable consumption behavior" is a policy that can be enforced to mitigate the damages caused by consumers (Jackson, 2005; Wells et al., 2010). Pro-environmental behavior is an area that needs to be researched and understood for "sustainable consumption behavior" to be practiced correctly and fully recognized (Wells et al., 2010). People are less likely to give immediate support to issues when there is uncertainty about the scientific evidence (Leiserowitz, 2007; Pralle, 2009). However, strategies must be implemented to encourage consumers that future climate change impacts must be tackled by immediate change, using metaphors and analogies, clarity of communication or target techniques for specific audiences (Pralle, 2009; Stone, 1988).

Consumers play a major role in setting the national mood and attracting policymakers' attention to certain issues (Pralle, 2009). International mitigation strategies have been executed with the 1992 Earth Summit and the 1997 Kyoto Protocol (Pralle, 2009). For instance, the European nations have recently increased their awareness of the correlation between consumer behavior and climate change and began the campaign *You Control Climate Change* (Sustainable Consumption Roundtable, 2006; Wells et al., 2010). This campaign was geared towards motivating consumers to take responsibility of climate change and turn down the home thermostats, turn off appliances, recycle, and walk instead of driving their vehicles (Sustainable Consumption Roundtable, 2006). However national strategies closer to home can be also implemented by public concerns and interest for change (Pralle, 2009). If the public loses interest in climate change issues, then the government will lose interest as well. "Problems without attached solutions are less apt to rise high on governmental agendas and are unlikely to make it onto decision agendas at all" (Kingdon, 1995; Pralle, 2009). It is up to the public and the media to heighten awareness of global warming and its impact on the environment. Increasing consumer awareness of future impacts is a key and can be achieved through environmental advocacy groups, scientists and journalists (Pralle, 2009).

4.4 Businesses and Transportation

Climate change is an economic issue. Reports indicate that global warming promises more expensive energy use (Tol, 2010). There are estimates that the "impact of three degrees Celsius global warming is as bad as losing 1.4% of income" (Tol, 2010). Green house gases are predominately emitted from high-income countries, such as the U.S., while low-income countries are impacted the most (Tol, 2010). It is important for businesses to recognize their impacts worldwide to address the problems happening at home (Tol, 2010). Businesses must evaluate their vulnerability and part in climate change to formulate sustainable strategies. Climate change will impact the amount of agricultural output from producers and the demand for these essential needs around the world (Tilman et al., 2002). Businesses are beginning to change their means of transportation by increasing their use of hybrid cars (Porter & Reinhardt, 2007). This helps the business economically by using the most efficient cars and will reduce the amount of CO2 that is emitted into the environment in the long run (Porter and Reinhard 2007). Businesses can also improve their resistance to climate change by developing strategies for the future based on the information already available in the Intergovernmental Panel on Climate Change (IPCC) reports and past Censuses. Businesses and policymakers can form partnerships to educate one another and provide policies to promote climate awareness and plans that can be used by producers to adapt to climate change (Schwartz, 2007). Some optimistic articles suggest that climate change could have positive impacts on certain business sectors. Tourist may drive to northern states to vacation during the summer months as global warming heats up the Southern states and causes earlier spring and summer temperatures across the nation (Tol, 2010). This shift if tourism will cause a redistribution of revenues for many northern states (Tol, 2010).

4.5 Government and Public Policy

The level of future emissions and emission-reduction agreements caught political concern on an international level in the early 1990's. (Howden et al., 2007; Pralle, 2009). More than 150 countries, including the United States, signed the United Nation's Framework Convention on Climate Change (the "UNFCCC") at the 1992 Earth Summit (Pralle, 2009). The Kyoto Protocol was created by the UNFCCC in 1997 as an international agreement that commits countries to reduce greenhouse gas emission by five percent of 1990 level during the five year period of 2008 to 2012. The Protocol was designed to help developed countries mitigate the effects of climate change (Pralle, 2009). Under the treaty, the countries must commit to submitting and meeting emission targets (Pralle, 2009). In 2009, members of the UNFCC met in Copenhagen, Denmark to discuss the global climate agreement that is soon expiring (Vidal, Stratton, & Goldenberg, 2009). The agreement aimed to provide $30 billion a year by 2012 for developing countries to adapt to climate change as a result of developed countries

and $100 billion a year by 2020 (Vidal et al., 2009). A proposal to reduce carbon emission by 80% by 2050 failed (Vidal et al., 2009). The fast growing nations of China and India insisted on remaining exempt from the stringent agreement in regards to developed nations standards and the fast concerns of the expiration of the Kyoto Protocol were not settled (Vidal et al., 2009).

