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Adopting Sustainable Agriculture in Order to Recover the Environment

Introduction

Agriculture practices changed drastically proceeding World War II coinciding with the eruption in birth rate that created the generation known as the "baby boomers". According to Richard Fry, in 1946, 3.4 million babies were born, increasing the population by 20%. This trend continued for several years following the war, and, by 1964, these "baby boomers" made up almost 40% of the United States' population (Fry 2016). In less than 20 years, the nation's population had grown by 76.4 million, generating the need to find newer, better ways to produce food in less time, with less land, and less labor than ever before, all of which resulted in the industrial revolution in agriculture. The industrial revolution of agriculture was highly efficient in achieving all of those goals, which were able to be completed due to the introduction of fertilizers and pesticides used in crops, medication and hormones used in livestock, and new farming practices, like monoculture crops. Though industrial agriculture was effective in creating a new food system that could feed such a large population, it was ineffective in leaving the environment in a state in which other organisms could thrive. Industrial agriculture is a main contributor to climate change, destruction of marine and terrestrial ecosystems, degradation of soil, and loss of biodiversity, all of which are threatening the survival of thousands of organisms across the globe. Industrial agriculture is thought to be exceedingly productive, yet nearly 800 million people a year still go starving (World Food Programme 2016). The agriculture system

needs to be altered in order to improve the state of the environment by implementing more sustainable growing techniques.

Current State of the Environment: Climate Change

Industrial agriculture poses a great threat to the environment because of its destruction of natural habitats through deforestation, overconsumption of water in the production of crops, degradation of soil through the clearing and over-plowing of topsoil, and depletion of biodiversity due to the implementation of monoculture crops. Of these practices mentioned, deforestation is considered to have the largest impact on the environment, for it is responsible for about 14% of global greenhouse gas emissions (World Wildlife Foundation 2016). Greenhouse gases, like carbon dioxide, are emitted into the atmosphere when fossil fuels are burned during the clearing of forest brush and through the transportation of lumber to markets. Additionally, livestock production in the modern agriculture system accounts for 18% of all greenhouse gas emissions, most prominently with the emission of methane in animal manure (Food and Agriculture Organization 2016). The emission of these greenhouse gases into the atmosphere from industrial agriculture contributes to climate change. According to Lester Brown of the Earth Policy Institute, "since 1970, the earth's average temperature has risen more than 1 degree Fahrenheit…[and] it is projected to rise by some 11 degrees Fahrenheit by the end of this century" (Brown 2012, 83). Through rising temperatures, climate change poses a great threat to the global ecosystem, as it disrupts pollination, reduces photosynthesis, reduces crop yields, melts glaciers, leads to rise in sea level, and intensifies heat waves. Rising temperatures present the greatest threat to the health of the global environment; however, climate change is not the only environmental factor threatening ecosystems.

Current State of the Environment: Degraded Soil

In addition to contributing to climate change, industrial agriculture also poses a great threat to the health and fertility of soils. Many industrial agricultural practices factor into the degradation of soil including deforestation for land conversion, overgrazing by livestock, use of chemicals in crops, over-application of water to fields, and over-plowing of crops (World Wildlife Foundation 2016). Today, nearly 30% of total global land area is degraded and this "accelerating loss of topsoil is slowly…shrinking [the] area of productive land" that can be used to produce food for the large population that inhabits Earth (Brown 2012, 56). This loss of productive land is due to desertification, a process in which fertile land becomes desert. Additionally, degraded soil is subject to erosion, which can have a major impact on surrounding ecosystems. For example, eroded soil often ends up in nearby streams or other marine ecosystems, leading to sedimentation. Sedimentation can "accelerate bank erosion, obstruct stream and drainage channels, fill in reservoirs, damage fish habitats, and degrade downstream water quality" (Ritter 2015). Additionally, fertilizers and pesticides are frequently transported along with eroded soil, causing the contamination of marine ecosystems through either poisoning of organisms because of their consumption of pesticides or through the growth of algal blooms through absorption of nutrients from fertilizer.

Industrial Agriculture: Use of Chemicals

Chemicals, such as pesticides and herbicides, are often applied to crops in order to deter other organisms from consuming the crops, thus improving crop productivity. Furthermore, chemical fertilizers are used to add nutrients to the soil that many plants thrive on, specifically nitrogen, potassium, and phosphorous. In retrospect, use of these chemicals can be productive without causing much harm to the environment when using the recommended amount. However, in both large and small-scale farms alike, chemicals tend to be overused within today's practice

of agriculture, where the goal is to produce as much product as possible. According to a study published in the *CIGR Journa*l by Faiz Syuaib, in response "to governmental encouragement to succeed growing agricultural productivity" the "Green Revolution" began, and ever "since the so called 'Green Revolution' program launched in [the] late 60s, application of chemical fertilizers was dramatically increased" (Syuaib 2016, 177). Use of both pesticides and fertilizers in fields may allow farmers to produce more food in their fields, but not without placing harm into other surrounding ecosystems.

