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A Place for Organic Farming in the Big Market?

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The origin of agriculture can be traced back to approximately 10,000 years ago in Mesopotamia (present day Turkey, Syria, and Jordan) and the original “crops” were edible seeds collected by hunter-gatherers (Unsworth 2010). Prior to the development of the types of crops typically seen today, ancient humans relied on this way of agriculture of hunting and gathering in order to survive. Humans of this time were of a nomadic life and by moving they were able to continue to locate food sources. They were at the mercy of nature to provide their food. Interestingly, ancient hunter-gatherers did not eat alot of cereal grains, and since they have lower amounts of micronutrients, Kious (2002) believes that they may not provide the same protection from disease. Farming a controlled area requires more labor than hunting and gathering therefore ancient humans most likely did not make the change to an agricultural way of life readily. However, necessity moved them toward agriculture and between 8000 and 3500 BC, humans shifted to the use of farming techniques (Guisepi, n.d.). From this point on, the incorporation of farming into the daily life of humans along with improvements in the farming world allowed increased quantities and better quality products, while reducing the amount of required labor. Obviously, pests would affect these early crops and diseases, much like crops today are impacted, although to a greater degree. A loss in the past caused famines, and therefore farmers were motivated to finding ways to decrease their losses. Historically, insecticides are recorded back 4500 years ago, and were of a natural origin. Ancient “agrochemicals” included smoke, tar, and salt or seawater, pyrethrum (derived from dried flowers), powder, and inorganic chemicals, some of which are still used today. In fact, up until the 1940’s, farmers used mostly inorganic chemicals, including DDT. With the advent of agrochemicals and the use of these artificial or synthetic chemicals for fertilizer and pesticides in the mid-1800s, farming began to take on a look similar to what we see today (Tyagi, 2016). A person so inclined, may trace American farming and, more specifically, agriculture and its beginnings in America throughout history since our nation's founding. As early as the 17th century, land grants offered in the United States were an effort to bring settlers to this land. As farmers began to grow more crops, the need for agrochemicals, as well as, technological improvements continued to grow. All farming practices evolved over time with improvements in farming techniques and tools. Agricultural farmers were able to cover more ground more efficiently due to these tools and techniques, as well as, other advancements in crops and chemicals lessened the workload.

Farming is as vital to human existence as the air we breathe, and in turn, farming can and does definitely affect the air we breathe. It keeps our planet going and is a worldwide necessity and without farming, the human race would rapidly cease to exist. There is, however, debate regarding if we can continue to exist with the current farming practices found in the majority of farms worldwide and particularly within the United States. Therefore, the need to adapt and/or to control the natural impacts on farming is an ongoing and vitally important endeavor. The primary focus of this writing will be to look at aspects of farming and attempt to ascertain the possibility of increasing organic technique use in the commercial conventional farming arena. If the commercial farming arena will ever make a change to organic farming practices here in the United States, we must look at all aspects of farming in an effort to make an informed decision. Therefore, an understanding of the history of farming, soil health the carbon cycle, in all types of farming are all-important pieces of the farming puzzle.

Farming is a simple word; however, when researching farming in depth the words are many: agriculture, farming, husbandry, organic, inorganic, arable, pastoral, sustenance, and commercial, just to name a few. The definition of farming is "the practice of agriculture or aquaculture" and its first recorded use was in 1659 according to Merriam-Webster.com, (n.d). Farming is a part of agriculture, and agriculture seems best defined as, "the art and science of growing plants and other crops and the raising of animals for food, other human needs, or economic gains," (Bareja, 2014). The terms farming and agriculture often are used interchangeably for all practical purposes. However, agriculture appears to imply more of the scientific end while farming seems to imply the "art" of the activity. There are many types of farming and these divisions or categories are dependent on, the type of product produced (plant, animal, or other), the purpose of the farming, the amount of farmer investment, and even ownership (Biosphere, n.d.). Pastoral and arable farming are ways to look at farming based on the product. Pastoral farming is the practice of animal farming and is a historic type of farming found centuries ago when our ancestors were still nomadic according to Sleight, (2011). Arable farming involves the growth of crops. Subsistence farming is seen mostly outside of the United States and is the practice of raising food for one's own use. Commercial farming is farming for profit and is big business in the United States. Within commercial farming, one can see that dependent on the amount of labor involved, as well as, the desired result; farmers will vary their practice methods. In intensive agriculture, one would see a large amount of labor and capital investment and the use of many synthetic products. Extensive farming, in contrast, relies heavily on nature. At one time, pastoral farming was an extensive type of farming (think, nomads) and still is when one thinks of the cattle ranches of the western United States. More often though we see pastoral farming as intensive agriculture with food brought to the animals, rather than the animals foraging and grazing (Sleight, 2011). Sedentary farming means farming the same ground every year and this practice is a vital part of big farming, (What is, n.d.). Shifting agriculture is a form of crop rotation where land is cleared and farmed until depleted the ground abandoned to revegetate or lie fallow (Shifting agriculture, n.d.). Mixed farming practices involve a combination of the above-mentioned agriculture techniques. Farms may also be categorized by ownership, whether farmer owned or rented, state or community. Community farms and farmer cooperatives are when farmers pool resources to maximize the benefit and are primarily in countries such as, Norway, Sweden, Belgium, Denmark and the Nethelands (Patra, 2014).

