The Truth About Organic: Sustainability, Practice, and Perception

By
Keli Baker
Department of Geography

Primary Thesis Advisor
Abby Hickcox, Honors Program

Committee Members

William Travis
Department of Geography

Sharon Collinge
Environmental Studies Program

University of Colorado at Boulder
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Abstract

It is an essential goal of conservation biology to find a way to sustainably meet the food needs of an exponentially increasing population without damaging the environment and the ecosystem services it provides us. The difficulty with "sustainable agriculture" is that there is much disagreement as to what it entails and how to approach it. Thus far, the organic movement has dominated practices and perceptions in the realm of alternative farming practices. Proponents of organic food production claim that it is more beneficial for the environment, as well as the humans and animals that inhabit it. However, some research has shown that organic food production can be more resource intensive and have a larger effect on the environment than conventional methods. At its conception, the organic food movement was associated with a production process that was small scale, environmentally friendly, and socially conscious; but, modern organic food production has been industrialized and now involves many of the same processes as the conventional food production system it set out to oppose. The consensus among the literature is that organic, as it is defined in any regulatory or certification system, is not inherently sustainable. The sustainability of organic depends on factors other than specific processes defined by organic legislation, including regional climate, pre-cultivation soil conditions, distribution techniques, access to fresh water, topography, and other site specific alternative farming practices used in a given organic system (zero tillage, crop diversification, closed nutrient cycling, local sourcing, these are practices not defined or prohibited in organic laws). Most scholars agree that farming techniques must be specific to land conditions, regional culture, and related factors, and that many practices must be combined with organic to achieve the highest degree of sustainability. This thesis evaluates the sustainability of organic based on environmental and social impacts in the existing policy context.

1. Introduction

Production and distribution of food is becoming increasingly industrialized and globalized. This industrial approach to producing food on a massive scale leads to degradation of soil, deforestation, eutrophication (the process by which nutrient runoff leads to oxygen depletion in water) and acidification of marine and freshwater systems, climate change, and pesticide and antibiotic resistance (Leinonen, Williams, Wiseman, Guy, & Kyriazakis, 2012; Tilman, Cassman, Matson, Naylor, & Polasky, 2002). It has also been linked to an increase in parasitism and infectious disease in humans (Johnson et al., 2010; McKenzie & Townsend, 2007). The consequences of industrial agriculture are global in scale. The global industrial food distribution system is inefficient, causes massive emissions of greenhouse gases (GHG), overuses resources, and has a huge carbon footprint (Lal, 2004; Wood, Lenzen, Dey, & Lundie, 2006). However, people need agriculture to survive, and with the exponential growth of the human population these problems will only intensify.

The world's population doubled to 6 billion between 1960 and 2000, and it is expected to grow to 9 billion in the next fifty years (Hole et al., 2005; Millennium Ecosystem Assessment, 2005). This massive population growth will be accompanied by a severe increase in the demand for ecosystem services. Ecosystem services are beneficial processes and materials that the ecosystem provides to life on earth, and they are essential for the survival of humankind. In the Millennium Ecosystem Assessment ecosystem services are divided into four categories: provisioning, regulating, cultural, and supporting. Provisioning services are valuable commodities that people can extract from nature, such as wood, water, and natural gas. Regulating services are processes provided by the ecosystem that balance nature, such as pollination, water purification, and erosion control. Cultural services assist cultural development through interaction with nature, and supporting services are fundamental background processes of nature, such as photosynthesis and soil creation (Millennium Ecosystem Assessment, 2005). The diversity of life on earth, or biodiversity, is created by and completely dependent upon ecosystem services.

Human settlement and conversion of undeveloped land for agricultural purposes leads to degradation and overexploitation of ecosystem services (Millennium Ecosystem Assessment, 2005). Twenty-four percent of earth's terrestrial surface has already been converted for agriculture use, and the intensification of farming practices on existing developed land only exacerbates the depletion of ecosystem services. In the past fifty years human development has changed ecosystems more quickly and intensely than in any other equivalent time in recorded history. These changes have led to loss of biodiversity due to introduction of invasive species, extinction, declines in genetic diversity, and altered natural biogeochemical cycles (Millennium Ecosystem Assessment, 2005). Loss of biodiversity reduces ecological resilience, diminishing the ability of an ecosystem to recover from disturbance that disrupts ecosystem services (L. E. Jackson, Pascual, & Hodgkin, 2007). It also decreases the genetic pool from which humans extract medicines, food, and other provisions. Once a species is extinct, its particular genetic sequence is forever lost and with it the ability of humans to benefit from it.

As population grows, demand for water is expected to increase by 30-85% and demand for food by 70-85% (Millennium Ecosystem Assessment, 2005); this means more land conversion and agricultural intensification. As more countries become developed and more people rise in economic class, meat consumption will grow; globally, meat production has already increased 60% in the last 40 years (Tilman et al., 2002). This is highly concerning because production and processing of cattle for beef has more impact on climate and the environment than all other forms of food (de Vries & de Boer, 2010; Schmidinger & Stehfest, 2012; Tilman et al., 2002; Weber & Matthews, 2008). Currently, 22% of total global greenhouse gas emissions are a result of agriculture, and livestock production is responsible for 80% of that number (McMichael, Powles, Butler, & Uauy, 2007). The livestock sector also accounts for 70% of agricultural land use globally (Flysjö, Cederberg, Henriksson, & Ledgard, 2012). The contribution to climate change of the present day approach to food production threatens food yields in parts of the world that already suffer from under-nutrition due to food scarcity (McMichael et al., 2007). It is an essential goal of conservation biology to find a way to sustainably meet the food needs of an exponentially increasing population without damaging the environment and the ecosystem services it provides us. The difficulty with “sustainable agriculture” is that there is much disagreement as to what it entails and how to approach it. The attempts at uniting agriculture and sustainable development are vast and varied. They include reduction or elimination of meat consumption and livestock production (McMichael et al., 2007; Weber & Matthews, 2008), biodynamic farming (Steiner, 1924), low external input sustainable agriculture (Reijntjes, Haverkort, & Waters-Bayer, 1992), local food sourcing (Weber & Matthews, 2008), integrated crop management (LEAF, 1991), permaculture (Mollison & Slay, 1991), small scale farming (Henle et al., 2008), land sparing, wildlife friendly farming, sustainable intensification (Phalan, Balmford, Green, & Scharlemann, 2011), agroecology (Altieri, 1995), integrated pest management (Carroll & Risch, 1990), agroforestry, crop rotation, multiline crop management (Tilman et al., 2002), minimum or zero-tillage prior to seeding (Snyder & Spaner, 2010), and organic (Henle et al., 2008; Leifeld, 2012; Rigby & Cáceres, 2001; Scofield, 1986; Seufert, Ramankutty, & Foley, 2012; Tilman et al., 2002).

Thus far, the organic movement has dominated practices and perceptions in the realm of alternative farming practices. There are several justifications for my emphasis on the organic system as a prospective solution to sustainable agriculture. Organic farming was the first recorded approach to sustainable food production and became widely known to society as a core theme of the 1960s and 1970s counterculture movement (Pollan, 2001; Rigby & Cáceres, 2001). Organic agriculture is the most well-known form of sustainable agriculture due to its frequent discussion in the popular media in response to food safety scares and health concerns associated with chemical fertilizers and pesticides (Benbrook & Baker, 2014; Rigby & Cáceres, 2001). Its publicity has also led to its appeal to growing public concerns about the humane treatment of animals and the health and welfare of the environment with respect to agriculture (Pollan, 2001; Rigby & Cáceres, 2001). Organic is also familiar to most people because it is the only sustainable option they see in the grocery store. The price premiums and high profit margins associated with organic food incentivize producers to get involved in the organic industry and heavily promote and market organic products leading to high consumer demand (Constance & Choi, 2010; Henle et al., 2008; Pollan, 2001). Organic agriculture is currently the most rapidly growing sector in the food economy with the market doubling between 2002 and 2007 (Snyder & Spaner, 2010), and land conversion for organic farms continues to increase; one highly influential reason for this is that many western governments promote and incentivize organic food production through policy or subsidies (Cederberg & Mattson, 2000; Hafla, MacAdam, & Soder, 2013; Hole et al., 2005; Rigby & Cáceres, 2001; Tuomisto, Hodge, Riordan, & Macdonald, 2012). Proponents of organic food production claim that it is more beneficial for the environment, as well as the humans and animals that inhabit it. However, some research has shown that organic food production can be more resource intensive and have a larger effect on the environment than conventional methods (Cederberg & Mattson, 2000; Fedele, Mazzi, Niero, Zuliani, & Scipioni, 2014; Flysjö et al., 2012; Thomassen, van Calker, Smits, Iepema, & de Boer, 2008; Tuomisto et al., 2012; van der Werf, Tzilivakis, Lewis, & Basset-Mens, 2007; Wood et al., 2006). At its conception, the organic food movement was associated with a production process that was small scale, environmentally friendly, and socially conscious; but, modern organic food production has been industrialized and now involves many of the same processes as the conventional food production system it set out to oppose.

The social and environmental consequences of the industrial food system are not evenly distributed in a geographical sense. They often originate in one place and affect environments much farther downstream of an actual industrial food production process. For example, nutrient emissions from farming and livestock production can affect water quality in aquatic systems far distant from their point of origin. Nitrogen oxides are transferred through the atmosphere over long distances and deposited far from the agricultural lands that emit them. Certain places are more affected by the processes and outputs of the food industry because they are more sensitive to ecological change. Ecological communities in polar regions, coral reefs, and freshwater systems are exceptionally vulnerable in this respect. Wealthy countries in the global west and north are the main proprietors and beneficiaries of industrial food production, but repercussions are experienced globally; this is chiefly because of the contribution of modern food production to changes in access to ecosystem services. Because of the global economy of industrial agriculture and food production, it affects social and economic conditions all over the world. The rural poor in developing countries are disproportionately affected in a negative sense due to their direct reliance on ecosystem services for subsistence and a lack of resources to compete in the global market. Dryland ecosystems in places like sub-Saharan Africa are more afflicted by the consequences of industrial agriculture because of existing deficits in many ecosystem services such as precipitation, soil organic matter, and clean water (Millennium Ecosystem Assessment, 2005).

The effects of the industrial food system also occur at multiple scales. Phenomena that are exacerbated by industrial agricultural activities, such as climate change, increases in extinction rates, reductions in genetic diversity, disruptions to biogeochemical cycles, and conversion of wild land for agriculture, are global in scale. Regional effects include changes in migration and species distribution patterns, water diversion (dams), declining or exhausted wild food sources, exotic species invasion, and local pollution (pesticide drift, water contamination). On a temporal scale, the effects of contemporary industrial agriculture, especially climate change, will continue to negatively influence environmental and social conditions for generations to come.

In this thesis, I compare organic and conventional agriculture in an attempt to understand the contributions of modern food production to climate change, environmental degradation, and food insecurity. My research examines the geography of the impacts of organic and conventional agricultural systems. Through compilation and analysis of data at local, national, and global scales I study how national and international policies on organic food production influence their success and sustainability.

My goal is to determine if organic is the form of agriculture that is the most efficient and the least disruptive to the ecosystem, whether organic food production techniques live up to the ideals that society has placed on them, and if they have the capability to sustainably solve the growing global need for food. If they do, how are they better than conventional production? If they do not, what are the alternatives? In this thesis I will use the existing body of research to do a comprehensive evaluation of organic farming in terms of its original philosophy, its current reality, and its candidacy as an effective sustainable food production system. I will also assess the influence of national and international organic policy on the intensity of environmental impacts associated with the organic food system.

There are countless studies cataloging the negative impacts of industrial agriculture on the environment (Garnett, 2009; Lal, 2004; Tilman et al., 2002; Weber & Matthews, 2008; Weiss & Leip, 2012; Yan, Humphreys, & Holden, 2011). Most of the literature on the sustainability of organic agriculture focuses on compilation of selected environmental impacts of organic farming practices (Haas, Wetterich, & Köpke, 2001; Lynch, 2009; Markussen, Kulak, Smith, Nemecek, & Østergård, 2014; Rigby & Cáceres, 2001; Schader et al., 2014; Tuomisto et al., 2012). Several studies compare the environmental burdens of organic production to those of conventional systems using Life Cycle Assessment techniques (Basset-Mens et al., 2007; Cederberg & Mattson, 2000; Fedele et al., 2014; Leinonen et al., 2012; Meisterling, Samaras, & Schweizer, 2009; Thomassen et al., 2008; Wood et al., 2006). Most of this research focuses on a single country, and the bulk of it takes place in Europe. Less work has been done on the economic sustainability of organic agricultural practices (Stonehouse, Clark, & Ogini, 2001), most of which are only small sections included in papers assessing environmental impacts, often including forms of agriculture other than organic (Hafla et al., 2013; Mohamad et al., 2014; Pimentel, Hepperly, Hanson, Douds, & Seidel, 2005; Snyder & Spaner, 2010). A few papers were found including the issue of food security as it relates to organic, but again these were small sections in works focused on other topics, like crop yields (de Ponti, Rijk, & van Ittersum, 2012; McMichael et al., 2007; Millennium Ecosystem Assessment, 2005; Rigby & Cáceres, 2001; Seufert et al., 2012; Tscharntke et al., 2012). Documents discussing national (Constance & Choi, 2010; Paull, 2008; The et al., 2008) and international (Caro & Durán, 2012; Hatanaka & Busch, 2008; Zoiopoulos & Hadjigeorgiou, 2013) organic legislation and standards are abundant, but do not discuss how these laws and regulations apply to the sustainability of organic food production. Literature on methods of sustainable agriculture alternative to organic is also ample (Barthel, Crumley, & Svedin, 2013; L. Jackson et al., 2010; Kumaraswamy & Kunte, 2013; Mattison & Norris, 2005; Notarnicola, Hayashi, Curran, & Huisingh, 2012; Swift, Izac, & van Noordwijk, 2004; Zimmermann, Baumgartner, Nemecek, & Gaillard, 2011), but none of it compares these the sustainability of organic in any detail.