Environmental Impacts of Pesticide Use

Pesticides and fertilizers are often carried away from fields in rainwater and irrigation runoff, as farmers frequently apply more chemicals than actually needed to obtain the desired outcome. This runoff often pollutes waterways and contaminates groundwater sources, thus harming wildlife. Additionally, pesticides have a tendency to poison, or even kill, more than just the target pest. The non-specific killing disrupts other natural ecosystems by killing other organisms that may play a crucial role in their environment. The most famous example of the effect of widespread killing due to pesticides was studied by Roy Barker in in *The Journal of Wildlife Management.* Barker studied the use of the pesticide dichlorodiphenyltrichloroethane, also known as DDT, in agriculture. Through his study Barker found that other non-target insects would consume plants covered in DDT and would carry DDT particles within their body until they were consumed by small birds. The DDT then biomagnified in these small birds, meaning that the concentration of DDT in their system persisted and multiplied, until they were later consumed by other, larger birds, such as hawks. This increased concentration of DDT in the hawk's biological system caused weakness in the shells of their eggs, substantially reducing their population (Barker 1958, 269-271). This example shows the harmful effects that pesticides exert

on the whole entire biosphere, rather than only affecting the target pest, which can vastly deteriorate the health of the environment.

Environmental Impacts of Fertilizer Use

Fertilizers, in addition to pesticides, pose a great threat to the environment even though they are not directly toxic to animal and plant species. Rather, fertilizers alter the nutrient system of which they are introduced, either intentionally by application or accidentally in runoff. Fertilizer transported in runoff has a huge effect on marine ecosystems; the additional nutrients found in fertilizers are absorbed by the plant species in the water, in a process known as eutrophication. Plant species, like sea grass or algae, grow densely, block sunlight, and absorb a majority of the oxygen, thus leading to the death of many animal species in the ecosystem, creating areas classified as dead zones. Dead zones occur in many places throughout the world, including the entire bottom of the Baltic Sea, the Gulf of Mexico, and the Chesapeake Bay (National Ocean Service 2014). According to the National Ocean Service, "there are many physical, chemical, and biological factors that combine to create dead zones, but nutrient pollution is the primary cause of those zones." (National Ocean Service 2014). Dead zones are an extreme example of the impact that fertilizers can have on surrounding ecosystems. Fertilizers also have the capability to deteriorate soil fertility by disproportioning the natural nutrient system, which consequently increases the demand for fertilizer application to crops, creating a positive feedback loop of fertilizer use. Similar to pesticides, the environmental impact of fertilizers is not confined to the local environment, but instead, the entire world.

Sustainable Agriculture Growing Techniques: Crop Rotation

The problems associated with climate change and degradation of soil can be mitigated by adopting sustainable growing techniques that improve crop productivity without causing harm to

the environment. One effective sustainable growing technique is crop rotation, which is an agricultural practice in which different crops are grown on the same ground in sequencing years. According to the College of Agriculture and Life Sciences of North Carolina State University, crop rotation improves soil quality, mitigates the build-up of pathogens or pests, and replenishes nitrogen in the soil, thus decreasing the need for synthetic chemicals in crops. In addition to reducing the reliance on synthetic chemicals, crop rotation has also shown "yield increases of 10 to 15 percent in soybeans and corn when rotation is utilized." Other studies have shown that planting alfalfa, corn, oat, and soybean considerably increased the abundance of nitrogen in the soil, as opposed to when a single crop was grown continuously (Cothren 2016). These findings confirm that, in addition to maintaining high crop yields, sustainable growing techniques can be used to improve the environment by producing less pollution due to synthetic chemicals, increasing biodiversity by diversifying crops, and by improving soil quality, which can also reduce pollution.

Sustainable Growing Techniques: Integrated Pest Management

Another form of sustainable agriculture that can be used to improve the state of the environment is integrated pest management. Integrated pest management "focuses on prevention [of pests] by removing conditions that attract pests," such as, reduced clutter, sealed growing areas, and installing "pest barriers" (Environmental Protection Agency 2016). Pest barriers consist of other plants that are aversive to specific pests that have a tendency to consume crops. Integrated pest management decreases the reliance on chemical pesticides used in crops, thus decreasing the pollution to waterways that would result from spraying pesticides, as well as decreasing the likelihood of other organisms becoming poisoned by consuming pesticides. According to a study done by Arden Colette that analyzed environmental impacts of integrated

pest management, by utilizing integrated pest management, the number of pesticide applications can be reduced from 3-4 applications, to 1-2 applications. This could lead to an estimated savings of more than $175 million, in respect to production and environmental costs, in an area of 3.82 million acres. Additionally, in the Texas Panhandle, an area where these practices are well utilized, "the production of the four major crops; corn, cotton, sorghum, and wheat has increased dramatically" (Colette, Almas, Schuster 2001). Similar to crop rotation, the employment of integrated pest management can reduce pollution due to the reduction of pesticide use and can increase biodiversity by growing numerous crops in the same relative area. Increase in biodiversity and reduction in pollution are the driving forces to an improved health quality of the environment, and can be accomplished by the utilization of sustainable agriculture practices.