Soil is the most obvious and important aspect of any type of farming. Soil options and changes as it pertains to yield and soil health must be addressed. Soil health can impact crop yields and the use of organic matter, such as, organic fertilizers and soil additives, can potentially prepare soil for long term viability. Lines-Kelley (1992), discusses the important nutrients needed for plants to grow and develop. Healthy soil needs to have nitrogen (N), phosphorus (P) and potassium (K). The three of these nutrients are NPK. Soil also needs to have the correct amounts of calcium (Ca), magnesium (Mg) and sulfur (S) in order to develop healthy plants. Other nutrients needed in trace amounts include: iron (Fe), copper (Cu), manganese (Mn), boron (B), zinc (Zn), and molybdenum (Mo). Hildreth (1994), discussed nitrogen as the “green giant” needed for plant growth and recommended using fish emulsion (foliar application) and root application of a commercially prepared organic fertilizer or dried blood, rabbit manure, and cottonseed meal to improve nitrogen. In order to produce a long-term source of nitrogen, Hildreth (1994), recommended compost with “with manures, tea and coffee grounds, feathers, garden wastes, and kitchen wastes”. He goes on to explain how rock phosphate can be used in the compost and directly on soil in an effort to improve phosphorus amounts in the soil. Other sources of phosphate Hildreth (1994), “Wood ashes, bone meal, citrus wastes, cottonseed meal, dried blood, fish waste.” Potassium is another important soil nutrient which can impact yield. Plants need potassium for growth and it can impact photosynthesis. Soils deficient in potassium will not produce effective yields. Blanchet, Gavazov, Bragazza, & Sinaj (2016), studied both organic and inorganic fertilization use, nitrogen (N) rates applied, the soil properties, microbial environment and the crop production. What was discovered is very interesting. The results indicated that the use of farmyard manure (organic fertilizer) and crop residues increased the soil organic carbon more than mineral fertilizer only. However, soil carbon stock was not significantly changed by this method. In fact, according to this study, only farmyard manure was noted to improve soil properties and yield (+ 3.5%) when compared to mineral only fertilization practices. Soil microbial population and biomass were both found to be enhanced by the organic practices (Blanchet, Gavazov, Bragazza, & Sinaj, 2016). These results along with other studies completed by other researchers show the benefit of using organic amendments to increase soil health, decreasing the need for an increased amount of mineral N. Lehtinen, Schlatter, Baumgarten, Bechini, Krüger, Grignani, Zavattaro, Costamagna, & Spiegel (2014), discovered similar results in their long-term study completed in Europe. Even more encouragement for organic practice was found in Leu's (2016) study, as he discussed the results of a 50-year agricultural trial and determined that the higher the application of synthetic nitrogen fertilizer, the greater the amount of soil carbon lost as CO2. This is one of the major reasons why there is a decline in soil carbon in conventional agricultural systems compared to the increased soil carbon in organic agricultural system. Other soil properties can be affected by organic matter as shown in multiple studies. According to Najafi-Ghiri, Niksirat, Soleimanpour, & Nowzari (2017), organic matter may affect potassium release in the soil. In this study, organic material (animal manure and household compost) was studied to determine the effect of potassium release in different types of soil. This study indicated that introduction of organic material had the most effect on potassium in clayey soils. This information could be useful to farmers as a possibility to improve soil health using organic matter. Hildreth (1994), explained additional organic practices for increasing potassium levels in the summer to "include a foliar feeding of fish emulsion and liquid seaweed and root feeding with wood ashes, well-rotted cow manure, cottonseed meal, aged-poultry manure, and compost enriched with corn stalks. Granite dust and glauconite (greensand) provide potash over the long haul." The secondary elements which are important to soil health include calcium, magnesium, and sulfur. Organic ways to increase calcium in the soil include: compost, bone meal, oyster shells, and wood ashes, dolomitic limestone will also increase magnesium levels. If additional sulfur is needed, sulfate of potash-magnesia is sufficient. Atkinson, Fitz, & Hipps (2010), examined the use of biochar in temperate soils as way to increase soil health. Biochar is a highly stable organic black carbon waste that has the potential to increase soil fertility. The biochar allows increased quantities of minerals, change the soil structure, and can provide micro-organisms which can increase binding of macro-nutrients such as nitrogen and phosphorus. In addition, biochar in the soil can create a more alkaline environment and decrease fungus growth. These changes in soil can lead to an increase in productivity with potential for long-term effects on the atmosphere as it decreases heavy metal contamination. Black carbon's resistance to decay allow it to be a viable option for long-term soil changes (Atkinson, Fitz, & Hipps, 2010). Research regarding biochar effects in less temperate soil, such as in the northern hemisphere appears to be limited at this time. Ways to improve soil health include disturbing the soil less, increasing plant diversity, growing a root in the soil year round, keeping the soil covered, according to Soil health management (n.d). Research is plentiful regarding the benefits of long-term maintenance of soil health, as opposed to the constant introduction of outside nutrients in an effort to restore health continuously. Sarrantonio (2012), states,

> Soil is an incredibly complex substance. It has physical and chemical properties that allow it to sustain living organisms—not just plant roots and earthworms, but hundreds of thousands of different insects, wormlike creatures and microorganisms. When these organisms are in balance, your soil cycles nutrients efficiently, stores water and drains the excess, and maintains an environment in which plants can thrive. To recognize that a soil can be healthy, one has only to think of the soil as a living entity. It breathes, it transports and transforms nutrients, it interacts with its environment, and it can even purify itself and grow over time. If you view soil as a dynamic part of your farming system, unsustainable crop management practices amount to soil neglect. That neglect could worsen as the soil sickens and loses its life functions one by one.

Sarrantonio (2012) also discusses how these practices can assist with weed and pest control and soil erosion, in addition to improving the soil healthier. While organic farming is not opposed to introducing outside supplements when necessary, natural sources rather than synthetic are preferred. According to Chait (2017), organic practices allows an improvement of soil health due to a buildup of organic matter even more efficiently than traditional no-till. This was found to be true in a nine-year study by USDA Agricultural Research Service (ARS), In this study a quote from Dr. Elaine Ingham, is amazingly important, "just one teaspoon of compost-rich organic soil may host as many as 600 million to 1 billion helpful bacteria from 15,000 species." While" one teaspoon of soil treated with chemicals may carry as few as 100 helpful bacteria." Tyagi (2016), believes that "Soil is the foundation of terrestrial life." Soil management is very important to "protect and conserve the soil resources", (Tyagi, 2016). Other effective methods of organic farming include a decrease in the greenhouse effect by keeping the soil carbon rich, increased biodiversity due to the types of seeds and the use of various plants and animals the nutrients are at their best level. In addition, the use of natural borders allows the native plant species and wildlife to flourish. The absence of GMOs, while the effect is not fully understood, is another way that organic farming is attempting to improve biodiversity. The implementation of all of these practices allow the farmer, as well as, the consumer to feel a satisfaction in doing his best to help our world, (http://www.fao.org/home/en/, n.d).

Soil health is so important that The Soil Health Institute formed in 2013. It is located in Morrisville, NC according to Hart (2017), the Institute's president Honeycutt, states the mission "is to safeguard and enhance the vitality and productivity of soil through scientific research and advancement. Conducting work that is economically viable and increases productivity for farmers and ranchers is vital." Honeycutt goes on to discuss the increased implementation of practices, which will increase soil health with cover crops.

Hart (2017) believes that organic farming can feed the world, as well as, sustain the biodiversity and ecosystems, decrease soil erosion, while decreasing the use of pesticides, which influence the health of humans. According to a meta-analysis by the University of Newcastle of 343 peer-reviewed publications, organic grain, fruits and vegetables contain 19% – 69% more of the important antioxidants than non-organic crops and 48% lower concentrations of the toxic heavy metal cadmium. When eating organic food, on average, one needs to eat 20% – 40% less to level the amount of important nutrients and antioxidants present in non-organic food. This reduces the intake of calories (Baranski & al., 2014). We generally already take in too much calories. If we take all of this into consideration, we might try a simple calculation to determine whether organic farming could feed the world. Even in case of a 25% increase of the world population in 35 years from now, while the yield per hectare in organic agriculture will be 9% – 19% lower than non-organic farming (Ponisio, M'Gonigle, Mace, Palomino, Valpine, & Kremen, 2014).