This thesis is a comprehensive, but by no means exhaustive, review of environmental, social, and economic sustainability of organic farming in relation to organic philosophy, national and international policy, food insecurity, and industrial agriculture. No literature was found addressing this combination of issues. My review looks at all aspects of organic to in respect to sustainability on multiple levels including economic, environmental, barriers to and incentives for the adoption of organic production, and food security. My analysis encompasses multiple geographic scales and looks at alternative sustainable agricultural practices to determine how organic measures up. It is important to comprehend the full range of benefits and burdens associated with the global industrial food system in order to provide a solid basis for making educated decisions about how to approach future agricultural policy and processes; I demonstrate and explain these as they relate to organic food production.

2. Comparisons of the Environmental Burdens of Organic and Conventional Agriculture

There is an expanding global concern about the resource inputs and outputs of agricultural products and how they contribute to climate change and ecosystem degradation. Researching agricultural production processes will elucidate ways to reduce their ecological impact. With the exception of biodiversity studies, much of the research comparing the environmental impacts of agricultural systems uses a technique called life cycle assessment, or LCA. LCA is a quantitative method designed to assess the environmental impacts generated from a commodity, which can be an activity, process, or product within a defined boundary. It is an integral assessment technique that allows for several environmental burdens and the environmental burdens of purchased inputs to be assessed in combination. The burdens of these purchased inputs are termed indirect impacts and are the result of off-farm activities, the production practices used to generate inputs purchased by farmers. Indirect impacts are created by the pollution and resource use of upstream actors in the agricultural economy, including, but not limited to, producers of animal feed as well as chemical and tractor companies. Direct impacts are generated by on-farm activities such as grazing, applying manure or fertilizer to crops, or greenhouse gas emissions from farm vehicles (Wood et al., 2006).

The life cycle assessment technique involves compiling data from life cycle inventories (LCI) of the resource inputs and outputs of a production system, and analyzing their potential impacts on the environment using statistics and modeling. Data on resources used and outputs to the environment, both on-farm and those included in the delivery and production of inputs used in a system, are collected and interpreted in terms of ecological burdens by multiplying the collective resources used and the collective emissions of each individual substance (Leinonen et al., 2012). LCIs include measurements of energy use, global warming potential, acidification potential, eutrophication potential, ozone depletion potential, and the potential to generate smog (van der Werf et al., 2007). The LCI best known to the general public is global warming potential (GWP), also known as the “carbon footprint.” This is a measurement of the combination of the emission of all GHGs which contribute to climate change emitted by a production system. Eutrophication potential (EP) is a compilation of all nutrient emissions in a system and includes such substances as phosphates and nitrates. Acidification potential (AP) is an LCI similar to EP except it measures sulfur compounds and nutrients leached from manure or crop production that lead to the acidification of aquatic systems. The LCA technique allows us to compare agricultural systems and determine areas of extreme environmental impacts that have potential for mitigation.

2.1 Biodiversity conservation

In the broader sense, the term biodiversity describes the diversity of life or species diversity in an ecological system. However, it also includes the genetic diversity within a species and the ways in which species interact with each other and their abiotic environment. Biodiversity is an essential ecosystem service because it is the collective pool from which nature assembles new life. Genetic diversity is necessary for the evolution of new species and the preservation and survival of extant species; diversity allows for disease resistance and ecological resilience. Biodiversity is the well from which humans draw food, medicines, and adaptation; it makes possible the ecological services that allow life to persist. Proponents of organic farming suggest that its practices help to conserve biodiversity (National Wildlife Federation, 2014).

In a life cycle assessment of grassland farming systems in south Germany, organic grassland was found to have the highest number of plant species when compared to conventional intensively and extensively farmed grassland (Haas et al., 2001). Other studies done in Europe show that when compared to conventional fields, there are higher levels of vegetative species richness organic fields; and in one study the non-crop species density was three times higher for organic plots (Hole et al., 2005; Knudsen, Yu-Hui, Yan, & Halberg, 2010). One study by Weibull et al. found contrary results. Organic fields were also found to contain more declining and uncommon plant species (Frieben & Kopke, 1995; Rydberg & Milberg, 2000). Weed abundance was found to be lower on organically maintained farms, most likely due to mechanical, as opposed to chemical, weed control processes and undersowing of crops (Brooks, Bater, Jones, & Shah, 1995; Pullen & Cowell, 1997; Welsh, Philipps, Bulson, & Wolfe, 1999). As far as microbial biodiversity, nematode roundworms were more abundant and active overall in organic systems; however, bacterial feeding nematodes were more plentiful in organic systems and a higher presence of fungal feeding nematodes was found in conventional systems; lower levels of fungal feeding nematodes means higher numbers of fungal microorganisms in the soil. Fungal microorganisms are important because they live symbiotically with plant roots enhancing disease resistance as well as water and nutrient uptake in plants; these symbiotic relationships also lead to more aggregated soil (Pimentel et al., 2005). One explanation for these results is the practice of applying animal manure to fields in organic farming, which adds significant amounts of organic carbon needed to sustain bacterial communities (Hole et al., 2005). However, it should be noted that microbial communities are highly influenced by soil and crop type, so farming techniques cannot be solely responsible for these results.

Six studies found higher density and species diversity of earthworms in organically managed farms; these results are also attributed to animal manure application, in addition to absence of synthetic pesticides (Berry & Karlen, 1993; Brooks et al., 1995; Brown, 1999a; Gerhardt, 1997; Liebig & Doran, 1999; L. Pfiffner & Mäder, 1997). Two studies reported no difference in number of earthworms between organic and conventional systems, and one study found lower numbers of earthworms in the organic plots (Czarnecki & Paprocki, 1997; Foissner, 1992; Nuutinen & Haukka, 1990). Numerous papers exist showing higher abundance and diversity of spiders in organic fields (Booij & Noorlander, 1992a; Feber, Bell, Johnson, Firbank, & Macdonald, 1998; Moreby, Aebischer, Southway, & Sotherton, 1994; L. Pfiffner & Niggli, 1996a; Lukas Pfiffner & Luka, 2003a; Reddersen, 1997a) but two papers showed no difference in species richness (Booij & Noorlander, 1992b; Weibull, Östman, & Granqvist, 2003). Four studies indicated higher numbers of and/or species richness levels of beetles on conventionally managed farms (Armstrong, 1995; Moreby et al., 1994; Weibull et al., 2003; Younie & Armstrong, 1995), where twelve articles showed the opposite (Booij & Noorlander, 1992b; Cárcamo, Niemalä, & Spence, 1995; Clark, 1998; Dritschilo & Wanner, 1980; Hokkanen & Holopainen, 1986; Irmler, 2003; B. Kromp, 1990; Bernhard Kromp, 1989; O'Sullivan & Gormally, 2002; L. Pfiffner & Niggli, 1996b; Lukas Pfiffner & Luka, 2003b; Reddersen, 1997b). Positive results for organic systems are likely a result of higher plant species richness and structure creating a stable microclimate for beetle populations. Between studies inconsistencies were found in beetle community composition, most likely due to differences in tillage practices, pesticide application, sampling methods and soil type. Less literature has been published on vertebrate communities; two studies found higher mammal diversity or abundance in organic systems (Brown, 1999b; Flowerdew, 1997) and five studies showed the same for avian species (Beecher, Johnson, Brandle, Case, & Young, 2002; Chamberlain, Wilson, & Fuller, 1999; Christensen, Jacobsen, & Nohr, 1996; Freemark & Kirk, 2001; Lokemoen & Beiser, 1997). Overall, it seems that organic farming systems have higher levels of biodiversity than their conventional counterparts. Explanations of these results are not consistent across studies, but many stated absence/reduction of pesticides and synthetic fertilizers and polycropping as potential factors.

2.2 Nutrient emissions: Eutrophication Potential and Acidification Potential

Nutrient emissions including, but not limited to nitrogen, nitrous oxide, ammonia, sulfur dioxide, and phosphorus lead to eutrophication and acidification of marine and freshwater systems. Agriculture is the main contributor of nutrient emissions globally, and accounts for up to 80% of the total aquatic nitrogen load and 50% of the total phosphorus load in Europe alone (Tuomisto et al., 2012). Organic farming practices are thought to mitigate acidification and eutrophication processes in general, but results vary based on the study. Work focusing on the production of different agricultural products is reviewed here.

In a life cycle assessment study done by Leinonen et al. on the environmental impacts of three broiler chicken production methods (conventional, organic, and free range) in the United Kingdom, the organic chicken feed production system has the highest eutrophication potential (EP). The greatest environmental impacts were due to production of feed. Leinonen et al. explain that the high EP associated with the organic system was most likely due to higher nutrient leaching in the growing of organic crops and differences in nutrient emissions from chicken manure due to differences in the composition of organic chicken feed.

In contrast, concerning the nutrient emissions of organic dairy production systems, two studies show that organic techniques lead to lower EP because nitrogen (N) and phosphorus (P) levels are lower due to lack of synthetic fertilizers in crops grown for feed, and absence of imported feed (Haas et al., 2001; Thomassen et al., 2008). Conventional dairy farms tend to use high levels of purchased inputs, such as concentrate feed and fertilizer; the production of these inputs results in heavy environmental burdens. One dairy study resulted in organic farming having a higher EP because more N is used in the production of feed crops due to low crop yields associated with organic systems (Cederberg & Mattson, 2000).

In a study by Tuomisto et al. reviewing a variety of organic products in Europe, organics resulted in lower EP than conventional when analyzing land area as a functional unit, but a higher EP when analyzing unit product as a functional unit. Similar results were seen in a study of leeks grown in the UK. (Backer, Aertsens, Vergucht, & Steurbaut, 2009). Inconsistencies are explained by low yields in the organic systems and the fact that manure application in organic crops, as opposed to the synthetic fertilizer used in conventional systems, leads to lower N leaching.

2.3 Greenhouse gas emissions/ GWP

The global warming potential (GWP) of a particular food production system is determined by emissions of greenhouse gases associated with agriculture, namely carbon dioxide, methane, and nitrous oxide. These emissions are caused by fossil fuel use, fertilizer application, fermentation during animal digestion, burning of biomass leftover after harvest, and production of off-farm inputs (fertilizer, machinery, pesticides). Organic farming processes are commonly thought to mitigate agricultural GWP.

Fifteen works analyzing the GWP of conventional versus organic agriculture were reviewed; of these, six resulted in lower GWP for organic, five resulted in higher GWP for organic, and four showed conflicting results. Three of the six articles demonstrating lower GWP in organic agriculture attribute their results to a lack of synthetic chemical fertilizer and pesticide use in organic systems; this exemption negates greenhouse gas emissions due to the production and application of such inputs (Backer et al., 2009; Snyder & Spaner, 2010; Wood et al., 2006). Reduced use of fossil fuels was another common explanation for low GWP in organic production, partially due to the fact that conventional farming systems use additional fossil energy to dry grass, support indoor confinement climate, and transport off-farm inputs (Haas et al., 2001; Pimentel et al., 2005; Wood et al., 2006). Other explanations include lower nitrous oxide emissions from manure in organic systems versus synthetic fertilizers in conventional systems (Backer et al., 2009; Haas et al., 2001; Knudsen et al., 2010; Snyder & Spaner, 2010), and extra emissions in conventional agriculture due to the burning of organic matter left in the field after harvest (Knudsen et al., 2010).

Of the four studies that show higher GWP for organic systems, two attribute their results to increased “enteric fermentation” in organic cattle due to differences in organic and conventional cattle feed; organic cattle spend more time on pasture and therefore eat more “roughage fodder” which produces more methane than concentrated conventional feed (Cederberg & Mattson, 2000; Thomassen et al., 2008). Direct nitrous oxide emission from management and spreading of manure were also cited as causes for higher GWP in organic systems (Fedele et al., 2014; Thomassen et al., 2008), contradicting aforementioned studies stating that synthetic chemical fertilizers emit more nitrous oxide. Two studies explained the higher GWP of organic livestock production methods by pointing out increased greenhouse gas emissions in the production and transportation of organic feed (Leinonen et al., 2012; Thomassen et al., 2008). However, the trend of importing organic feed varies spatially; the Leinonen et al. study took place in the UK, which consists of islands with limited space for crop production necessitating imported feed. One paper showed higher GWP only in the conversion stages from conventional to organic rice production in Japan (Hokazono & Hayashi, 2012).

Tuomisto et al. (2012) compared multiple types of organic and conventional agriculture, and found that organic olives and beef showed lower GWP than conventional and the opposite was true for pork and milk. These results are explained by lower fossil fuel use in organic olive farming and less reliance on off-farm inputs in organic beef production, as well as high nitrous oxide emission from the decomposition of straw litter in organic pork production and high methane and nitrous oxide emissions combined with lower milk productivity in organic milk manufacturing. Another study carried out in a cattle farm that includes both milk and meat production in the Netherlands showed that GWP was higher in organic production before emissions were allocated to either milk or meat, and equal GWP levels after allocation; the authors attribute this to the ban on chemical fertilizer in organic agriculture (Kristensen, Mogensen, Knudsen, & Hermansen, 2011). The functional unit of analysis highly influences the results of GWP analysis. When GWP is assessed using unit area, organic has the lowest emission of greenhouse gas; if kilograms of product is the unit of analysis, organic production has the highest GWP value (Basset-Mens et al., 2007). This can be explained by the lower animal density on organic farms. One study found that differences in GWP were not due to organic versus conventional production systems, but are a result of differences in topography of the land (some land is easier to use machinery on), the need to store products, and the way manure is managed (Liu, Langer, Høgh-Jensen, & Egelyng, 2010).

2.4 Human and Animal Health and Welfare

Conventional industrial livestock production often involves processes that are harmful to the animals it produces as well as to humans. Pesticides are toxic and have negative effects on human health. The high densities of animals in confined feeding operations greatly increase the risk of disease among livestock; many of these diseases, such as mad cow disease, can be passed to humans. Because of the high disease risk associated with conventional livestock manufacturing, animals in these systems are often fed preventative doses of antibiotics over their entire lifetime; this practice selects for antibiotic resistant bacteria, such as *Salmonella* and *E. coli*, that can wipe out livestock populations and cause human fatality (Tilman et al., 2002). It is a common consumer expectation that organic products are healthier for humans and better for the welfare of livestock animals (Lynch, 2009).

