Hydroponic Farming: Let’s Cool Things Down A Bit

Agriculture is always an important part of every society. The survival of a country greatly depends on the ability to grow and produce food, and the United States is no exception. Agriculture played an important role in the development of America from early on. Prior to the 1800s, ninety-eight percent of Americans were farmers ("National"). Over the last two centuries, that number has dropped to two percent, largely in part to the industrial revolution and modernization offering jobs and opportunities for people to move into the cities ("National"). There have also been a lot of political factors that have affected the numbers of farmers and farms in America. Large corporations bought multiple small family operated farms and turned them into massive, sprawling farms, driving some of the remaining family operated farms out of business due to their inability to compete with the production levels of the large corporate farms. Today, America produces not only enough food to feed its more than three hundred million inhabitants but to feed countless others around the world. Production this high requires the estimated nine hundred million acres, currently being farmed in America ("U.S."). In addition to this large amount of land, many other things go into producing food at such a high level. There are the basic farming necessities like fertilizer, seeds, equipment, and water, but there is also something that is often not thought about or is totally underestimated: the amount of fuel and chemicals used in the agriculture industry. These two items, in conjunction with poor farming practices, are adding greatly to the world's detriment by way of adding to the growing amount of greenhouse gas that is flooding into the atmosphere and contributing to global warming. There is
a solution to this problem although it may not be easy to implement. Instead of traditional farming, or rather what has become traditional farming, farmers can switch to hydroponic farming, which can greatly reduce agriculture’s contribution of greenhouse gas.

Many scientists believe greenhouse gas emissions are contribution to global warming, and if global warming continues, agriculture, and the world, as we know it could be severely affected. According to Julian Cribb, author of *The Coming Famine: The Global Food Crisis and What We Can Do to Avoid it* (2010), if the greenhouse gas emissions are not reduced, the whole world will suffer dire consequences. If the greenhouse gas emissions are not reduced, then global warming will continue, resulting in climate changes, which will render much of the land currently being farmed unusable (Cribb 136). This will result in massive food shortages around the world causing not only hunger but the massive relocation of entire populations, which can lead to tension and violence. Cribb argues that there will be a global shift in food production in which countries of the northern hemisphere will gain more farmland while countries of the southern hemisphere will experience the loss of farmland (142). The northern regions will then be responsible for providing food for the southern regions, which has been unsuccessful in history (142).

The carbon levels in the air are the biggest concern to scientists currently. Scientists who study climate find that if carbon levels in the atmosphere reach four hundred fifty parts per million, as opposed to the current three hundred eighty seven parts per million, temperatures are expected to rise anywhere from three to four degrees by the year 2050 (Cribb 144). Currently the world emits approximately one part per million of carbon every four months, which means levels will reach four hundred fifty parts per million by the year 2030 (144). The only way to avoid the
atmospheric carbon levels reaching this point is to reduce carbon emissions by eighty percent (144). A good place to start this reduction is in the agriculture industry.

Carbon dioxide, CO$_2$, is the most abundant greenhouse gas in the atmosphere, and agriculture produces ten percent of all CO$_2$ emissions (Dendooven et al. 232). CO$_2$ accounts for only one third of all greenhouse gasses emitted by agriculture (232). One particular, very old, agriculture practice is to blame for CO$_2$ emissions: tilling the land. Tilling the land is the process of basically breaking up the soil and turning it in order to plant seed. The problem here is that carbon, C, is stored in the ground and released into the atmosphere any time the soil is disturbed. The carbon which is released into the air can now combine with oxygen, O$_2$, and form carbon dioxide, CO$_2$. This was proven in an experiment conducted by L. Dendooven and associates in the central Highlands of Mexico. The experiment consisted of monitoring the CO$_2$ emissions that were given off by multiple plots of agricultural lands, which had been tilled at varying amounts, from no tilling at all, to standard tilling, to excessive tilling. The researchers found that the land where the least amount of tilling took place had the lowest amount of CO$_2$ emissions and the CO$_2$ emissions increased in accordance with the amount of tilling (Dendooven et al. 236).

The other two thirds of greenhouse gas emissions from agriculture are from nitrous oxide, N$_2$O, which is also from farming practices (Johnson 4). Much in the same way CO$_2$ is emitted, N$_2$O emissions are also caused by tilling, but there are several other practices which contribute to the release of N$_2$O into the atmosphere as well. Many of the chemical fertilizers which are being used today contain nitrogen (Johnson 4). Nitrogen, much like carbon, can bind to oxygen in the atmosphere to form N$_2$O. Another way N$_2$O is formed is by irrigation, which is obviously a very important part of agriculture (Johnson 4). N$_2$O emissions as a result of irrigation happens in two ways, the first being erosion exposing the nitrogen in the soil, which is then available to bind
with oxygen in the atmosphere, forming N\textsubscript{2}O. The second is when chemical fertilizers are carried away by irrigation or rain and the nitrogen within the fertilizer either binds with atmospheric oxygen or oxygen from the water that is carrying it away, forming more N\textsubscript{2}O. Avoiding the use of chemical fertilizers altogether would greatly reduce the N\textsubscript{2}O emissions.