The carbon cycle is yet another important player in the farming game and cannot be ignored when looking at soil health and environmental impacts of farming practices can potentially influence this cycle. Leu (2016) warns, "Soils are the greatest carbon sink after the oceans. We already have too much CO2 in the oceans." Soil carbon refers to inorganic or carbonate minerals and organic matter in the soil. Soil carbon is important in the carbon cycle which in turn makes it important in the global climate model. Chan (2008) defines soil organic carbon (SOC) as the "carbon associated with soil organic matter." He goes on to say "soil organic carbon is the basis of sustainable agriculture." Gattinger (2012) also hypothesized that organic farming would lead to reduction in soil carbon losses, higher soil carbon concentrations and carbon sequestration over time. He suggested that use of an organic systems approach within farming could improve farming life, biodiversity, as well as, the environment due to increases in soil organic carbon concentration and carbon stocks. Soil organic matter is important and includes plant and animal matter, which has already decomposed, in addition to microbial organisms. If we can increase SOC, we can increase soil health, as well as, decrease the effects of climate change (Chan, 2008). SOC storage is dependent on several factors including, the type of soil and its available carbon when farming is initiated, and the climate of the farming area and management of the farm. Farming management practices have a huge impact on the ability of the soil to store SOC and it has been found that by improving SOC a farmer can increase yields (Chan, 2008). Soil carbon levels are very important for the rerelease of nutrients such as nitrogen and phosphorus into the soil, as SOC holds the soil particles together to improve the ability of the soil to maximize water usage, controlling the soil inhabitants, and creating a buffer against disease and other sources, which might harm the vegetation. With maintenance of adequate soil carbon levels, the soil is capable of reaching equilibrium, however, when the soil is disturbed; it is knocked off kilter (Chan, 2008). Mu, Liang & Han (2014), completed a study in Australia and this study offers insight regarding the need to improve SOC in all farmland. This study found that when farmland is converted to forestland, the soil becomes a carbon sink (from 2.26×10^6 kg in 1999 to 8.32×10^6 kg in 2010). Other studies have found similar results and should serve as catalysts to improve our own care of our land. Mu, Liang, Han (2014) also reported, "It has also been estimated that UK forestry and grassland sequester 110±4 kg and 240±200 kg of carbon per hectare yr, respectively, whereas croplands lose on average 140±100 kg of carbon per hectare per yr [32]." The authors go on to caution that SOC is relative to the specific area and since we should be interested only in the net carbon change, organic practices are a good fit. In addition, to the cropping practices, pastures may also increase the soil carbon levels. Chan (2008) used the Wagga Wagga long-term studies to see the soil carbon level differences in various pastures. Chan (2008) states "A crop/pasture rotation sequestered more carbon than continuous cropping." Cultivation of soil causes carbon loss because it accelerates decomposition and removes soil biomass. The ability of the soil to hold on to carbon (C) is relative to the way the amendments are introduced and what happens after they are introduced, however, due to the fact that it does not appear to transfer additional C than that from the atmosphere, the end result cannot be classified as 'soil C sequestration'. Organic strategies for C sequestration must be improved by the debatable solution of increasing root systems, changing plants physiological traits, increased crop residue return, increased compost or biochar, and the use of various cropping options according to Gougoulias, Clark, & Shaw (2014). A second strategy discussed by Gougoulias, Clark, & Shaw (2014), is in regards to what happens once the amendments are added to the soil, if they are taken into the biomass and the C used here in an effort to increase the efficiency of the C use. However, these researchers determined that while the study did identify microbes, which can use C, due to the extracted biomolecules, they were unable to study the portioning of carbon on the whole cell level. Therefore, Gougoulias, Clark & Shaw (2014), felt that new methods need to be attempted in order to quantify the microbial use efficiency and the plant carbon destination. "The ultimate benefits from this investment will be the knowledge to inform manipulation of the plant–soil system to favour organisms or physiologies most important for promoting soil carbon storage across the diverse conditions present in the global agricultural land." Gougoulias, Clark, & Shaw (2014). Conventional farming practices include the use of synthetic mineral nitrogen sources. Dangers of this include the loss of nitrogen, which can leach into the soil or run-off, contaminating the ground water as well as, changing the soil microbiota. Whereas, organic nitrogen fertilizer does not cause these negative impacts. In fact, organic nitrogen fertilizers can improve biological activity and soil C and N content (Lori , M., Symnaczik, S., MaÈder, P., De Deyn, G., & Gattinger, A. (2017).

Over the past 20-50 years, farming has made significant changes partially due to advancements in soil and cropping options, and agrochemicals. These discoveries have allowed increased yields and productivity through pest, disease, and weed control. By using specific crops with complementary chemicals, seeds, topography, and cropping options, farmers can improve a crop's resistance to pests and disease. These farming advancements have generated certain effects with fewer efforts. While equipment and irrigation have also improved the quality of farming, the primary focus of this writing will be on soil and crop options for increased yields. Precise chemical use and precision farming practices have both positive and negative environmental, economic, and social impacts. One newer technique used in farming which has drastically changed the way farming is completed is precision farming. According to Wagner, (n.d.)

> Precision farming- i.e. quantifying sowing, fertilizing and spraying according to soil variation and plant population. This requires the recording of even small spatial differences in the factors relevant to crop growth, such as the quality of soil, the availability of water and fertilizers, or crop yield, just to mention a few. The recording of these variables and the spatially differentiated use of these factors of production is performed by electronically guided machines and implements that receive the signals for exact in-field positioning from GPS-satelites. This allows greatly improved efficiency of the resources made use of, leads to reduced waste of inputs and, in addition, improves the adjustability of biological-technical systems.

Plant (2000), further discusses precision farming as site-specific management (SSM), which allows the management fields on a smaller scale, and makes it more individualized. This allows the farmer to improve yields, while saving money and minimizing environmental effects. The use of GPS technology provides opportunities to increase management of the area, which can decrease waste, as well as, increase the ability to control specific crop needs in specific areas, thereby decreasing environmental impact through nitrate leaching. Goddard (1997), also discusses the disadvantages of precision farming as high intial costs, increased time and work for data collection for full implementation. While precision farming techniques work within organic practice, most of the available data comes from conventional or industrial farming, as most organic farming information is limited to hobby farms.

A panoramic view, as well as, the knowledge of the history, present, and future of farming provides a way to better understand and adjust or change the trajectory of farming, if needed. When looking at arable farming, two basic philosophies are noted: conventional and organic. Conventional farming uses chemicals and technology, while organic farming promotes the use of fewer chemical and works toward improving the bio-diversity of the area (Reference.com, n.d.). Conventional and organic farming techniques both have advantages and disadvantages. Most large or commercial farms in the United States utilize primarily conventional practices with some aspects of organic farming. In an effort to understand fully the need for organic farming in the big market, one must examine conventional arable farming, its benefits and its hazards. Conventional arable farming is by far the most popular farming choice for a variety of reasons. While there is not a specific definition of conventional farming there are some practices commonly seen in all types of conventional farming. These practices include commercial agrochemicals, technology and high capital investment according to Reference, (n.d). Farmers of conventional farming use synthetic chemicals to control pests and weeds, synthetic fertilizer to improve soil nutrients, as well as, genetically modified seeds and/or plants. The literature shows a considerable increase in yields, as well as, decreased labor demands. In fact, these conventional practices have increased crop yields by a factor of 2.6-3.6 over the last 50 years, according to Leifield (2012). In America, 90% of corn farmers rely on synthetic chemicals for weed control. (Pimentel, Hepperly, Hanson, & Seidel, 2005). Conventional farming has an impact on public health and environment due to chemicals. An estimation of $10 billion per year in cost because of the use of pesticides (Pimental et al., 2005). These chemicals have an effect on groundwater, as well as, crops. Advantages, or pros, of conventional farming are somewhat obvious as one considers the ease with which crops are managed with all of the advancements in farming available in this time. The following pros and cons, however, also shed light on the potential concerns of conventional farming. (6 pros and cons of conventional, 2015)

Pros:

1. The cost of food production is significantly low.
2. The cost of conventional farming is low and lucrative.
3. Conventional farming offers many job opportunities.