The effects of organic farming on livestock welfare are not well studied, and I was only able to find five references to it in the reviewed literature. Only one paper, on dairy cattle in Germany, focused heavily on animal welfare as an LCI, and found that low-input mixed organic livestock production had the highest animal welfare rating when using the categories of food intake, motion, social behavior, resting behavior, hygiene, and horn amputation (Müller-Lindenlauf, Deittert, & Köpke, 2010). Three other sources concluded that organic farming techniques are better for livestock. Haas et al. (2001), also a study on German cattle, found that housing conditions (such as space and brightness), medical care, grazing time, and herd management techniques were more beneficial for the cattle in organic farms. A second study found that cows in organic dairies in Sweden have longer lives and produce more calves than cows in conventional dairies (Flysjö et al., 2012). The third source in favor of organic livestock techniques argued that the increased use of pasture in organic cattle farming results in healthier cattle because bovine biology is designed to digest grass and not concentrated animal feed, which consists mostly of grain (Pollan, 2006). One article reported that organic livestock production has both positive and negative effects on animal welfare; the authors found that due to the increased use of pasture in organic cattle systems, animals suffered less from foot and leg problems, but they also experienced more exposure to parasites and lower rates of weight gain (Hafla et al., 2013). In most countries, in order for a livestock operation to be certified organic, the livestock are required to spend a significant portion of their life on a pasture. Pasture lands have a much larger area than confined feedlots, so animals are not in close contact and therefore less susceptible to disease.

I was able to find seven sources on the topic of the effects of organic agriculture on human health. One study on olive farming in the Mediterranean found that organic agricultural techniques have a more negative effect on human health than conventional processes (Mohamad et al., 2014). The results of this paper were highly influenced by the fact that carcinogens, respiratory organics, respiratory inorganics, climate change, radiation, and stratospheric ozone depletion were the categories comprising the human health indicator; in most literature, climate change and ozone depletion are not often included in human health metrics. The authors explain that the negative impacts associated with these categories can be attributed to manure fertilization. Five articles reported that organic agriculture is better for human health than conventional farming because most pesticides, which are toxic to humans, are banned in certified organic products (Backer et al., 2009; Benbrook & Baker, 2014; Cederberg & Mattson, 2000; Knudsen et al., 2010; Pimentel et al., 2005). Nitrogen runoff from crop fertilization has been found to increase parasitic and infectious diseases in humans (Johnson et al., 2010; McKenzie & Townsend, 2007). Organic farming can reduce this problem because it doesn’t rely on synthetic nitrogen fertilizers and higher levels of biological matter in organic soils lead to less nitrogen runoff.

2.5 Energy use

Energy use contributes to global warming and the carbon footprint of agriculture, and most of the energy used in food production comes from unsustainable sources. Energy use is akin to global warming potential because the effects of energy use include mainly fossil fuel use which leads to emissions of carbon dioxide. Sustainable farming practices include a need for low-energy production systems because it is unsustainable for the energy used in food production to exceed food energy yield. Comparisons of energy use in organic versus conventional agricultural systems are reviewed here.

Eight articles point to organic agriculture as a less energy intensive production process than conventional farming. Three point specifically to reduced reliance on purchased feed, which eliminates the energy consumption required to transport it (Cederberg & Mattson, 2000; Haas et al., 2001; Thomassen et al., 2008). Elimination of synthetic fertilizers and pesticides is another popular explanation for the energy efficiency of organic agriculture because the production and transport of these inputs is highly energy intensive (Cederberg & Mattson, 2000; Knudsen et al., 2010; Mohamad et al., 2014; Pimentel et al., 2005; Snyder & Spaner, 2010). The process of grass drying, where ventilators and heating are used for the production of grass pellets that become indoor feed, is common in conventional agriculture, but is rarely used in the manufacturing of organic food; this lack of reliance on grass drying for animal feed reduces the energy expenditure of organic farming (Haas et al., 2001). Mechanical weeding versus use of pesticides can also reduce energy consumption in organic crop production (Mohamad et al., 2014). All of these practices reduce fossil fuel usage in organic food production.

A paper by Leinonen et al. (2012) found the opposite result; the organic chicken feed production system used more energy than the conventional one. Most of this energy is used for production of feed, heating, lighting, and ventilation for broiler birds. Another study reported higher energy use in organic cattle farming attributing it to increased consumption of fossil fuels in the form of diesel fuel used in tractors. The reliance on pasture fodder, which has a low yield in organic livestock production, requires more tractor use for harvest (Flysjö et al., 2012). Conflicting results were found in three sources. Research on multiple types of organic farms in Australia show that off-site energy requirements are lower in organic production, but on-site energy use is higher. These results are explained by heavy reliance on agrochemicals in conventional agriculture as well as increased use of petroleum and diesel on organic farms (Wood et al., 2006). Snyder & Spaner also found that there is commonly more fuel usage on organic farms than on their conventional counterparts. Two papers report that organic agriculture appears to require less energy than conventional agriculture when the unit of analysis is based on area, but when unit product is analyzed conventional systems seem to be less energy intensive (Backer et al., 2009; Basset-Mens et al., 2007); this is most likely due to the reduced productivity and low animal density seen in organic, as compared to conventional, farming techniques. In research done on pear production in China, storage necessity, topographical variation, and differences in the handling of manure were credited for differences in energy consumption rather than differences between organic and conventional production systems (Liu et al., 2010). This mirrors the results for GWP in the same study.

2.6 Land Use and Yield

The transformation of wild land for agricultural production is an important contributor to reduction in ecosystem services. The majority of the productively valuable land on earth's terrestrial surface has already been converted for agricultural use (Tilman et al., 2002); as such, an aim of sustainable agriculture is to decrease land use change. As a candidate for sustainable agriculture, there is an expectation that organic food production would help reduce the negative effects of land use change.

In a review of literature on land use in organic versus conventional crop and livestock production, nine studies found that organic farming practices require more land than conventional techniques. Four of these focused on dairy farms. Two papers looking at Dutch dairy farms state lower yields in cattle feed production and lower animal density as reasons for the increased land use in organic livestock systems (Kristensen et al., 2011; Thomassen et al., 2008). Low animal density in organic dairy production is due to pastoral feeding versus the confined feed lots associated with conventional dairy farms. In research on Swedish dairy farms, organic production was shown to occupy more land when all land use associated with dairy manufacturing was considered equally, but shown to occupy less land when soy was included in the study (Flysjö et al., 2012); this is most likely due to the fact that less soy is used in organic cattle feed and it is the only paper showing organic to be less land intensive. An additional Swedish study by Cederberg and Mattson again found that the organic method occupies more land. In a paper by Leinonen et al. (2012) on chicken production in the UK, the organic chicken feed production system occupies the largest area of land. Research on pork manufacturing in France is in agreement with the dairy and chicken studies, with the highest land use being reported when LCA analysis is done on per kilogram of meat versus per unit area (Basset-Mens et al., 2007); this is again due to low animal density and less efficient production of feed. The consensus is that the high land occupation value is associated with the organic system in many studies is a result of the fact that more land is required to grow organic crops for feed than for conventional. However, low animal density in organic livestock production results in less disturbed land. In terms of non-animal organic agriculture, five articles reported higher land use in organic systems; none reported lower land use for organic production (Fedele et al., 2014; Knudsen et al., 2010; Kristensen et al., 2011; Tuomisto et al., 2012; Wood et al., 2006). All five studies cite low yield as the cause.

There is much agreement upon the fact that organic farming results in lower yields. In the sixteen articles reviewed on the topic of yield levels, only one showed that organic agriculture can result in higher yields than conventional, and only in melon production where soil organic matter is more abundant than in conventional production (Tuomisto et al., 2012). The remaining fifteen papers show the opposite results citing yields from 5% to 34% lower for organic production (Backer et al., 2009; Cederberg & Mattson, 2000; de Ponti et al., 2012; Flysjö et al., 2012; Hafla et al., 2013; Leifeld, 2012; Leinonen et al., 2012; Lynch, 2009; Meisterling et al., 2009; Paull, 2008; Pimentel et al., 2005; Schader et al., 2014; Seufert et al., 2012; Snyder & Spaner, 2010; Thomassen et al., 2008; Tuomisto et al., 2012). Justification for these results for organic farming include lower nutrient levels in pasture versus concentrated feed (Schader et al., 2014), lower nitrogen availability due to lack of chemical fertilizers (Thomassen et al., 2008; Tuomisto et al., 2012), lower animal density (Cederberg & Mattson, 2000), and increased crop loss due to pests (lack of pesticides in organic production) (Tuomisto et al., 2012). Three studies show that organic farming can match the yields of conventional, but usually only in drought conditions (Ceccarelli, 2014; Meisterling et al., 2009; Pimentel et al., 2005); higher water storage capacity in organic soils is the stated explanation for these results.

Some research shows that tradeoffs in exist in organic farming methods that can offset yield issues. One study found that organic cows produce 10% less milk than their conventional counterparts, but explains that this can be made up for by the fact that organic cows deliver 7% more calves during a lifetime than conventional cows (Flysjö et al., 2012). Analysis by Leinonen et al. (2012) uncovered that organic chickens require more feed per bird but produce more meat per bird due to their high efficiency in the conversion of feed to body mass and the low finishing weight in their conventional analogs. Two papers explained that enhanced nutritional quality in organic crops can make up for lower yields; this is demonstrated by higher nutrient levels due to more biodiverse fungal and microbe populations in organic plots (Hafla et al., 2013; Nelson et al., 2011).

Results vary widely between the impacts within both conventional and organic food processing schemes. Based on society's view of organic farming as more sustainable and environmentally friendly, these results are surprising. Although there are many differences between organic and conventional farming systems that make comparisons beneficial, reducing them to generalizations is problematic because there is no single conventional or organic agricultural system; each system includes a spectrum of agricultural management processes that vary spatially, temporally, and according to producer choice. Results vary based on conditions other than certified practices of organic farming technique, including, but not limited to, the unit and method of analysis, inclusion of upstream effects, tillage practices, weed and pest management techniques, degree of necessity for imported products, climate, topography, and method of manure management. Analysis of environmental burdens is more relevant when unit of production is used rather than unit area because it negates the effect of animal density on the results. With the exception of land use and yield, effects and emissions levels associated with a particular farming practice are at the same levels regardless of the area measured. For example, if 3 kg of carbon dioxide are released into the atmosphere over a 10 hectare field or a 100 hectare field, the greenhouse gas level in the atmosphere still goes up by 3 kg, meaning the burden to the climate is the same either way. There is no clear black and white answer as to which farming practice, organic or conventional, is more environmentally sustainable. Rather, there are a series of tradeoffs between environmental burdens and benefits. For example, conventional farming has higher yields, but organic farming is better for biodiversity conservation. The principle dilemma for organic production is to boost yields without further environmental degradation.

3. Sustainable Agriculture

As discussed in the explanation of ecosystem services in section 1, the pool of natural resources and processes that nature provides us are not infinite. The concept of sustainability, in relation to human development, concerns attempts at preserving this pool of resources to permanently support human life on earth. Humans rely on natural resources, such as water, nutrients, and land, and ecosystem services, such as pollination, trophic interactions, and photosynthesis to produce food. In broad terms, sustainable agriculture is aimed at trying to maintain the resource reservoir and ecological processes necessary to produce food in order to support society in the long term, if not indefinitely.

Currently, there is no consensus on the precise meaning or definition of sustainable agriculture. Opinions vary based on what aspects of agriculture benefit an individual or social group. The proceedings of the Convention on Biological Diversity, composed of international delegates, define sustainable use of land and natural resources as, “using biodiversity components in a way and at a rate that does not lead to the long-term decline of biological diversity, thus meeting the needs and aspirations of present and future generations” (Caro & Durán, 2012, p.49). Many concepts of sustainable agriculture focus only on environmental and biodiversity protection, the LCA studies cited in section 1 contain examples of this view. Others include not just environmental interests, but also concerns about economic and social sustainability. In their vision of sustainable agriculture the organization Sustainable Agriculture Research and Education present the 3 Pillars of Sustainability: profit over the long term, stewardship of our nation's land, air and water, and quality of life for farmers, ranchers, and their communities (SARE Outreach, 2012). The Food and Agriculture Organization of the United Nations define sustainable agriculture as "the management and conservation of the natural resource base, and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such development... conserves land, water, plant and animal genetic resources, is environmentally non-degrading, technically appropriate, economically viable and socially acceptable" (Food and Agriculture Organization of the United Nations Agriculture and Consumer Protection Department, n.d., n.p.). The USDA's definition of sustainable agriculture was first defined in the 1990 Farm Bill under U.S. Code, Title 7, Chapter 64. It states that, "the term sustainable agriculture means an integrated system of plant and animal production practices having a site-specific application that will, over the long term:

- satisfy human food and fiber needs;
- enhance environmental quality and the natural resource base upon which the agricultural economy depends;
- make the most efficient use of nonrenewable resources and on-farm resources and integrate, where appropriate, natural biological cycles and controls;
- sustain the economic viability of farm operations; and
- enhance the quality of life for farmers and society as a whole" (Gold, 2007, n.p.).

Although these definitions include economic and social components, they are vague, subject to interpretation, and lack detail on the specific factors and processes involved in their descriptions. Any prospective sustainable food production system can be greatly impeded by social and economic barriers to its adoption or persistence. It is, however, important to acknowledge the difficulty of making any short concise definition of sustainability comprehensive.

An economically viable production system traditionally brings to mind benefit to industry, but must also include production practices that are affordable for small scale or subsistence farmers as well as products that are affordable for consumers in developed and developing nations. Affordability includes not only the costs of land, conversion, farming equipment, labor, and agricultural inputs, but also the cost of certification, which is necessary for entry into the organic market. Producers of organic goods must also be able to acquire financing, and in the end, make a profit on their products, a profit that reflects a price consumers are willing to pay. Ideally, a sustainable food production system would allow for equal opportunity among farmers to gain access to the market.