Switching from current agriculture practices to hydroponic farming can reduce the amount of CO\textsubscript{2} and N\textsubscript{2}O emissions substantially. Hydroponic farming is a farming technique in which “ecosystems that are influenced by humans” are used to produce food from raw materials void of soil (Busby). Several different hydroponic farming systems fall under the category of hydroponic farming. The Ebb and Flow system is a system in which plants are grown in a “growing medium,” which consists of minerals, solutions, or fibers, as well as many other media aside from soil (Busby). The medium and plant are placed in a tray which has a nutrient solution pumped into and then drained out of at timed intervals; the drained solution is then recycled and used again (Busby). An aeroponic system is a system in which the root systems of a plant are housed in an aeroponic compartment and gently sprayed with a nutrient spray, and any excess spray is then collected and recycled as well (Busby). Seeing as hydroponic farming does not involve soil, no CO\textsubscript{2} is emitted from tillage. N\textsubscript{2}O is also not emitted from the use of fertilizer because fertilizer is not used in hydroponic farming in the same way it is used in traditional farming (Busby). Everything the plant needs is provided in the nutrient solution, including the fertilizer (Busby). Since the solution is recycled, runoff does not exist, and the N\textsubscript{2}O does not find its way into the atmosphere. Switching to hydroponic farming can reduce both CO\textsubscript{2} and N\textsubscript{2}O emissions, but that leaves the question of if a switch of that magnitude can be done or if it is even feasible.
The question of feasibility in this paper is in reference to whether or not enough food can be produced hydroponically to support the United States and if the quality of that food is comparable to that of the food which is currently produced using traditional farming practices. Hydroponic farming can typically yield more produce per acre than traditional farming ("Alaska"). This is largely in part to proper management and use of space. Currently, one hydroponic operation alone in Alaska is growing enough lettuce to provide for the entire state ("Alaska"). Chena Hot Springs Resort in Alaska is a greenhouse that operates all year to produce baby salad green, herbs and lettuce ("Alaska"). The reason they are able to keep up with the demand of such produce is proper use of space ("Alaska"). Not only do they have an Ebb and Flow system on the floor of the greenhouse, they also have them mounted on the walls and stacked to maximize production ("Alaska"). If produce can be produced year round in Alaska despite the elements, it is perfectly reasonable to say that produce can them be produced anywhere. There are many urban farms already up and running, meaning that farming can now be done in the middle of a city, resulting in more available farmland.

As far as the quality of the produce, it is quite comparable with the ability of being superior. Plants intake nutrients through their roots as well as other substances that are not necessary to the growth and development of the plant (Raviv and Lieth 293). In the book Soilless Culture: Theory and Practice (2008), authors Michael Raviv and Johann Lieth argue that “soilless culture methods offer unique capabilities to control […] nutrient concentrations in the root zone” (292). The fact that the plants grown in hydroponic systems are provided with controlled nutrition means that the plants have the nutrients necessary for proper growth and development readily available, while the unnecessary substances can be eliminated. With the
ability to produce an optimal amount of quality produce, it would appear entirely feasible, as far as quality is concerned, to switch to hydroponic farming.

Initiating a change of such massive proportions would be somewhat of an uphill battle with a lot of possible objections to consider. The first and probably most prevalent would be the financial cost. It does not matter what change is taking place, but with such a sizeable change, the cost would be astronomical. One way the cost could be offset is through government subsidies, and if the switch to hydroponic farming were spread out over twenty years, some of the financial pressure could be offset as well. Another objection that may be had is the fact the disease among plants spreads much faster through a hydroponic system due to the shared water source. With proper care, the spread of disease can be controlled. The last possible problem with implementing the switch to hydroponic farming, could be getting the agriculture industry on board in the first place. According to Dr. Randall Beeman, PhD Agriculture History, “the idea would have to be, not only adopted by the system, but by land grant colleges and various other entities, as well as the greater public (Beeman). Basically, this means the agriculture industry, the government, and the public would have to agree to such a change. There are a great deal of people who do not believe global warming exists making the switch a very hard sell as far as the public is concerned. The farmers also have to be considered; many farmers are farmers whose families have been farming for many generations making many of them more than likely resistant to change. Dr. Beeman thinks the hardest sell is most likely to agribusinesses (Beeman). Some of the larger agriculture based companies could stand to lose substantial amounts of money if the switch hydroponic farming was implemented (Beeman). For example, less fertilizer is used in hydroponic farming, so it would be unlikely that fertilizer producers would jump on board and support the switch.
Even though initiating such a change could prove impossible, the fact still stands that hydroponic farming could reduce greenhouse gas emissions associated with agriculture. If the switch from current agriculture practices to hydroponic farming is not made, the greenhouse emissions associated with farming will continue to climb as the need to produce more food rises.
Works Cited


Beeman, Randall. Personal Interview. 2 Dec. 2013