Cons:

1. Conventional farming may present health concerns for people and animals.
2. Conventional farming may harm the surrounding environment.
3. Large scale farming takes away from small-scale farmers.

Environmental effects are an obvious con of conventional farming, as Leifield (2012) discusses the cost of yield gains in terms of "nutrient loss, soil degradation, and compromised biodiversity" (p. 121). Conventional crop cultivation may also be referred to as industrial or chemical farming and this type of farming is seen across the country. Conventional farming is big business and currently, according to Sass, (2015) "in the entire United States, 99.98% of acres used for agriculture are conventionally cultivated (USDA 2010)". While this is great for the farming industry, one does not have to look far to see another side of conventional farming and proponents for a bit more environmentally friendly way of farming. According to Gurian-Sherman (2014),

> Industrial agriculture has huge, unsustainable impacts on our environment. And while organic and other ecologically based farming systems (agroecology) have huge benefits, some have suggested that it will never produce enough food.

> Production is only one of the challenges for food security. But, according to new research, even by this measure, critics seem to have substantially underestimated the productivity of organic farming.
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> I want to point out that, despite the fact that we currently produce more than enough crops to feed our global population, around a billion people are hungry around the globe. And, in the meantime, we waste between 30 to 40 percent of the food we produce. In other words, crop productivity is only one piece of the food security puzzle. Food sovereignty is another important one.

Food sovereignty is relatively new movement focused on ending poverty, while improving the quality of food through culturally appropriate choices grown in a sustainable manner. We do not seem to have a good grasp of this concept yet and according to Hart (2017), “on a worldwide level, 30% to 40% of all the food is wasted by various causes.”

A review of current agrochemical research produces many studies regarding conventional chemicals used for weed and pest control. However, delving into the more sustainable and environmentally friendly arena of organic pesticides proves a bit more challenging. In an effort to defend and bring this viable option to light in the conventional farming arena the available research perused and provided enough information to defend organic practices by presenting the current hazards and pitfalls of conventional farming was determined. According to Aktar, Sengupta, & Chowdhury (2009), the use of pesticides (insecticides, fungicides, herbicides, rodenticides, molluscicides, nematicides, plant growth regulators and others) does improve productivity through reduction of crop loss, disease control and improving quality of food. However, the inherent hazards in humans and the environment are apparent and need addressed. Aktar, Sengupta, & Chowdhury (2009), Pesticides can cause widespread damage to soil, water, and organisms. Incesticides are the most toxic. More than 90 percent of the water and fish tested by the U.S. Geological Survey (USGS) contained pesticides and insecticides. Pesticides can also be found in cereals, fruits and vegetables, as well as, milk products. This contamination is then shared with the consumer (including humans). The effects of agrochemical varies dependent on the soil, amount of application and the environment. The soil effects are far-reaching as it effects the biodiverstity, which in turn effects the ability of the soil to grow successful crops. Bhandari (2014) defines agrochemicals (pesticides and herbicides) as" the result of modern technology that depends on inorganic fertilizers and pesticides." (p.15) Bhandari (2014), also shares information regarding potential environmental effects farmers must be privy to in order to improve farming safety. Bhandari's (2014) study was completed in Nepal in 2008. He wanted to examine farmers' awareness of potential damage caused by agrochemical use, as well as, look at the amount of chemicals used, frequency of use, application, disposal of chemicals and containers and feelings toward agrochemical use. Bhandari (2014), concluded that farmers in Nepal have limited knowledge of safe chemical use and potential unwanted effects on human health. This study is useful to gain information about agrochemical knowledge of Nepal farmers and is encouraging to others to complete similar studies in other areas of the world in an effort to increase knowledge and encourage possible safer options in farming. Another piece to the farmer puzzle when looking at organic vs. inorganic practices is the use of fertilizer necessary to improve soil health, plant growth and increase yields. McKenzie (1998) discussed fertilizers use and how they will improve proper soil health to provide food for plants to growth and produce. He described fertilizer as a mixture of chemical elements, which can be applied to soil in an effort to allow plants to grow. According to McKenzie (1998) the types of fertilizer include, “Organic manures, plant residues, biological nitrogen fixation and commercial inorganic fertilizers.” (p. 2). McKenzie (1998) states,

> The chemical fertilizers can be broadly classified into nitrogen, phosphorus, and potassium fertilizers. A straight fertilizer contains only one of the nutrients. A compound fertilizer contains two or more nutrients. A complex fertilizer that is formed by mixing ingredients that react chemically, as opposed to a mechanical mixture of two or more fertilizers.” (p.2).

Traditionally, inorganic fertilizers have been used in large-scale agriculture for a few reasons. Due to the nature of the fertilizer and its ability to be rapidly absorbed and readily available for use, it allows the farmer to predict and plan when the soil needs will be met. Omidire ,Raymon, Khan, Bean, & Bean, (2015) , discussed and reviewed organic and inorganic fertilizer options and their effects on crop yields. Current industrial practices to introduce potassium, nitrogen and phosphorus into the soil include inorganic fertilizers are known as chemical or mineral fertilizers. The release of the nutrients of inorganic fertilizers are relatively quick since there is no need for decomposition as opposed to organic fertilizers, which must decompose over time. This allows the farmer to predict the nutrient uptake; however, environmental effects are expected. In opposition, organic fertilizers are difficult to predict and the nutrient contents are more difficult to control. Organic fertilizers, however, offer other benefits, which cannot be ignored. Sharma & Agarwal (2014) completed a randomized study on organic fertilizer performance in spinach. The results indicated that the use of organic fertilizer can improve all of these factors in organic vegetables. In addition, there were soil improvements noted.