Sustainable Growing Techniques: Cover Crops

Cover crops can also be used to improve soil health, manage erosion, control pests and diseases, and increase biodiversity (Bjorkman 2009). The most common types of cover crops used in the United States are grasses, legumes, and, less commonly, brassicas or buckwheat. These cover crops help to improve soil health by adding nutrients to the soil, holding soil in place as to avoid erosion, and increasing water infiltration through the soil. According to a study done by the Ohio State University, it was found that cover crops can "reduce nutrient and pesticide runoff by 50% or more, decrease soil erosion by 90%…and reduce pathogen loading by 60%" (Hoorman 2009). Improved soil health, in regards to stability and nutrient-richness, can benefit the environment substantially; with added nutrients to the soil, there is a reduced need for the application of fertilizers to fields, and, with stable soil, there is decreased risk of erosion. The

combination of these benefits results in less pollution to marine and terrestrial ecosystems, thus resulting in a healthier environment for organisms to thrive and expand.

Sustainable Growing Techniques: Crop Diversification

Crop diversification is another common practice in sustainable agriculture that decreases the need for pesticides and fertilizers to be used on crops. Crop diversification is the "practice of growing more than one crop (or enterprise) in any year to increase financial and biological stability of the farm" and is a culmination of many agricultural practices, including crop rotation, integrated pest management, and cover crops (Johnston, et al 1995). Furthermore, diverse crops are more stable than monoculture crops, for crop losses and price fluctuations could potentially put a farm out of business, whereas a diversified farm would have other crops to make up for those potential losses. It is necessary to increase biodiversity, for a lack thereof makes a habitat more susceptible to destruction by other organisms or natural disasters, thus threatening food security, which is essential, as "the world is now living from one year to the next, hoping always to produce enough to cover the growth in demand" (Brown 2012, 5). The practice of crop diversification can reduce the amount of fertilizers and pesticides applied to crops, improve biodiversity, decrease water consumption, and improve soil health, thus leading to a healthier environment.

Sustainable Agriculture: Limiting Chemical Use and Benefits

By utilizing the aforementioned sustainable agricultural techniques, the reliance on chemicals used in crops is greatly reduced. In response to reduction of chemicals being applied to crops, marine ecosystems and soil fertility will have the ability to return to their stable conditions. Many farmers and policymakers fear that sustainable agriculture practices will lead to increased costs in production. A study done by David Pimentel found that reducing the use of

pesticides in crops in the United States by 50% would result in an increase of $1 billion spent to control pests without with nonchemical alternatives, similar to peoples' fear. However, the environmental and social costs of pesticide use, like poisoning of organisms, would be decreased by approximately 50%, thus offsetting the added cost for nonchemical alternatives (Pimentel, et al 1991, 406-407). This shows that by adopting sustainable agriculture techniques, such as reducing the use of synthetic chemicals in crops, there is theoretically no change in monetary costs, but substantial decreases in environmental costs. Additionally, in a study done by William Mitsch, it was found that by changing farming practices, specifically, nitrogen management, alternative cropping systems, improved management of animal manure, and increased spacing of farm drainage tiles, up to 2.4 million metric tons of nitrogen fertilizer could be saved each year (Mitsch 2001, 382). The possible reduction in the use of fertilizers could lead to "reduced river pollution…improved river ecosystems…enhanced terrestrial wildlife…[and] mitigate the effects of floods" (Mitsch 2001, 384). By reducing the use of pesticides and fertilizers, money can be saved through a decreased demand for synthetic chemicals, soil fertility can be increased, and marine and terrestrial ecosystems can recover.

Conclusion

The food and agriculture system has changed immensely since the mid-1900s in order to feed the large population that now occupies the United States, as well as other parts of the world. These changes have proved to be very detrimental to the health of the environment, for natural habitats continue to be destroyed with conversion of land, water is continuously used unsparingly in an attempt to make production easier, soil is degraded with overproduction of monoculture crops, and biodiversity in the agriculture sector has been lost with unnatural selection for single crops. By practicing sustainable agriculture, such as adopting new farming techniques or limiting

the use of pesticides and fertilizers, the impacts on the environment due to industrial agriculture can be diminished. Though sustainable agriculture does not necessarily have the same capabilities as industrial agriculture with respect to the consistent amount of food it can produce, it does have the capability to produce food security. "[Reaching towards the goal of sustainable agriculture] is the responsibility of all participants in the system, including farmers, laborers, policymakers, researchers, retailers, and consumers" (Feenstra, et al 2016). Revolutionizing the agriculture system is the first step that can be taken in order to improve the state of the environment, for it was the old system that generated so many health risks and complications into the environment upon its origin.

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