Even though definitions of sustainable food production often highlight environmental burdens as paramount, I argue that social sustainability is equally important. Sustainable agriculture includes food security and adequate nutrition for the entire human population, because this is a necessity for the support of posterity. Any sustainable agricultural system would need to have a crop yield high enough to sustain the nutrition needs of a population as well as an effective system of distribution. Supplies of organic goods must be able to meet societal and consumer demands. Requirements for sustainability in food production include promotion of human health and well-being. This consists of safe working conditions and a living wage for farmers and farm workers and the production of healthy food with an appropriate nutrient to calorie ratio to avoid negative health effects such as diabetes and obesity; highly processed foods do not often meet these qualifications. If taking into account human health, sustainable farming would also require mitigation of processes that contaminate water supplies with antibiotics, pesticides, or fertilizers. Additionally, it is important to incorporate animal welfare; many people are opposed to and put off by food production techniques that are cruel to animals, and profits can be obliterated by a bad reputation or if large numbers of animals get sick and die.

In order to persist, an agricultural system that has the potential to be considered sustainable must be socially acceptable. Social acceptability consists of government, community, and institutional support. Government support requires government endorsement, acknowledgement of the benefits of a particular farming practice, and financial assistance. Community support includes education and acceptance of consumers and society in general. If your neighbors disagree with or feel threatened by a particular farming method, it will be difficult for your farm to survive. It is also essential that farmers, ranchers, and customers be educated about the components, requirements, and processes of any proposed sustainable practice. People are unlikely to take risks and spend money on something they don't fully understand. Institutional support incudes the acceptance and cooperation of private and public groups and institutions such as scientists, organizations that fund research, Land Grant Universities, certification bodies, consumer advocates, NGOs, and business interests. Proposed methods of sustainable agriculture that downplay or disregard social viability are not comprehensive (Constance & Choi, 2010).

Environmental and ecological preservation are better understood and most often associated with sustainable agriculture. Farming and ranching approaches are considered sustainable if they protect ecosystem services and mitigate the consequences of conventional industrial agriculture (detailed in section 1), such as greenhouse gas emissions, climate change, acidification and eutrophication of aquatic systems, deforestation, land use change, fossil fuel use, biodiversity loss, and development of antibiotic, pesticide, and herbicide resistance.

It is difficult to prove or asses the sustainability of a particular method of agriculture because any evaluation of the extent of a sustainable production system could not occur until the distant future. Therefore, any testament to the true sustainability of any method of agricultural production is necessarily hypothetical and speculative (Rigby & Cáceres, 2001). Regardless of differing ideas as to what attributes should be included in sustainable agriculture, as pointed out in the introduction of this thesis, there is little argument that the status quo of agricultural production is unsustainable.

Another aspect of sustainable agriculture that makes it difficult to define is that the sustainability of any food production system will vary temporally and spatially (Rigby & Cáceres, 2001). Agricultural practices that are sustainable for sub-Saharan Africa may not be sustainable for southern California. Temporal variation may depend on seasonality or future effects of climate change. It is difficult to create a regulatory or certification system for sustainable agriculture because of the lack of a comprehensive and united description of the term (Rigby & Cáceres, 2001).

In the absence of a universally accepted definition of sustainable agriculture, it is difficult to steer agricultural policy toward more sustainable production practices. Nevertheless, many governments and institutions have been influenced enough by the plethora of definitions of sustainable agriculture to develop social attention and conversation on the subject.

4. The Organic Ideal

The first appearance of the term “organic agriculture” was in *Looking To the Land*, written in 1940 by the Oxford agronomist Sir Northbourne, and focused mainly on societal concerns about the growing use of synthetic farm chemicals. The concept of organic agriculture was developed as a critique of the industrialization of agriculture during the Green Revolution in the second half of the 20th century and emphasized environmental conservation, crop rotation, elimination of chemical inputs, soil health, and sustainable use of land (Caro & Durán, 2012). The idea was further developed by another British agriculturalist named Sir Albert Howard in his book, *An Agricultural Testament*. Howard's book has been termed the bible of the organic movement because it parallels agricultural industrialization with the problems of society. It mixes a call for a return to nature with a rejection of the industrial machine in the form of synthetic fertilizers and proposes that "reductionist science" has whittled the complex ecological processes involved in plant growth down to three components: Nitrogen, Phosphorus, and Potassium (NPK). The book was a warning that artificial fertilizers would lead to the creation of artificial people, through artificial nutrition and the ingestion of artificial food and animal products, and damage the health of the soil and the health of the British nation (Pollan, 2006).

The processes and ideals of the organic food system were popularized by the counter-culture movement of the 1960s and 1970s in the United States and Europe and were aimed at changing the way society grows and consumes food. In a time when so called "hippies" were protesting the Vietnam War and trying to renovate society, organic farming represented a way of nourishing oneself without participating in the military-industrial complex. These initial proponents of organic agriculture wanted not only to reinvent the way food was grown; they wanted to change the world and the human relationship to it. This desire led to the creation of communes and food co-ops as alternatives to capitalist food distribution and a "countercuisine" of unprocessed chemical free foods and whole grains that were a challenge to conventional "white bread" or "plastic" industrially produced foods (Pollan, 2006). To its supporters, organic food began to represent a challenge to industrialization's conquest of nature and the war machine, and as such became a hot political issue. Organic food production symbolized sustainability and environmental responsibility and emphasized community living/sharing, buying locally produced food, leaving land more nutrified after harvest, crop rotation, composting, polycropping (growing multiple types of crops per plot), permaculture (agricultural practices that mimic systems found in nature), on-farm feed production, pasturing, and small scale operations. A central tenet of original organic farming was the "closed system," meaning that all inputs are generated on the farm, and all outputs are used or recycled back into the system. For example, cows graze on a pasture and their manure is then used to fertilize that same pasture (Leifeld, 2012).

As the radical movements of the Vietnam era slowly gave way in the 1980s, organic food became more of a health choice and less of a political message. After multiple food safety scares, people became much more cautious of what they were consuming, and organic seemed like a cleaner, safer, and more wholesome way to eat. During this time period, organic also came to be associated with affluence. R. Brooks Geckler of Small Planet Foods, the maker of Cascadian Farms organic products, calls affluent health-conscious consumers "health seekers" (Pollan, 2001). They represent a new generation of people who purchase organic foods for the health benefits they claim to offer versus social responsibility or environmental concerns, and they make up an estimated 25% of US consumers. As this demographic began to grow in the 1980s, demand for organic products skyrocketed (Buck, Getz, & Guthman, 1997).

In my own experience, when asked what organic entails many people have described organic to me as a more natural way to produce food. A common conception of organic is that it is less processed and more local than conventional food, that it is produced without synthetic chemicals, it's more environmentally friendly, and that livestock are treated better. Organic farming is also often associated with the image of a small family farm. Buying organic allows consumers to feel that they are making a more socially responsible and healthy decision about where their food is coming from and how it is produced. Because of the counterculture and health seeking movements, society has come to highly regard the term organic. This esteem for organic products has proven to be very beneficial for their producers. When consumers see the word “organic” on a product’s packaging they attribute their personal definition of what organic is to that product. People make up their own ideas of what organic is based on a conglomeration of what they have learned about organic, their own personal experience, marketing, and anecdotes on packaging and in the media. Due in part to the fact that organic means something different to each person depending on his or her life experience, the USDA codified the term beginning in the 1990s, (Buck et al., 1997; Caro & Durán, 2012) shaping the organic reality, which will be examined in the following section.

5. The Organic Reality

The most common food production system in the United States is the conventional industrial system, also known as factory farming. Conventional farming and livestock systems attempt to fit food production into an industrial business model. They are designed to process ever greater amounts of food commodities to increase the profit per unit product and increase the market share of producers and processors. Conventional industrial practices include, but are not limited to, mechanized farming of large contiguous plots of land, use of antibiotics and growth hormones, use of genetically modified organisms (GMOs), concentrated animal feeding operations, use of large amounts of synthetic petroleum-based fertilizers and pesticides, intensive irrigation, and monocropping (Cederberg & Mattson, 2000; Lynch, 2009; Notarnicola et al., 2012; Pimentel et al., 2005; Tilman et al., 2002; Tuomisto et al., 2012). Organic food production was originally developed as an alternative and opposition to conventional agricultural practices and the negative consequences associated with them.

To ensure that consumers knew what they were paying for and that they were getting the same quality of food across different producers, the term “organic” needed government legislation to define and codify it. Before the 1980s, the movement of organic agriculture was kept alive by an assortment of trade groups, farmers, and grassroots associations that formed national cooperatives and associations in several different countries to campaign for their cause (Caro & Durán, 2012).There was no governing body, regulation, or certification system surrounding organic food production. The first laws standardizing organic were drafted in the late 1970s by Oregon and California (Caro & Durán, 2012), but as demand grew for organic products and larger companies became involved in the business of organic food production it became clear that national legislation was necessary. Confusions concerning a nationally unified definition of organic were put to rest, at least in the United States, in the 1990s when the Organic Food Production Act was passed by Congress (Pollan, 2001). This act instructed the USDA to create nationally unified standards on what organic food and production processes were to include. The process of fine tuning this codification was a difficult battle between the old organic movement and the new agribusiness industry that took the better part of a decade, resulting in the 2002 National Organic Program (NOP) (Heffernan & Constance, 1994). On one side of the bargaining table were the pioneers of organic farming who were concerned about the land and trying to create a standard based on the organic ideal, on the other were large agribusiness interests who were concerned mostly about how to make money using the organic process. In the end, the business interests won, leading to a US organic standard that was based on a list of approved inputs versus a prescription of the ecologically sustainable practices. Organic farmers did have one victory over the desires of organic business interests; due to protests by organic social movements, municipal sludge, GMOs, and irradiation were prohibited under the NOP regulations (Constance & Choi, 2010).

4.2 Conventionalization of organic agriculture

Before the passage of the NOP, starting in the 1980s when consumer demand for organic products began to increase rapidly, large agribusiness firms began to get involved in the business of organic food production. This involvement on the part of large food production conglomerates gave birth to a second type of organic farming, the most dominant organic system used in North America and Europe, industrial organic. Agriculture, conventional or otherwise is a risky business because it is unpredictable. The unpredictable processes of nature, such as weather and pests, can cause unforeseeable losses in product and profit; a phenomenon that Julie Guthman terms “Agricultural Exceptionism,” as it is an exception to the average industry that fits neatly into the industrial model (Guthman, 2004, p.63). Agribusiness firms attempt to fit agricultural production to the industrial model in order to mitigate these risks. The industrial organic farming and food production systems implement large scale industrial farms and feedlots, contract farming, global transportation networks, mechanized production, crop fertilizers, high levels of off-farm inputs, and monocropping (growing a single high profit crop on large areas of land). While still meeting organic standards, the emphasis in industrial organic farming and livestock production is placed on making profit and growing market share.

The misconceptions of consumers concerning the agronomics of organic food production are associated with its industrialization by large agribusiness, a process known as “conventionalization” (Buck et al., 1997). As organic farming practices are conventionalized, focus shifts from process to input. The process by which industrial organic food is produced is much the same as conventional mass production, except it uses only the inputs, most commonly pesticides and fertilizers, ordained by the agencies and government organizations that certify it as organic (Buck et al., 1997). The process of producing agricultural products is not really changed, only the inputs. However, production processes are the most environmentally impactful step in food manufacture, encompassing 83% of the GHG emissions associated with the average US household's food consumption carbon footprint (Weber & Matthews, 2008). Figure 1, below, shows the amount of overall climate impact, using GHG emissions as a proxy, of different food groups broken down by steps in the supply chain. Transportation (delivery and other freight categories) accounts for 11% of GHG emissions, wholesaling and retailing of food make up 5%, and the largest portion of GHG emissions come from the production phase of food (83%). Note the length of the graph bars for the four categories associated with production in Figure 1 below.