Literature shows the decision to use organic, inorganic, or a combination of agrochemicals and other farming practices has been studied in depth, however, most studies have not compared organic farming as a possible option for the industrial farming community. de Ponti, Rijk, & vanIttersum (2012) completed a meta-analysis of 362 published organic and conventional crop yields in an effort to address the possibility of organic farming as a possibility to feed the 9 billion people in the world food economy. The authors proposed several questions regarding organic farming yields in comparison with conventional farming and determined that yield-limiting factors are a much bigger concern in organic farming due to decreased ability to control nutrients, pests and diseases. In addition, according to the authors, organic farming requires additional land, which would affect the surrounding ecosystems; however, organic farming could improve local biodiversity. They reported that while organic farming can produce 80% of conventional yields, there is a high variation (standard deviation = 21%). Most studies within the last 20 years involving organic practices are limited to hobby farms. The possibility of organic farming as a method for corporate farming might be considered in an effort to increase yields and productivity, while sustaining viable farming practices for human, plant, and animal progeny. Cost and profit ratios are of course important to farmers when determining to use conventional or organic methods. Urfi ,Hoffman, & ; Kormosne - Koch, (2011) examined the cost and profits of a large agricultural company in Hungary. While they found differences in the costs, they feel some of this could be partially due to differences in technological methods. Their findings and recommendations are as follows: Urfi , P., Hoffman, A., & ; Kormosne - Koch,, K. (2011),

> According to the production data, in organic farming direct costs per hectare were lower in all of the four examined crops. Even cost per production unit and contribution were more favourable in three of the investigated crops. Regarding the calculation done by economy models, the costs per hectare relating to the two

> production methods were not significantly different. Yields in organic plant production were typically lower but costs per unit and selling prices were higher. Differences in gross profits may be explained by different yields and selling prices. In a majority of the model variations, organic farming is more profitable, but the extra bio price ensuring this, in accordance with trends from literature, is not sufficient for achieving a higher profit in every year.

Organic farming focuses on a closed system in which local resources, such as plant residues and manure from livestock, as well as, the integration of perennial plants is utilized in order to maintain ecological balance (Gattinger, Muller, Haeni, Skinner,Fliessbach, Buchmann,, Mäder, Stolze, Smith, El-Hage, Scialabba, & Niggli, 2012). However, what does it mean to farm organically? Sass (2015) states that

> Under the USDA's National Organic Program (USDA 2012), a food or product may only be labeled as organic if it "a) has been produced through approved methods that integrate cultural, biological, and mechanical practices that foster cycling of resources, b) promotes ecological balance, and conserve biodiversity and c) avoids use of synthetic fertilizers, sewage sludge, irradiation, and genetic engineering." (p. 39).

While organic farming has typically been a "fringe" activity in the past, its popularity is steadily increasing in light of environmental and health benefits. Hobby farmers are aware of the benefits and often are not pressured to produce a high yield, as often the farmer's livelihood is not contingent on the crop yield. Sass, (2015) "Although the acreage for organically cultivated land in the U.S. is a marginal number relative to conventionally cultivated land, this number has nearly doubled over the past few years (USDA 2012), from approximately 2.9 million acres in

2006 to 4.8 million acres in 2008". (p.39). Another source, Lori ,Symnaczik, MaÈder, De Deyn, , & Gattinger (2017), report that "approximately one per cent of the world's farmland is organically managed." According to (6 pros and cons of conventional), organic farming and its focus on organic methods (natural fertilizer, crop rotation, and natural pesticides) allows the soil to maintain its health for longer periods which can increase the nutritional value of the crops produced organically. This may be due to the fact that chemicals can make the crops or produce mature faster, not allowing the natural ripening process to take effect. (6 pros and cons of conventional), also discusses the cons of organic foods of only being available in-season, as well as, the higher cost of organic foods. Organic foods are more expensive due to fact that the yields may be less and are more dependent on the weather and environment. Results showed that overall organic systems produced yields equal to conventional plots while at the same time improving soil quality. Ceidel, Moyer, Nichols, Bhosekar, (2007), reported on their studies in Pennsylvania and concluded, "Organinc farming systems also led to greater profitability while requiring less energy and emitting fewer greenhouse gases to produce the same amount of crops as the conventional systems." Additional findings from Pimental et al (2005), show:

- Soil organic matter (soil carbon) and nitrogen were higher in the organic farming systems providing many benefits to the overall sustainability of organic agriculture.
- Although higher soil organic matter and nitrogen levels of the organic systems were identified similar rates of nitrate leaching were found as in conventional corn and soybean production.
- Fossil energy inputs for organic crop production were about 30% lower than for conventionally produced corn.

> • Depending on the crop, soil, and weather conditions, organically managed crop yields on a per hectare basis can equal those from conventional agriculture, but it is likely that organic cash crops cannot be grown as frequently over time because of the dependence on cultural practices to supply nutrients and control pests.

These factors are important and the conventional farming industry is urged to consider them. The benefits of organic farming are paramount and must carry weight when considering a larger transition to organic practices in industrial farming. Some of the benefits are scrutinized in depth by a variety of sources.

The first and perhaps the most important advantage of organic farming is sustainability. In contrast to industrial farming, organic farming looks at long-term effects of agriculture on the environment. Tyagi, (2016), is a proponent of organic farming and shares information regarding the eco-friendly organic practices, which are less detrimental to human health, and protects the environment from chemical damage. Tyagi, (2016), does discuss the challenge of organic farming's capability of meeting the world's demand for food due to the slower pace of growth of organic crops. Lori, Symnaczik, MaÈder, De Deyn, & Gattinger (2017), reiterate the needs for organic and/or more environmentally safe farming options to feed the world, while protecting it. Organic farming's use of internal natural resources along with its decreased impact on the environment make it a very viable and beneficial option. As one continues to delve into the literature, one finds even more pro organic allies. Kremen & Miles (2012), state:

> Multiple studies of long-term field trials have demonstrated a strong positive impact of organic and diversified farming practices on the enhancement of key soil quality indicators (Bengtsson et al. 2005, Pimentel et al. 2005, Fliessbach, et al. 2007). In particular, surface soils under organic management with high residue

> return rates or organic matter inputs generally have higher levels of soil organic matter (Franzluebbers 2004, Kong et al. 2005, Marriott and Wander 2006). Improved levels of soil organic matter generally enhance soil quality with respect to ten critical and interrelated functions within agroecosystems: biogeochemical cycling and retention of nutrients, soil aggregate formation and stability, water infiltration and water-holding capacity, decontamination of water, pH buffering, erosion reduction, and promotion of plant growth (Mäder et al. 2002, Weil and Magdoff 2004). Organic management can increase soil organic matter through recycling of crop residues and manure, green manuring, cover cropping, vegetated fallow periods, and the addition of compost.

Kremen, and Miles (2012), also discuss the “greater abundance, diversity, and activity of soil microorganisms, and macro organisms responsible for nutrient cycling”. Organic farming practices also provide improved physical, chemical and biological properties in the long term. One goal of organic farming is to prevent ecological imbalance with a proactive approach. This means preparing the agricultural environment for continued use over the years. Ways that organic farming achieves this include soil-building practices, such as cropping options, minimal tillage and organic fertilizers. The reason for encouraging these practices is to create a more stable soil environment that is more capable and self-sufficient to produce nutrient rich crops. According to, Organic farming for health and prosperity (2012), the use of crop rotation allows soil enhancement while discouraging pests and weeds, decreasing the threat of disease and increasing soil health. Additional ways to improve soil health include manure, cover crops, natural fertilizers and pesticides, habitat corridors and borders.