In 2010, the UNFCCC met again in Cancun, Mexico for the Cancun Conference to discuss climate change (Goldenberg, 2010). At the Cancun Conference a green climate fund was created to help developing countries fight against climate change (Goldenberg, 2010). The fundamental questions of the soon to expire Kyoto Protocol were not discussed (Goldenberg, 2010). Tension was reached at the conference as Japan and Russia both announced that they would not sign on to the Protocol for a second term unless China and the United States were "legally bound to action" (Goldenberg, 2010). Therefore, the next meeting of the UNFCCC in later 2011 in Durban is the last opportunity for the countries to deal with the Protocol and immediate climate concerns (Goldenberg, 2010). A legally binding agreement of greenhouse gas emissions is a concern that many countries either want or fear (Goldenberg, 2010). The agenda for Durban is to discuss methods to cut greenhouse gas emissions, increases clean energy, and mitigate global warming (Goldenberg, 2010). The United States never fully ratified the Kyoto Protocol, which is not a legally binding agreement, and there are fears that they will not agree to a future Protocol (Goldenberg, 2010).

Recently, President Barack Obama's administration is seeking to pass "legislation mandating caps on carbon emission" (Pralle, 2009). These efforts to promote policies for agricultural sustainability by reducing the cap of greenhouse gas emissions have been slowly progressing (Howden et al., 2007). Policymakers are greatly concerned with the national mood via public opinion polls and legislate accordingly (Pralle, 2009; Zahariadis, 1999). A legally binding climate agreement could place the United States in grave danger of being subject to international authority. The American economy would no longer be solely controlled by the government and national security risks would heighten.

While the government's main concern has been ensuring that the promotion of sustainable development will meet the needs of future food security, it is important that national morale regarding climate change remains high so that this concern remains at the forefront of the political agenda (Howden et al., 2007; Pralle, 2009). Hurricane Katrina put climate change on the U.S. political agenda in 2005 after it caused more than $80 billion in damages and killed more than 1,800 people (Busby, 2008). An anti-government reaction from the citizens may cause a laissez-faire attitude by the government and prevent proposals or policymaker from intervening (Pralle, 2009). The balance of interest between consumers and policymakers can be directly and indirectly addressed through government interaction with the citizens (Pralle, 2009). Adopting mitigation policies will help to lower the costs and risks associated with adaptation (Howden et al., 2007). Policymakers can enhance their knowledge of future climate change by working with environmental advocacy groups, consumers, scientists, journalists and cabinet members to produce national adaptation and mitigation strategies (Pralle, 2009; Sabatier & Jenkins-Smith, 1993).

5. Conclusion

Agricultural yields across the nation have been impacted by the stressors of climate change. Scientists have confirmed that global warming is expected to increase at least 0.2 degrees Celsius each decade. Producers, consumers, and businesses have been and will continue to be directly impacted by the effects of global warming. The evidence has verified that climate change is an unpredictable force of nature (e.g., hurricanes, droughts, precipitation fluctuations, and temperature increases). Past agricultural yields show that even the crops most suitable for warmer weather are already declining in the Southeastern Region. Producers are immediately affected however billions of people around the world who depend on these outputs will also be impacted. Agricultural sustainability is essential for the vitality of life as we know it and for more than two million producers. Climate awareness if its impacts on agriculture by consumers, producers and policymakers are essential to develop adaptation strategies to mitigate the effects of climate change.

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Table 1. Farmland and Agricultural Yields

Category	**2007**	**2002**	**1997**
Farms (number)	2,204,792	2,128,982	2,215,876
Land in farms (acres)	922,095,840	938,279,056	954,752,502
Total cropland farms (number)	1,685,339	1,751,450	1,857,239
Total cropland (acres)	406,424,909	434,164,946	445,324,765
Harvested cropland (acres)	309,607,601	302,697,252	318,937,401
Irrigated Land (acres)	56,599,305	53,311,236	56,289,172
Selected Crops:			
Oats for grain (farms)	42,558	63,763	94,811
Oats for grain (acres)	1,509,149	1,996,916	2,739,810
Oats for grain (bushel)	89,508,669	109,840,449	154,654,269
Barley for grain (farms)	19,848	24,747	43,269
Barley for grain (bushels)	207,089,232	214,800,035	346,413,080
Cotton, all (farms)	18,605	24,805	33,640
Cotton (acres)	10,493,238	12,456,162	13,897,404
Cotton (bales)	18,898,128	17,145,345	18,706,703
Tobacco (farms)	16,234	56,977	93,530
Tobacco (acres)	359,846	428,631	837,363
Tobacco (pounds)	778,301,825	873,350,412	1,744,192,909

(Source: US Department of Agriculture)

Table 2. Farmland Dimensions

State	**Item**	**2007**	**2002**	**1997**
Tennessee	Farms #	79,280	87,595	91,536
	Land in Farms (acres)	10,969,798	11,681,533	11,986,258
	Average size of farms (acres)	138	133	131
Georgia	Farms #	47,846	49,311	49,343
	Land in Farms (acres)	10,150,539	10,744,239	11,262,838
	Average size of farms (acres)	212	218	228
Florida	Farms #	47,463	44,081	45,808
	Land in farms (acres)	9,231,570	10,414,877	10,659,777
	Average size of farm (acres)	195	236	233
Alabama	Farms #	48,753	45,126	49,872
	Land in farms (acres)	9,033,537	8,904,387	9,517,377
	Average size of farms (acres)	185	197	191
South Carolina	Farms #	25,867	25,541	25,807
	Land in farms (acres)	4,889,339	4,845,923	4,974,138
	Average size of farms (acres)	189	197	193

(Source: US Department of Agriculture)

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