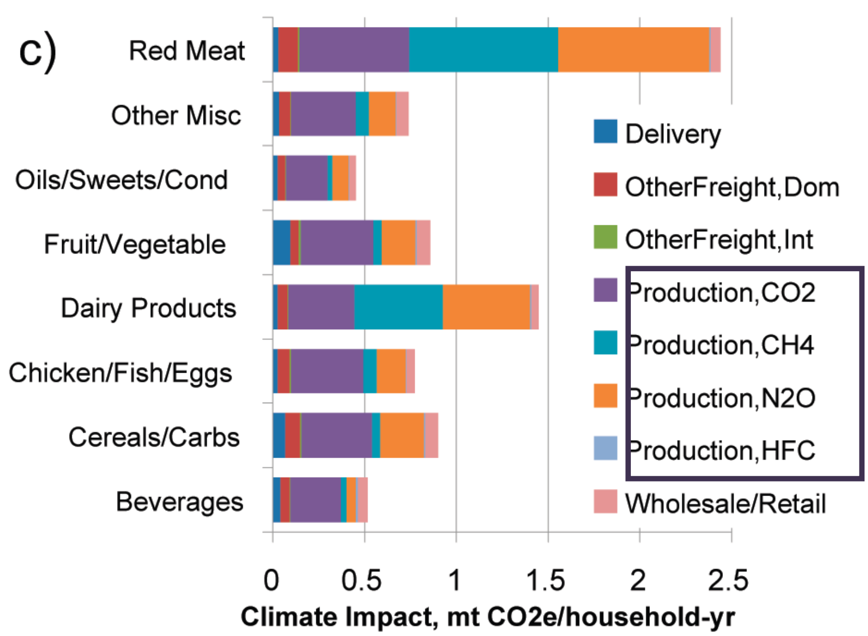


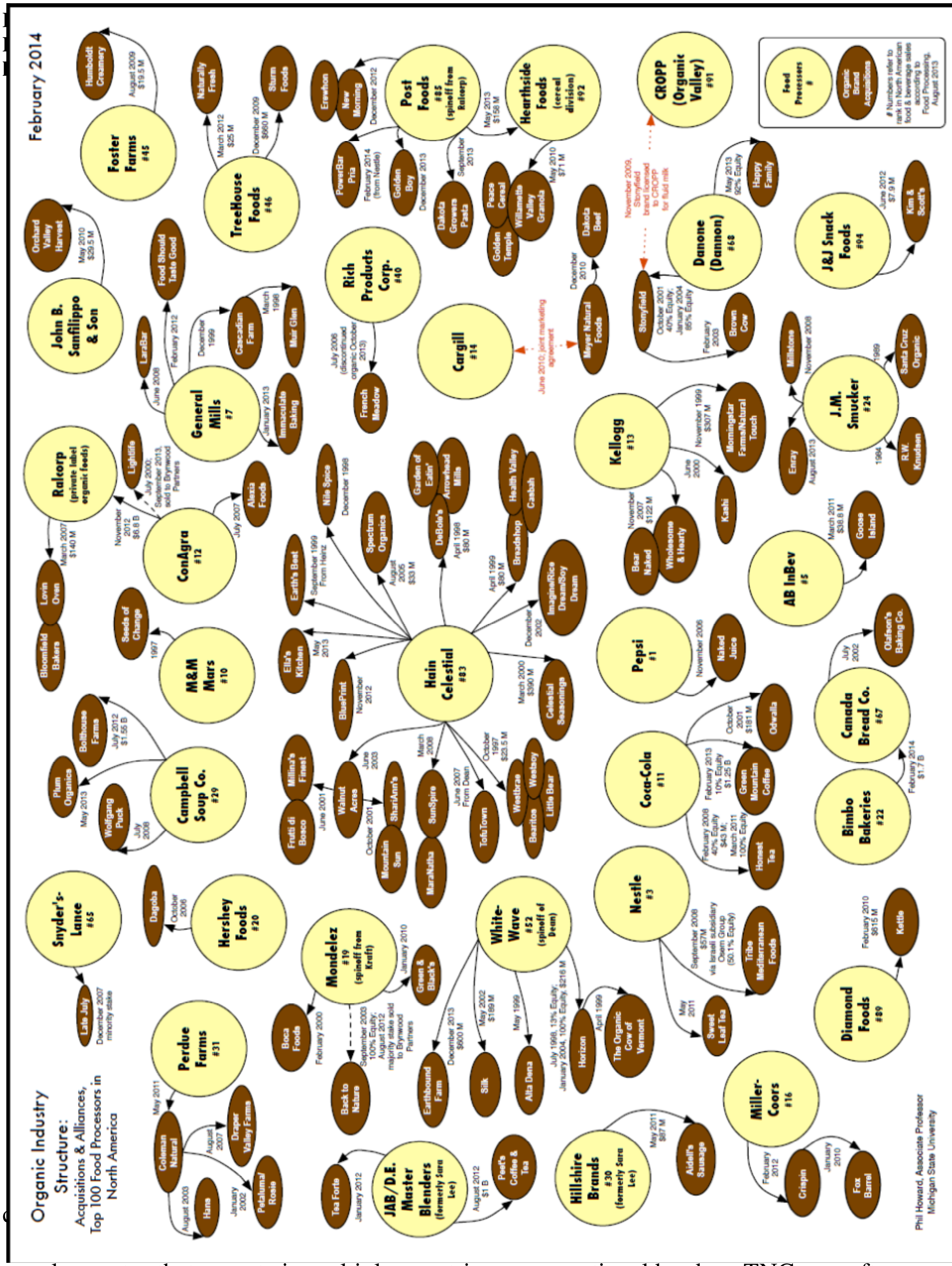
Figure 1: Total t-km of freight by mode per year per household associated with household food consumption in the United States, and comparative climate impacts of different food groups. (Figure 1(c). Total t-km of freight by mode per year per household (c) associated with household food consumption in the United States,

and comparative climate impacts of different food groups. From "Food-miles and the relative climate impacts of food choices in the United States," by C. Weber and H. Matthews, 2008, *Environmental science and technology, Vol. 42,* p. 3508-3513. Copyright [2008] by American Chemical Society.)

How did conventionalization take organic from the organic ideal to industrial organic? Beginning in the 1980s, conventional agribusiness began infiltrating the organic market and changing the nature of organic food production. To avoid the expensive sustainable agronomic processes once associated with the organic food movement, mitigate risk, and to achieve economies of scale, industrial food manufacturers applied conventional industrial food production systems and processes to organic. These techniques are quite the opposite of the practices of the original organic methods. Instead of polycropping or growing diversified crops, industrial organic emphasizes monocropping. Monocropping allows for mechanized production by growing a single high profit crop on large parcels of continuous land; this process decreases the cost of production per unit product, thus increasing profit per unit product. Instead of using composting, crop rotation, and permaculture to nutrify crops, industrial organic practices involve high levels of mechanized fertilizer application of both natural and synthetic origin (United States Department of Agriculture, 2013). This contradicts the practice of the closed nutrient cycling farm system that characterized the organic ideal. Instead of an emphasis on locally grown products, industrial organics sold in the United States and Europe are often imported to meet counter-seasonal consumer demand. A 2001 New York Times article uncovered that Cascadian Farms, an agriculture conglomerate that produces processed organic foods, imports raspberries from South America to use in their frozen products because the ones produced on their farm in Washington state are too expensive to use (Pollan, 2001). Organic ranchers and dairy farms in Europe often import grain and soy for organic animal feed from Romania, Ukraine, and China (Knudsen et al., 2010; Leinonen et al., 2012). Confined Animal Feeding Operations (CAFOs), in the conventional sense, are prevented by USDA organic standards because animals are required to have access to the outside; in addition, recent legislation requires that organic cattle spend a certain portion of their life grazing on pasture (United States Department of Agriculture, 2013). What is not mentioned is that “access to the outside” can be as little as a single door with a small platform for animals. There is also no specification of how much space organic livestock and poultry must have to move, so animals can be crammed into a small space as long as they have “access” to the outdoors. With respect to organic cattle, after they complete the pasture portion of their lives, they are often taken to feedlots where they are in conditions similar to the CAFOs found in conventional livestock production. The conventionalization of organic processes allowed, and continues to allow, industrial organic producers to take advantage of the high profit margins associated with the sale of organic food by using conventional industrial food production processes and simply changing the inputs to meet the standards associated with an organic label (Buck et al., 1997). Agribusiness capital has revamped the structure of organic food production because large growers and processors dominate the business of organic agriculture, and therefore influence competitors in the market to adopt their methods.

Part of its induction into the industrial model was the consolidation of the organic market. Industrial consolidation occurs when a small number of producers control a large portion of the commodity chain in a particular industry (Buck et al., 1997; Harper & LeBeau, 2002). Market concentration happens through the processes of vertical and horizontal integration. When a market becomes vertically integrated, a few firms own multiple stages of production in a supply chain. In relation to agriculture, an example would be one company owning a growing operation, a livestock slaughtering operation, and a packing operation. Horizontal integration refers to a situation where a few market actors own a single step of a supply chain; an example would be one company owning 90% of all meat packing plants in the livestock market. Vertical and horizontal integration in the organic farming industry have led to a market situation where there are so few producers or sellers that the actions of one can affect prices and profits of market competitors, limiting competition. In order to achieve economies of scale, it was necessary for organic agribusiness firms to produce more and more products leading to a reduced cost per unit product. These actions drive consolidation because one easy way to increase your production is to buy out your competitor and thereby gain their market share. This is the process of conglomeration, and it leads to one parent company that owns multiple subsidiary companies. The larger a company gets, the more competitive it becomes, and this drives down profit margins enabling the company to dominate the market. Figure 2 illustrates the concentration and conglomeration of the US organic market as of February 2014.

Along with market concentration, came appropriationism and substitutionism. Because of the risks associated with agricultural exceptionism, agribusiness found ways to make money in agriculture off the farm. This involved appropriating processes that were historically generated on-farm and converting them to inputs that are produced in a factory and then sold back to the farmer, also known as appropriationism. Another way for agricultural production to generate profits off-farm is substitutionism, where value added products, such as pre-cut and packaged apples, are created to capture additional profits in retail, distribution, and processing sectors of the commodity chain (Buck et al., 1997; Wood et al., 2006).



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conglomerates that operate in multiple countries across national borders. TNCs are often unaffected by organic regulations because if they don't like the rules in one country, they can just take their business to another country. Through this behavior, and their incredible wealth, TNCs are able to influence legislation by refusing to set up production in countries with laws that are too strict to support their profit margins. Being located in multiple countries also allows TNCs access to products from around the globe; if they can't get grapes from California because of weather, they can just source them from Chile. TNCs are the primary players in and organizers of the modern system of food production because they create a globally sourced international food regime (Heffernan & Constance, 1994).

Farmer motivations for converting to organic production prior to the 1980s were based mainly on the opinion that it was the socially and environmentally responsible thing to do. After the demand for organic food began to skyrocket in the 1980s, conventional farmers started switching over to organic to take advantage of the high value production, high profit margins, and potential for market share associated with the untapped organic label. At the time organic was a niche market and there was little risk because the conversion period from conventional to organic only took one year. Some farmers were brought into organic production by contract incentives from intermediate buyers who guaranteed a market for their goods. In the 1990s farmers, mostly large farms operated as trusts that needed a place to sink money, were incentivized by changes in tax and pesticide regulation that made the pesticide-free low-input process of organic farming more appealing. Some converted because of personal experience with the health consequences of pesticide exposure, or consumer preference for "cleaner" food. The "character of the organic farmer" changed over time from environmentally concerned hippies to larger agribusiness firms that converted to organic in response to government regulation or high margin low risk investment returns. The original organic farmers got into organic farming for reasons much different than conventional farmers; but as the industry became more profitable and as consumer demand grew, farmers' motivations for converting to organic began to parallel those of conventional farmers (Guthman, 2004).

Agribusiness influence has effectively negated and defeated the original motivations associated with organic farming of creating an alternative to industrial conventional agriculture. Misconceptions are perpetuated by the fact that the producers of industrial organic still try to take advantage of the symbolism of the organic ideal. Organic products are often branded as something they aren't; small farmers are the face of organic because the idea is compelling to consumers. The visions of the organic ideal cultivate consumer trust; retailers are happy to tell consumers the story they want to hear. Production costs aren't as high as they are made to seem and they are crop-specific; this allows organic agribusiness interests to dupe people into paying a higher premium than they would when making a conventional purchase. This high pricing is acceptable because people feel that they are paying more to contribute to the benefits bestowed upon society of a sustainable and safe method of food production.

The benefits of organic agriculture touted by health seekers are not necessarily all they are cracked up to be. As mentioned in section 2 of this thesis, there are very few studies that have found an increase in nutrition quality in organic food versus its conventional counterparts. Organic products are marketed as pesticide-free, but they have been found to contain pesticide residue, albeit at levels much lower than conventional products. This phenomenon is much more prevalent in imported organic products than in those produced in the US or Europe (Benbrook & Baker, 2014). Because of the industrial production practices involved in most contemporary organic food manufacturing, many of the organic products seen on supermarket shelves today are processed. This is contradictory to the idea of pure, natural, whole foods embodied in the organic ideal. Although it may seem contradictory to USDA regulations and fairly controversial, organic products are not always free of genetically modified ingredients. GMO's (genetically modified organisms) transported from conventional farms can contaminate organic crops through windblown pollen. Because of this, certification doesn't guarantee GMO-free food, it just proves that no GMOs were intentionally used in its production.

Hiding behind the empty signifiers on organic food labels, pretty pictures of rolling fields of grain and "happy cows," is the hidden truth of the industrial organic food production system: It is much the same as the industrial conventional system and does not embody the organic ideal. Take Michael Pollan's description of his experience of reading a Cascadian Farm frozen dinner box that told the story of his meal in evocative prose. It described free roaming chickens, recycled packaging products, and chemical free veggies. However, when he looked at the ingredients list, it included many chemically synthesized and highly processed "enigmas of modern food technology" (Pollan, 2001, p. 2). In addition, the box revealed that Cascadian Farms, an organic farm trying to promote a "better world," is owned by one of the largest food conglomerates in the Americas, General Mills. Most people associate "organic" with the ideals of the aforementioned original organic ideal. They imagine a small scale family farm with an old beat up tractor and compost piles from the chickens and cows in the nearby barn. Industrial organic, however, is a whole different animal.

I have experienced these misconceptions myself. For example, I recently purchased a bulb of organic fennel at a local Kroger-owned grocery store (shown below). Figure 3 below explains to me, in no uncertain terms, that organic means:

Figure 3: Cal-Organic fennel label

1. Soil is “nurtured” with organic matter.
2. Crops are rotated.
3. Cover crops are planted.
4. Farming is in “harmony,” sustainable, and promotes a healthy environment.

First of all, this label uses a significant amount of evocative prose, flowery descriptive words like “nurture,” “healthy,” “harmony,” and “fertile.” These words are obviously intended to appeal to emotion and environmental friendliness ideals. Secondly, the label seems to claim that all organics are produced in this way as it says “Some of the benefits of organics” and not “Some of the benefits of *our organic system*.” The point is, this label leads people to believe that anything with a USDA organic label slapped on the package has been produced using the techniques of original organic, and this is just not true. Surprisingly, the label doesn’t mention some of the positive attributes of organic that are included in its official regulations, such as production without GMOs, sewage sludge, or pesticides.

This label, and the fennel bulb it was attached to, are produced by Cal-Organic, a subsidiary of Grimmway Farms. The Grimmway Farms website has a link to the Cal-Organic website which shows a picture of this “family farm.” It is a picture of a giant combine harvesting a massive plot of land on an industrial-looking site. Grimmway Farms does appear to be family owned, but they are a corporation wherein a member of the original Grimmway family runs the board (Grimmway Farms, 2014). Grimmway’s status as a “family farm” is best understood as an empty signifier, a symbol that suggests meaning without actually stating it or pointing out what it is. It suggests that all organic farms, including the one this fennel was produced on, embody the techniques once proposed by the purveyors of the original organic movement. I can say with certainty, however, that even though it was produced using industrial organic techniques, this fennel was quite a bit more expensive than the conventional variety.