Another important aspect of industrial farming, which needs to be addressed when considering organic practices, is cropping options. One cropping option that should be considered is intercropping. Intercropping is the cultivation of two or more crops in the same field. This ancient practice has decreased with the advent of more mechanized or industrial farming in the United States. However, it remains a viable option in sustainable farming. The question remains, "Is this a potentially lucrative move for industrial farmers in today's market?" The benefits of intercropping needs to be explored further within today's conventional arena. Studies are limited in this particular area on a variety of crops, therefore, the available literature by Bapatla, Patil, & Yeddula (2017), was reviewed in order to attempt to glean insight in this area as it pertains to industrial farming practices. His study assessed the impact of defoliators (a common insect pest of soybean) when an intercrop was introduced in an attempt to reduce the damage of defoliators and their effect on soybean yields. Three species were studied: *Spodoptera litura, Hedylepta indicata,* and *Diachrysia orichalcea.* According to Bapatla, et al. (2017), "Maize and pigeonpea proved the most effective intercrops because of their phenology, repellent chemicals, and physical barriers and also because they were not the natural hosts of the defoliators and did not compete with soybean." The possibility of intercropping for pest control appears to be a viable option and deserves to be further examined.

As anyone can see, in light of pressing environmental and health issues, the need to assess the viability of organic farming as more than a fringe activity should be encouraged. Several questions come to mind when one thinks about the ecological and health benefits of organic farming: Is there a place in the BIG farming market for organic farming? Can organic farming feed the world? On the other hand, is it destined to remain a fringe activity for hobby farmers? Why should we implement organic practices? Ponsinio (2014), discusses the need for increasing our use of organic techniques in order to improve and guarantee ecological sustainability for the future of our world due to the fact that current conventional farming practices impact the biodiversity. This impact on biodiversity is projected to continue to increase as the human population, food waste, and consumption grow. These concerns reiterate the need for organic farming practices as they lessen the environmental impacts. Ponsinio (2014), reported that organic yields were found to be only 19.2% (±3.7%) lower than conventional yields, a smaller yield gap than previous estimates, and that organic diversification practices can reduce the gap even more to around 8.5%. In order for agriculture to be sustainable, there must be a balance of "productivity, profitability, and environmental" health according to Davis, Hill, Chase, Johanns, Liebman,(2012). Davis, et al (2012), conducted a long-term study in Iowa to compare conventional cropping with organic cropping while changing the amounts of fertilizer and herbicides. The findings indicated that the organic yields, mass of harvested product and profit as good as or better than the conventional crops. Both organic and conventional systems effectively controlled the weeds, however, the organic system produced less freshwater toxicity. The results showed that diverse cropping can prove very useful in maintain harvest and yield expectations.

Comparisons of organic vs. conventional farming practices need to be explored in depth in an effort to assist the farming industry to consider implementing more organic practices for societal, ecological and environmental advantages. According to http://rodaleinstitute.org/, (n.d), the Rodale Institute is one of the most apparent supporters of organic farming and its benefits. This institute has researched organic farming practices for the past 35 years. The Rodale Institutes results also have found an improvement in the soil health. Compost is the most important aspect of the ability to maintain a successful organic farm. In addition to soil health, quality compost increases the ability to the soil to hold water for a longer period of time which is useful in the event of a season with inadequate rainfall. Another important part of soil health is the pH level of soil and compost is an excellent way to maintain the pH of the soil, cutting down on the need for soil addition, such as, lime. The institute has collected much data on all organic practices and this information is very valuable in the organic and conventional farming communities. According to http://rodaleinstitute.org/ (n.d.),

> The Farming Systems Trial (FST)® at Rodale Institute is America's longest running, side-by-side comparison of organic and chemical agriculture. Started in 1981 to study what happens during the transition from chemical to organic agriculture, the FST surprised a food community that still scoffed at organic practices. After an initial decline in yields during the first few years of transition, the organic system soon rebounded to match or surpass the conventional system. Over time, FST became a comparison between the long term potential of the two systems. As we face uncertain and extreme weather patterns, growing scarcity and expense of oil, lack of water, and a growing population, we will require farming systems that can adapt, withstand or even mitigate these problems while producing healthy, nourishing food. After more than 30 years of side-by-side research in our Farming Systems Trial (FST), Rodale Institute has demonstrated that organic farming is better equipped to feed us now and well into the ever changing future.

Permaculture may prove to be even more success in the effort to incorporate organic practices into big farming. More than just organic farming practices, permaculture is an important philosophical approach in farming. The definition of permaculture is more encompassing than organic farming and according to Ferguson & Lovell (2014),

> The definition of permaculture varies among sources and displays an expansion in subject area over time. In 1978, permaculture was defined in the founding text as "an integrated, evolving system of perennial or self-perpetuating plant and animal species useful to man … in essence, a complete agricultural ecosystem, modeled on existing but simpler examples"(Mollison and Holmgren 1978, p. 1). By 1988, the definition had grown in scope to encompass broader issues of human settlement while maintaining a core agricultural focus: "Permaculture … is the conscious design and maintenance of agriculturally productive ecosystems which have the diversity, stability, and resilience of natural ecosystems. It is the harmonious integration of landscape and people providing their food, energy, shelter, and other material and non-material needs in a sustainable way" (Mollison).

Permaculture has not been studied in depth in the current scientific research. In 2010, a permaculture activist created a permaculture area in Urbana, IL. The creator believed that we must look for a way to use sustainable practices to satisfy our needs while decreasing the environmental effects, (Scott, 2010). However, permaculture was not being studied empirically at that time and Scott (2010), knew that if permaculture was going to establish itself in the agricultural and environmental arenas, it would need to showcase more than anecdotal proof of success. The answer to Scott (2010), quest appears to lie in agroecology. Ferguson & Lovell (2014), discuss agroecology as the scientific equivalent of permaculture. Permaculture is a

philosophy while agroecology attempts to prove permaculture practices through empirical studies. Agroecology includes permaculture, is an alternative to conventional agriculture, and is suspected to decrease the negative impacts associated with conventional means of farming. Agroecology first emerged in 1928 and evolved during the 20th century as the application of ecological concepts to agricultural practices, with the primary aim of reducing the use of chemical inputs and the impact of agriculture on the environment (Altieri, 1999). Nicholls, Altieri, & Vazquez (2016), also discuss the need for a change in our agriculture environment in an effort to improve the quality of the ecosystems for continuation of successful farming.
A change is necessary in the modern agriculture environment utilizing “well defined agroecological principles.” (Nicholls, Altieri, Vazquez, 2016). The standard of monoculture farming must be changed to include agricultural diversity in order to develop a healthier ecological environment in the agriculture arena (Nicholls, Altieri, & Vazquez, 2016).
Hatt, Artru, Bredart, Lassois, Francis,Huarbruge, . . . Boeraeve, (2016), recommend that agroecology needs to look at each area individually and create specific solutions for each specific area. We must ensure the continued renewal and sustainability of the soil and environment by improving our ability to recycle the biomass, while improving soil health critical for minimizing the loss of water and nutrients, thereby creating habitats with an increased biodiversity for self-sufficient ecosystems, (Nicholls, Altieri, & Vazquez, 2016).

The effort to encourage and provide suitable alternatives to current industrial farming practices is paramount for our future generations and our world. Current practices, while efficient, have cumulative impacts on environmental and human health, which cannot be ignored. Soil health, weed and pest control, and cropping are improved through long-term organic practices; yields can be increased over time and are sustainable. As organic and sustainable practices are increasingly embedded in industrial farming, farmers will see the previously unseen benefits. In turn, the farming industry will be able to hand down to future generations a healthy industry, which is capable of sustaining life and will provide increasing levels of satisfaction and intrinsic motivation to continue such practices. Moseley (2017), states,

> The basic problem with a supply-side solution to global hunger, involving the use of GM crops, is that it does not address the issue of food access for the poorest of the poor. GM crops may make sense as a strategy for wealthier farmers to increase yields and production—although even that is questionable given recent experiences in the Global North. But increasing, overall production is not the problem, it is how to help the poorest farmers improve production and avoid unnecessary financial risk. For this, agroecological approaches may hold some promise. By smartly capitalizing on interactions within agroecosystems, farmers may be able to improve yields and manage pest problems through improved intercropping and agroforestry combinations, as well as more tightly integrated crop and livestock systems. While these practices have long existed within traditional farming systems in the tropics, there is enormous potential for scientists to collaborate with local people to make improvements to these techniques. Unfortunately, funding for work in this area has been woefully limited, probably because agroecological approaches are unlikely to generate the profits derived from the GMO nonsolution to global hunger.

In order for agroecology to become a more stable part of the agricultural arena, the use of transdisciplinary knowledges, interdisciplinary agricultureal practices and social movements is necessary, (Nicholls, Altieri, and Vazquez, 2016). "The way forward in the transformation of the food systems according to the goals of sustainability, justice and sovereignty will require responsible action to improve access to food and nutrition of a constantly growing global population" without discounting the role of the farmer, (Nicholls, Altieri, & Vazquez, 2016).

In the literature, regenerative agriculture is a newer term, which appears to be more encompassing than, organic, permaculture, or agroecology. However, when researching current environmental and agricultural literature and studies, there is little empirical data for or against regenerative agriculture. In reality, regenerative agriculture can include organic all types of organic practices. According to Musgrove (2017),

> Regenerative agriculture is a method of farming that aims to restore the fertility of the soil and the overall health of the land it's conducted on. There are various ways this can be done that are consistent with sustainable agriculture practices more generally such as limiting the use of synthetic inputs like pesticides and fertilizers and limiting tillage of the soil, which can negatively impact soil health. But often regenerative agriculture involves livestock. This might seem confusing if you've read the countless headlines that livestock farming is the biggest culprit of greenhouse gas emissions — according to the FAO it accounts for 18% of emissions — but there is a school of thought that's gathering momentum and evidence that managing livestock in certain ways can not only reduce the negative impact of livestock farming on the environment but actually regenerate the land and have a positive impact. Through what's called holistic planned grazing, or rotational grazing, ranchers strategically move their cattle around the land so that no one area is too depleted, yet every inch of rangeland is trimmed and fertilized by the cows. These methods can lead to increased forage production, soil fertility,

resistance to drought, water retention, and the sequestration of carbon from the atmosphere into the soil, among other benefits.

According to http://www.regenerativeagriculturedefinition.com/ (n.d.),

The principles of regenerative agriculture are to:

1. Progressively improve whole agroecosystems (soil, water, and biodiversity)

2. Create context specific designs and make holistic decisions that express the essence of each farm

3. Ensure and develop just and reciprocal relationships amongst all stakeholders

4. Continually grow and evolve individuals, farms, and communities to express their innate potential

The practices of regenerative agriculture include:

1. No till farming and pasture cropping
2. Organic annual cropping
3. Compost and compost tea
4. Biochar and terra preta
5. Holistically managed grazing
6. Animal integration
7. Ecological aquaculture
8. Perennial crops
9. Silvopasture

10. Agroforestry

In order to progressively improve whole agroecosystems (soil, water, and biodiversity), we must make improvements to the soil, rather than constantly removing nutrients. To create context specific designs and make holistic decisions we must look at each farm individually and create plans for that specific area. This would require a vast change from what we currently use in conventional farming, although precision farming and GPS technology would allow this to be a less daunting task. In an effort to ensure and develop, just and reciprocal relationships amongst all stakeholders we must engage the intrinsic motivation of both producer and consumer to develop more sustainable food options while guaranteeing the viability of affordability for the consumer and profitability for the producer. In turn, as all of the other principles of regenerative agriculture are integrated into conventional commercial farms, the growth and evolution of each individual, farm and community will develop, as well as, intrinsic motivation as the crops grow http://www.regenerativeagriculturedefinition.com/(n.d.).

While the practices of regenerative farming are seen in bits and pieces into today's conventional farming world, a more intentional and widespread integration of the practices would be vastly beneficial to the farmer, the community, the ecosystem, and the future. The first practice of regenerative farming is no-till and pasture cropping. While no-till is a relatively standard practice in todays' farming industry, the idea of pasture cropping may seem a bit more unusual and is a newer development. In the practice of no-till, soil organic carbon are improved in the top layers of soil. Pasture cropping came about in the early 1990s as a farmer initiated land management system (Dunn, 2012). This practice involves growing winter cereal crops in the perennial pasture grasses. "There are important sustainability benefits of maintaining more perennial plants across agricultural landscapes, and the low input costs and flexible nature of the system make it attractive to producers." Dunn (2012). Organic annual cropping is the practice of growing a different crop every year on a piece of land to reduce the risk of disease and to allow the soil to build up nutrients. The practice of annual cropping is not solely used in organic farming and conventional farming has taken on this practice with good results. The next premise of regenerative agriculture is compost and compost tea. These are vital and according to Compost (n.d.),

> Compost is organic matter that has been decomposed and recycled as a fertilizer and soil amendment. Compost is a key ingredient in organic farming. It is used in gardens, landscaping, horticulture, and agriculture. The compost itself is beneficial for the land in many ways, including as a soil conditioner, a fertilizer, addition of vital humus or humic acids, and as a natural pesticide for soil. In ecosystems, compost is useful for erosion control, land and stream reclamation, wetland construction, and as landfill cover (see compost uses). Organic ingredients intended for composting can alternatively be used to generate biogas through anaerobic digestion.

Use of synthetic chemical fertilizers, especially nitrogen and phosphorus, will seriously reduce or in many cases even eliminate any soil carbon buildup. The appropriate use of manure and compost, however, does not seem to impede soil carbon increase. (Jones SOS, Rodale).