It is easy to vilify TNCs and large agribusiness firms, but all farmers are subject to the pressures of operating in a capitalist society; it would be negligent not to acknowledge the fact that businesses need to innovate, cut costs, and effectively eliminate competition in order to survive in the market. Unfortunately, in this scenario, environmental concerns as well as social and market equality, are left in the dust. These things are the easiest to neglect because they are not in the public spotlight for the entire world to see. The narrative of the organic ideal and the misrepresentation of the corporate nature of organic farms allow the conventionalization of organic agriculture to persist, and all the while consumers of organic products think they are making more socially responsible and environmentally friendly food choices.

6. Organic Policy

Organic products are regulated both nationally and globally. The purpose of organic legislation is to take the principles associated with organic food production and convert them into acceptable defined practices. They set minimum requirements, regulate organic certification, and protect farmers and consumers from fraudulent organic designation. All national organic standards are based on international standards, but they vary across countries. The International Organization for Standardization (ISO) and the International Federation of Organic Agriculture Movements (IFOAM) are private international organizations that help develop and approve national organic legislation. IFOAM is a nongovernmental organization that helps nation states draft organic legislation through consulting and facilitation of organic adoption; it represents the organic movement at the United Nations. ISO is a nongovernmental organization composed of national standards institutes from 162 countries that votes on proposed organic legislation (Caro & Durán, 2012).

The IFOAM Standard is based on four principles including health, ecology, fairness, and care. It covers the topics of organic ecosystems, general requirements for crop production and animal husbandry, processing and handling, social justice, criteria for the evaluation of inputs, and lists of permitted substances. World Trade Organization (WTO) Technical Barriers to Trade Agreement (TBT) requires that national organic standards be based on the IFOAM Standard, but they don’t have to mirror it exactly (Caro & Durán, 2012). The TBT was created to prevent discrimination against foreign products on the part of importing countries. It mandates that all foreign products should be treated with as much favor as domestic products or products from a country different from the one seeking to export, that restrictions be no stricter than is necessary for a legitimate purpose (national security, protection of human or animal health, etc.), and that developing countries are provided technical assistance to understand and meet requirements of importing nations. IFOAM Standards and ISO accreditation are not legally binding, but are often necessary to gain access to export markets because of pressure from the importing nation or large companies. In this section, national organic legislation for the European Union (EU), Japan, the United States (US), India, China, and Canada are discussed and compared.

These countries were chosen because of their relative importance and level of influence in the global organic market. The US, EU, and Japan are the largest importers of organic products and also contain the largest numbers of organic consumers, and the EU has the highest proportion of organic to conventionally farmed land in the world. Canada is a major player in the organic industry because production of organic products has increased by 20-25% every year since 2004, they are a major exporter, and they are the sixth largest organic retail market in the world (Caro & Durán, 2012). As of 2008, half of the organic producers in the world were in India (The et al., 2008). They are a major exporter of organic products and one of the few developing nations that have been included in the list of standards equivalency with the EU and US, which means Indian organic products can be imported to these regions without recertification. As of 2006, China was the country with the second highest acreage of land in organic production and it is a leading exporter of organic products to the west (Knudsen et al., 2010).

Because national organic standards must use the IFOAM Standard as a guideline, they are all fairly similar, but there are some major differences in the details. One major difference between the organic legislation of different countries is whether they use a standards model or a technical regulations model. Technical regulations are mandatory and legally binding, where standards are voluntary. The major difference between these two models is their implications for international trade; if a product fails to meet standards it can still be sold but sales will be affected by local consumers' preference for "certified" products, whereas products that fail to meet technical regulations cannot be sold period. The organic legislation for the US, EU, and

Japan are all technical regulations; India and Canada use the standards model. It is more difficult to determine which model China uses because there is so little information published in English on their certification process, but they, like Japan, impose mandatory fines and/or jail time for the misuse of the organic label.

The motivations behind creating an organic standard, as well as the objectives and principles associated with it, are also different across countries. US motivations for creating organic standards are detailed in section 4 of this thesis. Canada and India share the motivation of aspiring to trade with major importers of organic products (US, EU, Japan) and capturing the associated high price premiums. This motivation also applies to China, although China has the added interests of "securing food security by relying on its own resources," and producing hazard free food (Paull, 2008). Another issue in the Chinese market is the "Made in China Problem," the phenomenon wherein Chinese products are devalued globally because of a long list of food scares that have been covered by the international media; conforming to an internationally accredited standard helps reduce this stigma (Paull, 2008). The FAO legal proceedings, *Organic Agriculture and the Law*, state that Japanese motivations for creating organic legislation were consumer confusion associated with the Japanese concept of "Yuki Shokuhin," which means food processed with few or no chemicals, and the term "organic"(Caro & Durán, 2012, p.250). EU motivation was to unify the meaning of organic across all member states.

US objectives, as specified in the National Organic Program (NOP), are to create a unified standard across states, promote interstate commerce, and consumer assurance. The objectives in India's National Program on Organic Production (NPOP) focus on accreditation of organic products and encouragement of organic farming. These are the only two national standards that do not include environmental or health concerns in their objectives. Canadian objectives, on the other hand, concentrate on environmental and health matters such as protecting biodiversity, renewable resources, soil fertility, and livestock welfare. Similar objectives are noted in Japan's "JAS System" with more emphasis on chemical free food production techniques. The European Union includes many of the same ideas in its objectives as in the Canadian and JAS System, but they are much more detailed and include the ability to meet consumer demand (Caro & Durán, 2012). China's objectives are less clear due to an inability to gain access to a copy of their legislation, but they include increasing farmer income, oversight of organic production, and reduced use of pesticides.

In order for a conventional farmer to become certified organic, he/she must go through a conversion period during which products, even if grown using organic techniques, cannot be labelled organic. Japan and the US both specify three year conversion periods, but they don't specify details on whether the conversion process starts before or after a farm is under a system of inspection. Japan has different conversion periods for livestock based on species. India recommends a two year conversion period, but it can be extended or reduced based on the certification body, no less than one year. The US legislation doesn't regulate the conversion of crops used for feed or pasture lands. The EU standards don't specify a conversion period; currently the decision is left to the member state, but plans are in the works to determine a definite time period. Canadian legislation indicates a conversion period of one year for annual, and three years for perennial, plant crops or feed crops; livestock must be fed 80% organic feed for the first nine months of a conversion of one year, and 100% organic for the last three months. In Japan, poultry must only be raised as organic after it has hatched, its mother can be non-organic, but not genetically modified. Partial conversion, or growing both organic and conventional crops or livestock on the same farm, is allowed in all six countries/regions, although all but India discourage the practice. India is the only country that has an in conversion organic label. In the EU, US, and Canada barriers and buffer zones must be implemented to prevent contamination, and organic and conventional livestock cannot be in contact. Japanese legislation makes it unclear under what conditions this practice is allowed, and specifies that measures must be taken to protect organic integrity and contamination from “surrounding areas,” but it doesn’t specify specific techniques (Caro & Durán, 2012).

National regulations all include information on allowable growing and processing methods, prohibited substances, organic integrity (separating organics from non-organics or prohibited substances), seed and livestock origin, certification, labeling, import, and the treatment of livestock. Many of them are very similar because they are all based on the IFOAM guidelines, here I will focus on the main differences. The EU regulations contain a “flexibility clause” that allows the European Commission to provide temporary exemptions from rules on processing and production to allow adaptability to geographic conditions. This provides a major loophole for producers to get out of certified practices. All countries emphasize preventative measures for pest and weed management as well as health of livestock, but allow for use of certain substances (generally defined by a list of allowable substances) in emergency situations when the health of the animal is highly endangered or if extreme amounts of crops will be lost. The ability to use non-preventative techniques must be authorized by a certification or regulatory body. The EU regulation is the only one that doesn’t require that non-preventative medicines be administered by a vet, and India is the only country that allows medical treatments to use GMOs. Japan requires a withholding period for all treated animals and has the least detailed description of preventative measures; it simply states that techniques should “strengthen resistance to disease" and pest management must use "biological methods." All countries provide examples of preventative pest and weed management techniques with the US NOP and Indian NPOP being the most detailed, examples include protecting natural enemies of pests, crop rotations, crop diversity, and planting of hearty species that are adapted to local conditions. Most countries just use vague terms like "cultural," "mechanical", and "physical" techniques.

With regard to fertility and bioactivity of soil, all countries mandate that no synthetic nitrogen fertilizers be used and contamination of the environment should be minimized; tillage and cultivation should enhance or maintain soil chemical, physical, and biological activity without increased risk of erosion. The use of non-biological or non-organic fertilizers, with the exception of synthetic nitrogen, is permitted in all regulations in emergency and extreme conditions. India and the US are the only countries that don't require fertilization substances to come from local sources, and India prohibits the clearing of primary forest. The EU specifies that use of non-renewable fertilizer material should be minimized. Regulations universally require that organic seeds and plant starter material be used unless not commercially available. Japan's JAS System is the only regulation that doesn't require authorization from a certification body or government authority to use conventional seeds and starters (Caro & Durán, 2012).

Organic livestock are a requirement in all regulations with no derogations, with the exception of course of the overarching use of the EU flexibility clause. The US NOP is the only regulation that doesn't specify the use of a breed that is adapted to local conditions. The EU, Canada, and India simply require that organic livestock be born and raised on organic land, but there is no specification of whether the mother must be organic. In Japan the mother must have been organically raised for 6 months, and in the US the mother must be raised organic for the last third of the animal's gestation period. The EU, US, India, and Canada all require that livestock feed be mostly on-farm or local and 100% organic. The US NOP put into action the Pasture Rule in 2010 which requires that ruminant livestock be allowed to graze for no less than 120 days per year and get a minimum of 30% of their daily dry feed from organic rangeland or pasture. The US is the only country that doesn't allow for conventional feed under any circumstances. Japan allows up to 50% non-organic feed if organic feed is difficult to find. In terms of animal welfare, India's NPOP is the most detailed and most focused on prevention of animal suffering from birth, to transportation, to housing, to slaughter. All other countries use the description, "maintain living conditions that accommodate the health and natural behavior of all animals, including access to open-air runs, pasture and fresh water" and mention that suffering should be minimized. Canada has no additional requirements. All but the US specify stocking densities; US only requires freedom of movement. The EU law includes space requirements as well as developmental, physiological and ethological needs, but it is alone in specifically allowing the use of tranquilizers and electric shocks during transport. Physiological and behavioral needs are mentioned in the JAS System, and additional detailed species specific housing requirements. The US doesn't regulate animal breeding, transport, or slaughter and has no species specific requirements for housing. The US is the only country to include surgeries and alterations (castration, horn removal, etc.) in their list of preventative measures. These are permitted in Canada and the EU only if they minimize animal suffering and are specifically to be avoided. India calls these procedures "mutilations" and prohibits them unless an exception is granted by a certification body (Caro & Durán, 2012).

Certification and labeling requirements are different in each country; however, all countries consider any product with 95% or more organic ingredients to be eligible for the organic label. The EU regulation is the only regional law covered in this thesis. East Africa also has a regional organic regulation, and is the only organic legislation to discuss social justice. In the EU, the member state controls certification and it can be done by a public or private entity. The EU has a "free circulation" clause that allows any certified organic product imported or sold in a particular member state to be circulated anywhere in the EU without recertification. Any product with less than 95% organic ingredients is not considered organic, but can specify which ingredients in the product are organic. To be eligible for import of organic products into the EU a country must have an equivalency agreement with the EU or have their product certified by an accredited EU certification body. Only nine countries have achieved an equivalency agreement because it is a long difficult process. If a country misuses the organic label or misrepresents a product as organic, the label will be removed from the batch of products and there are potential legal repercussions and a period of exemption from organic certification. Japan has two additional categories of organic food, 95% organic feed and unprocessed plant or livestock. The Japanese organic logo is not required, but jail time can be faced if it is misused. Japan uses only third party certifiers (TPCs), and if any accredited TPC commits an infringement all of its producers have their certifications cancelled. This is one negative consequence of using solely non-governmental certification bodies and has led to such a decrease in TPCs that there aren't enough TPCs to certify all of the organic producers in Japan. The US NOP allows for certification bodies to be public or private, domestic or foreign. Unlike other countries, the US doesn't require formal accreditation of certifiers, and the NOP has no formal section on imports. A country can import to the US via an equivalency agreement, recognition by the USDA of the exporting country's certification system, or by direct accreditation of a certifying body by the USDA. In addition to the 95% organic category, the US has a 100% organic category; any product between 70% and 95% can be labelled "made with organic ingredients" but cannot use the USDA organic logo and products with less than 70% organic ingredients can only state which ingredients are organic. The USDA organic logo is voluntary, but the certification body of the exporting country must be named on the package.

China is unique in that it has historic legislation on an alternative food production method, called Green Food, which is very similar to organic farming. The production of green food is half way between organic and conventional and involves reduced pesticide use, input regulation, and testing for residue on produce. The Green Food certification was split in two in 1995 leading to Grade A and Grade AA Green Food; Grade AA Green Food is equivalent to organic (Paull, 2008). This has aided the Chinese public in understanding the meaning of organic agriculture. China doesn't recognize international standards, and unlike other countries, has no option for an organic certification equivalency agreement. China doesn't require products that it exports to conform to domestic standards, only those of the importing country (Certification of Environmental Standards, 2014). Like the US, India has no separate sections of legislation dedicated to organic imports, most likely because it is a primarily exporting nation; import to India can be achieved by equivalency agreement or certification by any accredited certification body. Certifiers can be public or private entities. The Indian organic logo is mandatory, but it doesn't require the name of the certification body to be printed on the package. However, organic products cannot be labeled GE or GM free in India to avoid consumer confusion. The Indian NPOP specifies three additional categories for organic products, single ingredient 100% organic, multi-ingredient product with at least 70% organic ingredients (can be labeled made with organic ingredients, but is not labeled organic), and multi-ingredient product with less than 70% org ingredients (can designate ingredients as organic in ingredients list). If organic products are misrepresented, they are removed from the lot and not eligible for sale. Canada requires accreditation of certifiers, but doesn't specify any criteria concerning who can accredit a certifying body or what the requirements of accreditation are; Canada has no minimum regulations for organic inspection. Like the US and India, Canada has no detailed section on imports, but it has three criteria: products must be organic under Canadian Regulations, come from a country with an equivalency agreement with Canada, or be certified by a certification body recognized by Canada. In addition to 95% organic, Canada has two organic categories; 70% to 95% organic can be labelled "contains #% organic ingredients," and less than 70% can specify which ingredients are organic. Neither can use the Canadian organic logo. Information on accreditation of certification bodies and organic oversight and inspection are not included in this thesis as they are long and varied.

The European Union promotes organic agriculture through its Common Agricultural Policy Rural Development Program which offers financial support for more sustainable and environmentally friendly forms of agriculture. Under this program, farmers are offered payments based on land area to facilitate conversion to organic production methods (Cederberg & Mattson, 2000; Hole et al., 2005). Under the 2006 EU Action Plan for organics the European Union has created a unified approach to promoting organic agriculture which includes support in the form of stakeholder participation, research, extension services, market development, training and education, and information services (Constance & Choi, 2010). Canada created statues in 2009 to create a new Canadian Organic Regime wherein organic farmers and producers of organic livestock will receive payments for "environmental stewardship" (Lynch, 2009). There are no direct subsidies for organic farmers in the United States, but the 2008 Farm Act allocated $78 million in extension, research, and education for organic agriculture and food production. Its stated intentions are to "support the collection of economic data about organic production and markets; offset part of farmers' organic certification costs; eliminate bias against organic growers in crop insurance programs; and establish financial and technical support for conversion to organic production" (Constance & Choi, 2010, p.169) The Obama administration in the United States has promised to promote organic agriculture during the president's time in office; in that vein, the United States Deputy Secretary of Agriculture has allocated a further $50 million to finance the 2009 Organic Initiative.

Although not an exhaustive list of countries/regions that are prominent in the organic industry, the five countries mentioned above and the EU are representative of the global organic market. China and India are developing export nations, and the US, EU, and Japan are developed wealthy nations and the largest importers of organic products. They represent both sides of the organic coin. Regulations for these countries are extensive and detailed, but many of their components are vague and ambiguous allowing for numerous exceptions. Furthermore, the conditions of these exceptions are unclear and seem to allow sale and import of products that are not truly organic in the international or ideal sense.

7. Is organic sustainable?

Is organic sustainable? The answer to this question is both complicated and nebulous. It varies based on what sustainability factors are considered (environment, society, economy), geographic place, social perceptions, market players, market conditions, motivations, and legislation. Although social, environmental, and economic sustainability overlap and are intertwined, I discuss each one separately for structure, context, and ease of reading. I start with an explanation of the effects of standards in general and key industry climate and players.

7.1 Standards and Industry Conditions

Standards standardize more than processes, inputs, and certifications. They standardize capitalists, products (commodities), markets, standards writers, consumers, the environment, and they even standardize standards themselves. They standardize markets by generating fixed prices, and specific types of harvesting, growing, planting, and shipping. This is due to the standardization of capitalists who control the market. For example, a farmer can't get a loan or a buyer for his products unless he agrees to grow a specific crop strain, use a particular harvesting method, or use a certain amount of chemicals dictated by investors or potential buyers. This reduces freedom in the industry because processes and inputs are standardized and farmers are not permitted to produce the way they would prefer to; this especially applies to contract farmers. Consumers are homogenized because they are conditioned to look for standardized mass produced products; their preferences are standardized by advertisement and fads. This causes consumers to expect uniformity in food products. Uniform products make it easier for processors because they can use the same set of tools for all of their processes; this allows them to produce more efficiently and achieve economies of scale more easily. Because processors, consumers, and retailers demand uniform food the practice of monocropping has become commonplace in organic agriculture; this reduces advantageous interspecies interactions, increases vulnerability to disease, and leads to loss of biodiversity and heirloom species. Multiple standards for different countries cause barriers to trade and keep producers from accessing certain markets; producers explain this problem to international organizations (FAO, ISO, World Trade Organization (WTO)) who are pressured to create universal standards that override local ones and apply to all members of that organization. In this way, standards themselves are standardized. This also standardizes standards writers, aforementioned global organizations, governments, and industry purchasing agents. It does so by creating uniform conversation among these standards creators leading to a “global community of practice” (Busch, 2000). Standardization of all of these actors leads to more of a focus on uniformity of a commodity and less of a focus on quality; production becomes instead centered on maximizing profit. It defines how producers and consumers interact and removes the necessity for human judgement.

Organic standards are an attempt at taking the principles of the organic ideal and reducing them to specific inputs and practices. This is problematic because standards have no grey areas and they must be precise, clear, measurable, and well defined. This makes it difficult to incorporate multifaceted concepts such as sustainability, social justice, or ecological conservation. It is difficult for standards to fully capture the idea they are meant to symbolize. This leads to the exclusion of many important principles of the organic ideal and the goals and values of organic farmers. This is exemplified by the derogations, exceptions, and ambiguities, explained in section 6, in all organic legislation; these are a result of the need to compromise between all competing interests that have a say in the creation of such regulations. This is a major part of why the perceptions of organic agriculture are not aligned with its practices. Countries and regions that draw on these loopholes and contradictions in legislation permit themselves to cut corners and produce more cheaply and efficiently, thereby negating the equality the standards are meant to create and destroying the character of organics. It has been argued that this phenomenon will eventually lead to the full conventionalization of organic agriculture (Zoiopoulos & Hadjigeorgiou, 2013).

One of my intentions with this thesis originally was to see how national legislation affects sustainability, but I discovered that the sustainability of organic agriculture is not highly impacted by country; it is instead highly influenced by the global restructuring of the organic food regime by Transnational Corporations (TNCs). International organic certification standards have granted agribusiness conglomerates entry into the organic market. Because TNCs are global in nature, they have the power to influence national and international organic legislation. The fact that they can obtain inputs from and market outputs to multiple countries globally allows them to avoid the unpredictability of commodity sales and input acquisition associated with agricultural exceptionism. The ability of TNCs to source globally gets rid of corporate accountability and allows them to play both sides against the middle to maximize profit; they can relocate their operations to whichever geographic location has regulations that make production cheapest. They are beyond the regulation of nation state governments and only the WTO can govern them, which doesn't seem to be a frequent occurrence (Heffernan & Constance, 1994). It is for this reason that it is difficult to make sweeping statements about the sustainability of organic agriculture by country; if TNCs own all of the farms and processors in a nation, they make the rules.

Another type of player that has clout in the organic market is the third party certification body (TPC). TPCs are discussed in detail in section 6 of this thesis; in short, they are non-governmental entities that evaluate and certify organic products and they are accredited by nation states. They profess to be independent from other actors in the organic industry which gives them the appearance of transparency and objectivity. Organic processors and retailers have increasingly become involved in creating informal regulations, often more strict than national or international regulations, by way of requiring producers to meet their criteria to become suppliers. By enforcing the standards of retailers of organic goods, TPCs allow them to reduce costs, reduce damaged reputations and losses due to food borne illness, discriminate products according to qualities they value, and secure that standards are implemented invariably despite the country of origin of the product. In this way, farmers that obtain third party certification have an advantage over non-certified producers in the organic market, an advantage effectively granted and controlled by TPCs. As this practice becomes more common third party certification may, by proxy, become mandatory for survival in the organic market.

7.2 Environmental Sustainability

The FAO and IFOAM documentation on the standards for organic agriculture uses the word sustainable 53 times, but at no point gives a clear definition of the word as it applies to agriculture. The term organic is explicitly defined (see section 6) and many claims are made about its sustainability. The document claims that organic agriculture promotes soil conservation, reduces contamination of water, uses less energy, extends/mitigates climate change, protects nature, conserves biodiversity, and increases animal health and welfare. This is in line with society's perception of and esteem for organic agriculture. However, as explained in section 2 of this thesis, not all research confirms these assertions.

In general, the literature supports the claims that organic farming techniques, when compared to conventional, conserve biodiversity, increase soil organic matter, retain more water, are better for animal welfare, and reduce the use of fossil fuels overall (as opposed to just on-farm or off-farm). Apart from those attributes, most studies conflict on environmental sustainability metrics, and some reveal that organic agriculture is less sustainable than its conventional counterpart. Figure 4 below gives a summary of the findings of my literature review from section 2.

Environmental Sustainability Factor	Organic is sustainable	Organic is not sustainable
Biodiversity	in general	excessive tillage situations
	species specific conditions for beetles	
Nutrient Leeching	dairy production	chicken production
	sustainable manure management	unsustainable manure management
	functional unit = area	functional unit = kg of product
	outdoor pig production using solid manure	indoor pig production using slurry manure
Global Warming Potential	olive and beef production	dairy and pork production
	sustainable manure management	unsustainable manure management
	functional unit = area	functional unit = kg of product
		conversion periods
		livestock systems using imported feed
Human Health	in general	when air pollution and climate change are included as health factors
Animal Welfare	in general	high exposure to parasites on pasture
	low-input mixed livestock and crop systems	
Energy Use	off-farm activities	on-farm activities
	livestock systems using feed produced on-farm	livestock systems using purchased and imported feed
	functional unit = area	functional unit = kg of product
Land Use		in all cases
Yield	Drought conditions	in general
	melon production	

Figure 4: Table of sustainability factors for organic agriculture

The findings illustrated in figure 4 demonstrate the reality of the sustainability of organic farming: sustainability varies geographically and according to farming methods not included in national or international organic regulations. There is no one obvious victor for all farming circumstances. The certified practices of organic agriculture are not necessarily more sustainable than those of conventional agriculture; levels of sustainability display spatial and temporal variation and often depend on alternative farming methods and mitigation measures not specifically prescribed in regulations. High variability among the characteristics of farms makes it impossible to use a single universal method for all organic farming situations. Temporal variation hinges upon seasonality, climate conditions, and how long an agricultural system has been under organic management. Yields also depend on climate conditions, such a drought, as well as plant species or variety and seeding rates. In livestock systems GWP and energy consumption are affected by whether feed is imported or grown on the farm. Nitrogen emissions are contingent upon manure management and stocking densities. Erosion and soil nutrient content are partially controlled by tillage methods and crop rotation choices. Farming intensity is another farming characteristic that highly influence sustainability factors including climate impact, emissions of ammonia and nitrous oxide, land use, and animal welfare. Intensive farming is beneficial for GWP, land occupation, and deforestation; low-input systems are advantageous for nutrient leaching levels and animal welfare. Multiple sustainability factors are affected by the functional unit of analysis (area vs. kg product), geographic boundaries, whether upstream and off-farm activities are included in life cycle analysis, and abiotic conditions, like topography. Surprisingly, neither national nor international organic regulations mention energy use or efficiency, which are a large component of most life cycle analyses and assessments of sustainability.

In general the introduction of agribusiness interests and capital leads to a reduction is the sustainability of organic agriculture. This is because of the aforementioned focus on input mandated by organic regulations, which are highly influenced by TNCs, retailers, and agribusiness conglomerates, versus the focus on process embodied in the organic ideal. The use of appropriationism and substitutionism by large agricultural production firms leads to an increased reliance on off-farm inputs on the part of organic farmers. This is concerning because indirect off-farm processes contribute much more to the environmental pressure of agriculture than direct/on-farm processes. Unfortunately, organic regulations, especially in the United States, are more concerned with profit generation and “free market” than environmentally sustainable agricultural practices (Zoiopoulos & Hadjigeorgiou, 2013).

7.3 Economic Sustainability

One critical component of the economic sustainability of organic agriculture is equal market access on global scale. As mentioned in section 7.1, derogations in organic regulation, as well as third party certification and the influence of TNCs, can give certain producers an unfair market advantage. Many retailers require that farmers and suppliers be certified by TPCs accredited in developed countries because they are viewed as more capable and proficient than their counterparts in developing nations. The products of farmers and producers of livestock in developing countries are frequently unable to meet the criteria required for certification in industrialized nations; this is because they have insufficient access to the knowledge associated with the standards of retailers in developed countries. In addition, the extensive renovations in technology and changes in farming methods and processing involved in complying with the demands of TPCs and retailers in industrialized countries are often expensive. Conversion periods range from one to three years according to most organic regulations; during this time producers often operate at a loss, so the conversion process ends up being very expensive. Because large farms and agricultural systems in developed nations can afford to make the alterations necessary for third party certification, they have an advantage in the market and more access to sales opportunities. This is chiefly a result of economies of scale achieved by large industrial organic producers in developed nations, which allow for cheap production. Because they cannot achieve economies of scale, small to medium-sized organic farmers, especially those in pre-industrial countries, are pushed out of the organic market; most of the profit generated by organic farming goes to retailers, TNCs, and large-scale producers (Hatanaka & Busch, 2008).

Despite the market inequality in the organic industry, there are ways for small-scale farmers and farmers in developing nations to overcome some of the barriers to market entry. One way is by forming farm cooperatives that can achieve the financial security and crop prices required to attain organic certification. International non-profit organizations, like IFOAM and the FAO, often create their own TPCs that allow farmers in developing nations to achieve certification more easily. They also assist in helping these farmers understand the requirements of certification and upgrade their production methods and product quality to meet industrial organic standards. The TBT agreement of the WTO also aids small and pre-industrial farmers by requiring than no importing nation can refuse to buy their product if it meets standards and is comparable to domestic product or product from larger producers.