Regenerative farming also involves biochar and terra preta. Biochar is a 2,000-year-old practice that converts agricultural waste into a soil enhancer. Terra preta found in the Amazon allows terra preta studies to improve researchers understanding of the benefit of this product. Biochar increases a soil's ability to hold onto "carbon, boost food security, and increase soil biodiversity, and discourage deforestation." www.biochar-international.org/biochar (n.d.).

Biochar can be most beneficial in severely depleted soils, and in areas where supplies are limited. It can increase yields as well by improving soil health. “More nutrients stay in the soil instead of leaching into groundwater and causing pollution.” Hofstrand (2009).

Holistically managed grazing is a bit more controversial topic; however, the premise seems promising. “The term was coined by Allan Savory in 2013 at TED conference in Long Beach, California, and offered his grand theory about livestock.” Ketcham (2017). Savory’s theory involves managing cattle the way they were managed on the open range centuries ago. He believes that by doing this—“the animals churning the soil with their hooves, fertilizing it with dung and urine, stomping grass, creating mulch, stimulating plant growth—we can re-green the arid lands and, at the same time, encourage soil microbes that eat carbon dioxide.” Ketcham (2017). Another premise of regenerative farming is called animal integration involves the introduction of livestock into a crop area to provide a biological weed control, assist with weed control. This has been a part of farming worldwide for years. Think of goats and sheep to clear an area or control weeds in crops. This type of weed control is cheaper and more environmentally friendly. Most studies have involved trees as the crops and has proven effective to increase the yields. By combining the animals with the crops, the farmer is able to use the animals for a source of income in the first few years of transition to organic principles. In addition, the animals offer naturally occurring manure (Sanchez, n.d.). Obviously, this type of farming requires some forethought as to which animals can be safely integrated into which crops to reach a level of satisfactory equilibrium between production and sustainability (Sanchez, n.d.). “One of the simplest approaches is to use neighbours' animals to graze the natural annual vegetation growing during certain times of the year, particularly after the rainy season, for example, sheep grazing in olive-growing regions (Vera y Vega, 1986). “, Sanchez, (2017).

Perennial crops are crops that last a longer time. They typically die down in the winter and come back the next spring. Glover & Reganold (2010), discuss the use of perennial crops and the benefits they provide in maintaining topsoil and increasing soil carbon. In addition, they can reduce water and nitrate losses due to the longer growing season and deeper roots. Other benefits include shelter for wildlife, and the “potential to mitigate global warming, whereas annual crops tend to exacerbate the problem”, Glover & Reganold (2010). Other sources have also found that one of the best ways to restore carbon is through perennial growing systems. According to (Machmuller, Rodale, 2012), the pasture based trials completed indicate “exceptional amounts of carbon restored from 1.9 to 3.2 metric tons of carbon per acre annually, and averaging 2.6 tons.” Carbon restoration seems to be more successful with perennial woody crops at this time, but more research needs to be done to fully evaluate the benefit of herbaceous crops. This type of carbon farming allows the improvement of the the rate in which plants and organic matter converts atmospheric CO2. It has been found that the excess carbon in the oceans are causing acidic conditions that are potentially damaging to animals and plants. Regenerative farming allows carbon sequestrations and will build organic matter in the soil, creating food that is more nutritious and improving the overall ecosystem. As a 2014 Rodale Institute report states, “Organically managed soils can convert carbon CO2 from a greenhouse gas into a food-producing asset." Two major upsides to this approach are drought-proof soils and, thanks to more nutrient-rich foods, reduced healthcare costs.

If this is the first you have heard about this idea, it is because the good news is just starting to trickle out. For example, the Marin Carbon Project's work with compost and rangeland was recently featured on the cover of the *San Francisco Chronicle*.

Jokela (2010), also shares knowledge of the benefits of nitrogen (N) released into the soil. Finally, agroforestry is defined as the "intentional integration of trees and shrubs into the crop and animal farming systems to create environmental, economic, and social benefits", Agroforestry (n.d.). While it has been around for a very long time, the increased implementation of it into conventional farming could prove salient in accordance with regenerative agriculture's principles. One type of agroforestry is silvopasture. Silvopasture (n.d.), defines Silvopasture as "a combination of trees with forage and livestock production". Lastly when looking at regenerative agriculture we see ecological aquaculture. This principle integrates the best management practices for farming in an aquatic environment, while taking into account the health of the ecosystem and wild fisheries, https://umaine.edu/seanet/, (n.d.).

So, what is already out there and readily available to address and propel this transition to an increase in regenerative farming in the big market? One source currently working toward regenerative farming is TomKat Ranch. TomKat Ranch, Eduational Foundation (TKREF) is located on an 1800-acre cattle ranch in Pescadero, CA. TomKat ranch believes that with the growth of precision agriculture and technology to assist with data collection, regenerative agriculture will be able to prove itself as a viable option for farming. TomKat Ranch is applying the fundamentals of regenerative agriculture to cattle grazing. By utilizing practices that increase soil organic matter and overall soil health through the practice of minimal soil invasion, the soil biota will diversify above and below the surface. This will then allow increased water hold capacity and carbon sequestration "thus drawing down climate-damaging levels of atmospheric CO2, and improving soil structure to reverse civilization-threatening human-caused soil loss" http://www.tomkatranch.org/about-us/, n.d.). Rhodes (2017), believes, "By using methods of regenerative agriculture, it is possible not only to increase the amount of soil organic carbon (SOC) in existing soils, but to build new soil.” Regenerative farming

There are many facets to farming and the simplest answer to the question “Is there a place for organic farming in the big market?” appears to be “No”. It would require too much time and money to effectively transfer large farms to the full organic way of operating. However, when one considers all the other factors besides money and yields, the attraction of organic farming becomes more appealing. When one thinks about future generations and the earth in general, as well as, the intrinsic satisfaction that comes with the knowledge that the farming practices you as a farmer are using are creating a sustainable future, the possibility remains viable. The benefits of regenerative agriculture are far reaching and possibly the most important benefit is the fact that regenerative agriculture is capable of making agriculture into a solution for climate change rather than a contributor. Other positive aspects of regenerative agriculture include improving farm yields, while making the ground more drought resistant, and increasing its health and water-holding capacity (Leu, 2016)**.** In order to propel this movement forward, we need to spread the awareness of the potential of regenerative agriculture’s ability to improve all aspects of farming, and we need to start with yields. To get farmer’s interest, we must hit them in their pocketbook. American farmers are very interested in feeding the world, but are more interested in feeding their own families, and that takes money, which is based on yields. While ccontinued research into the currently available literature uncovers more supporters of the move toward regenerative agriculture, the lack of clear empirical data is apparent. However, many well respected researchers and highly regarded individuals do seem to be showing a strong interest in organic farming and do recognize the need for continued empirical research on the topic. It appears, agroecology is the way to achieve the desired status in the big market, as this is a field of study, which is respected and does hold “scientific” water. The supporters and organizations such as Rodale and TomKat Ranch do appear to have more work to complete with additional and widespread empirical studies in order to bring the big market to their way of thinking. They are laying a strong foundation, and with continued support and growth, it is definitely possible that we will see the change to organic farming in the big market in our lifetime.

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