TPCs create many economic advantages for retailers. Third party certification shifts the responsibility and costs of product inspection from retailers to TPCs. Third party certification also creates advertising opportunities for retailers because they can claim that their product is superior and safe because it has a certified organic label. It also makes it less likely that a retailer's product will spread food borne illness and destroy that retailer's reputation in the organic market. Market concentration in the organic retail sector gives retailers to enough power and influence to demand that their suppliers meet their product quality demands and be certified by a TPC. The FAO and IFOAM claim that increased demand for organic products in developed nations has resulted in willingness to pay high premiums on the part of consumers thereby opening up profitable markets for farmers in developing nations (Caro & Durán, 2012). Market concentration is driven in part by increased farmer reliance on purchased inputs because investors and processors demand that producers use particular off-farm inputs in their agricultural systems. Conglomeration in the organic industry has led to the dominance of large agribusiness firms who have enough economic power to stay in business and increase market share by buying smaller competitors or putting them out of business. This shrinks organic price premiums because larger firms can afford to sell their product at a lower cost, undercutting their competitors and making the organic market less lucrative. This prevents farmers in developing nations from accessing or benefiting from the high profit margins available in the organic market. On the other hand, one aspect of organic farming that allows producers to save money is that they don’t have to rely on agribusiness and biotechnology companies for GMO seeds or chemical inputs.

In order to stay in business, many family farms in both developed and developing nations have had to turn to contract farming. In this situation, farmers sign a contract with a particular agribusiness buyer or processor who provides a guaranteed market for their products. In return, farmers must use specific farming techniques and crop varieties/livestock species in their production. In the organic market, buyers and processors convince farmers to convert to organic by offering a price premium; the downside is that the buyers control the price, and it is often fixed for a particular time period and often gets reduced as time goes on so that agribusiness buyers and processors can acquire a larger portion of the profit. This can be good or bad for the contract farmer. The price offered by buyers is fixed, so if the market price is lower when the product reaches the supplier, the farmer wins; if the price is lower, the farmer loses. If a farmer experiences a low yield due to weather or pests, they lose money and are unable meet the product quantity expected by the buyer. If the farmer ends up with a bumper crop, they are left with the surplus that they cannot sell as buyers and processors only agree to buy a certain predetermined amount of product (Buck et al., 1997). Many small-scale organic farmers have to rent land to produce on. If they convert from conventional methods to organic ones they increase their own profits as well as the market value of the land; in turn, the farmer’s rent goes up driving down their profit (Guthman, 2004). In short, contract farming provides a guaranteed market for farmers, but they have no freedom of production method, no choice of who they can to sell their products to, and the burdens of overproduction or underproduction are shifted from the buyer to the farmer.

In addition to being taken advantage of by retailers, large agribusiness buyers, and processors, farmers in developing countries can rarely afford to buy the organic products that they themselves produce. This is why most developing nations that engage in organic production, such as India and China, are primarily exporters. Not only can consumers in developing nations not afford to buy organic, most of the domestic consumer population in these countries doesn't completely understand the difference between organic products and their conventional counterparts; this is mostly due to a lack of education and public promotion of organic agriculture. As mentioned in section 7.1, some national governments, such as Canada and the member states of the EU, have reduced this phenomenon on by subsidizing organic farming and acknowledging its benefits. In the United States, the pasture rule has made it easier for small dairy and cattle farmers to convert to organic production because they don't have to depend on buying feed from off-farm sources (Hafla et al., 2013).

7.4 Social Sustainability

One of the most important components of the social sustainability of organic agriculture is food security. In order for organic food production to ensure food security, it must be able to generate enough food supply to meet the demands of a society. The main problem with organic agriculture, in terms of food security, is that it produces lower yields than conventional systems; this makes it difficult to produce enough food to feed an entire population affordably with organic crops and livestock. Organic farms in the US, EU, and Japan cannot produce enough organic products to meet the demands of their populations, which is why these countries import so many organic products from the developing world. Although the inhabitants of these industrialized countries are by no means starving or impoverished, they represent a true-to-life example of the effects of yield deficits. The upside is that there are site specific ways to increase crop yields. The motivations for increasing crop yields are different among developed versus developing countries. In developed nations the question is whether the environmental gains associated with organic food production will be able to make up for the costs of reduced yields. Motivations for increasing yields in the developing world are to produce enough food to feed the country and make enough profit to lift organic farmers out of impoverished situations.

Organic yields are lowest during conversion periods and early stages of organic production due to nutrient deficits; after these early periods of production, nutrient levels can be raised by using manure fertilization or legume cover crops. Organic yields fluctuate based on crop type, climate conditions, topography, and initial soil composition; when these factors are carefully considered and management techniques are chosen based on site-specific conditions, crop yields can be increased or match those of conventional farming methods. However, this is difficult to achieve with mass produced “cash crops” because they cannot be harvested as often as conventional cash crops due to restriction of chemical pesticides and fertilizers (Pimentel et al., 2005). For example, a conventional farmer can obtain as much synthetic nitrogen fertilizer as is needed as often as is necessary; an organic farmer using a closed system must wait for enough manure to be generated to fertilize crops.

Low-input small-scale farms are the most environmentally sustainable, but this approach would most likely only be beneficial in rural areas or developing countries where inhabitants practice subsistence farming. This is because, in our current system, it would be difficult to produce and transport enough organic food on many isolated small farms to feed residents of highly populated urban areas. On the positive side, organic does have benefits for promoting food security in the developing world. Organic farming requires fewer and less expensive inputs leading to a greater level of self-sufficiency for low income rural farmers. Organic products fetch a higher price on the market, and due to high demand in developing nations, prices for organic foods are more stable (Caro & Durán, 2012). If crop diversity is high, organic agriculture can also reduce the risk that farmers will lose an entire crop due to pests or disease. Organic farms in rural areas can create jobs for inhabitants of rural communities and deter mass migration to urban areas.

The sustainability of organic agriculture is reduced by social barriers to its adoption; my explanations of social barriers to adoption are confined mostly to the United States and Europe due to a lack of detailed research on the subject in other countries. Despite the creation of national organic regulations, conversion rates of conventional agriculture systems to organic in the United States are low (Constance & Choi, 2010). This has resulted in a marginal impact on the reduction of the environmental burdens of industrial agriculture. There has historically been a lack of government support for organic agriculture in the US. Instead of subsidizing organic farming, as is the case in Europe, the United States has taken a neoliberal approach relying on market mechanisms to facilitate the expansion of the organic industry. Until the endorsement of organic farming by the Obama administration in 2008, the US government has neither sanctioned organic agriculture nor acknowledged the ways in which organic agriculture is superior to conventional. The development of the NOP organic standards and label was simply a market-based measure designed to create a price premium to make up for the additional costs associated with organic farming methods. Research has shown that government subsidies have led to a 300% expansion of the European organic market. In the US, in contrast, a nationwide study on the practicality and financial benefits of organic farming was done in 1980 resulting in the suggestion of government support for organic agriculture in the form of public policy assistance, research funding, and education for organic farmers and those wanting to convert conventional systems, but it was dismissed by the administration of Ronald Reagan (Constance & Choi, 2010). At the same time, member state governments in the European Union had already began touting the societal benefits of organic agriculture. This reluctance on the part of the US government to support or acknowledge the benefits of organic agriculture is largely due to the fact that it is threatening to conventional agribusiness interests, and most agricultural TNCs are based in the US.

Due to the lack of research and government support for organic agriculture, and the ambiguities and contradictions in NOP regulations, many farmers do not fully understand what it means or what the certification process entails. This confusion causes apprehension on the part of conventional producers who are considering conversion to organic farming. To farmers, conversion to organic seems complicated and precarious, and the lack of research and clear information on the subject only compounds the problem. Major concerns on the part of potential organic converts include costs of certification, profit losses during the three year conversion period, apprehension about changing their entire system, market stability, availability of buyers and processors, availability and high cost of organic inputs, and lack of confidence in the ability to attain higher profit margins. The bulk of research on organic agriculture has taken place in the EU. Because of this, European farmers are well educated on the costs and benefits of conversion from conventional to organic agriculture and the European public is in support of it. Farmers' concerns in the United States are enhanced by a lack of institutional support. Government funded researchers, extension programs, and farm advisors have been virtually nonexistent in the United States. Historically, scientists who have researched organic agriculture have encountered disapproval on the part of the public and their colleagues. Farmers who want to convert to an organic system have experienced criticism and social isolation in their communities because their peers see organic agriculture as an attack on the conventional system that has been the common practice for so long. Land Grant Universities have publicly attacked and condemned the pioneers of organic production. In 1998 organic farmers disclosed that the biggest obstacle they experienced in the conversion process was lack of cooperation on the part of extension agents, who are supposed to aid and inform them. Other reported constraints are denial of insurance and financing, unreliable availability of organic inputs, and lack of support on the part of land owners (Constance & Choi, 2010). Because of the lack of research and social, institutional, industry, and government support, there has historically been an antagonistic climate in the US toward organic farming. The increased profit margins and consumer demand associated with organic products have not been enough to outweigh the risks and social stigma attached to organic conversion in the United States.

Protection of human health and well-being are an integral part of the sustainability of agricultural systems. Many organic farming methods are more beneficial for human health than their conventional counterparts. Confined Animal Feeding Operations create biological conditions that promote the spread of disease; since these systems operate on an industrial scale, contaminated products from one farm can cause widespread food borne illness. Organic livestock practices help to mitigate food borne illness by providing space requirements for animals and requiring that cattle graze pasture instead of being fed indoors or in a feedlot. Small scale operations are even more sustainable because they reduce the number of people potentially affected by food contamination. Organic livestock systems don’t use antibiotics, so there is less chance of the development of antibiotic resistant strains of disease. Organic regulations prohibit the use of pesticides; this practice reduces the occurrence of pesticide resistant weeds. Because of wind assisted contamination pesticide residue is found in organic products, but in much lower quantities than in conventional food. The nutritional quality of organic food is reduced by the advent of processed organic food brought about by the industrialization of organic agriculture.

Organic farming has thus far had no measurable effect on labor welfare; organic farm workers are not treated any better or paid any more on average than workers on conventional farms. The manual weeding and harvesting techniques characteristic of many organic production systems can be much more physically damaging for agricultural workers because they spend most of their day repeating the same motion in a stooped over position. The organic industry has not supported prohibition of these practices (Guthman, 2004). In developing nations, organic production can require up to twice as much labor as conventional; worker conditions are site-specific and dependent upon factors other than the mandates of organic legislation. For example, in Indonesia, the organic rice sharecropping system is unjust and exploits workers (Komatsuzaki & Syuaib, 2010). The application of the industrial model to organic agriculture has reduced prices providing large numbers of people with access to pesticide free food. On the other hand, this has increased the income gap between producers and retailers and contributed to the bimodal nature of industrial agriculture. In order to sell more products and make organic commodities more accessible to consumers, companies must reduce the price of their products. Because they don't want to reduce their share of the profits, they reduce premiums/wages for producers (often factory farmers) and farm workers. Because of the conglomeration of agribusiness firms and the concentration of the organic industry, this phenomenon has become global.

TNCs source products from developing nations and sell them in wealthy countries. This causes an increase in the financial inequalities between the first and the third world. TNCs are not concerned with the welfare of a country, only in making money. TNCs are conglomerates that frequently buy and sell their subsidiaries, so they have no personal investment in any product they sell or company they own. In order to keep production in their country, developing nations are pressured to relax regulations to meet the needs of TNCs. In this way, TNCs extract resources from the developing world and make countries dependent upon their business presence to stay in the market and boost their economy.

Even though they create an advantage for large agribusiness firms, TPCs can lead to increased social sustainability in organic agriculture. TPCs can help advocate for the rights of workers and protection of ecosystem services by emphasizing these issues in their certification processes; they can be used as a way to incorporate ethical practices into organic production. Social movements have the power to influence policy by publically ridiculing and discrediting the exploitative actions of TNCs; in order to avoid public humiliation and the stigmatization of their brand, TNCs can change their policies or practices toward more sustainable versions. Global sourcing, distribution, and trade networks contribute to reduced sustainability in organic systems. Even when on-farm activities and farming methods are sustainable they are often involved with off-farm processes and transportation networks that are unsustainable. The demand for counter seasonal produce and the need for imported farm inputs lead to high transportation costs and increased use of fossil fuels.

8. Discussion and Conclusion

The industrialization and conventionalization of the organic industry have transformed organic agriculture from a set of ideal principles and social movements to a farming system defined by inputs and prescribed practices. Consumers' conceptions of organic products and the processes used to generate them are often far different from reality. Research has shown the organic farming systems can often be more impactful for the environment than traditional systems, making it an unlikely candidate for sustainable farming alternatives. It is improbable that industrial food production will simply go away or revert back to a pastoral system, so it is essential that we understand the links between conservation of biodiversity and drivers that shape agricultural land use in order to find ways to compromise between the two. As it stands, despite its advantages over conventional, organic does not seem to be a sustainable solution for the future of alternative agriculture.

Rather than focusing on the differences between organic and conventional food production as a whole, it is essential to recognize the tradeoffs in sustainability amongst the two. Organic farming requires more land because it generally produces lower yields than conventional agricultural systems. On the other hand, organic production methods result in higher soil organic matter leading to greater water use efficiency and are much better for animal welfare. Organic production methods directly conserve biodiversity, but the increased land use change causes deforestation and indirect biodiversity loss. Prohibition of synthetic nitrogen fertilizers results in lower nitrogen emissions in organic production in general, but organic production systems often use more energy than conventional intensified systems. Organic livestock require more feed per animal, but they produce more meat per animal as well. Organic crops are more susceptible to losses due to pest invasion, but crop diversification can reduce this risk. The question is whether the ecological benefits of organic agriculture outweigh the costs of reduced productivity. Economically, the reduced yields associated with organic production practices are offset by reduced input costs and higher price premiums for organic products. Socially, organic farming can enhance the livelihoods of rural farmers in developing countries, but the conversion, certification, and export costs often make it unrealistic.

The sustainability of organic production is contextual; it varies in space and time. The sustainability of a particular method of organic farming is affected by abiotic and climate conditions, topography, seasonality, how long land has been under organic management, the unit and method of analysis, and inclusion of upstream effects. Farming practices other than those specified in organic regulations (permaculture, zero tillage, composting, low-input), which vary according to producer choice, also affect the sustainability of organic systems. Perhaps if organic farming were combined with other more sustainable techniques or revamped to remove the processes which cause so much environmental stress it could have the potential for success. As it stands there are several ways to reduce the carbon footprint of the human race as it relates to agriculture. Free range systems have been proposed to make livestock production more sustainable. Smaller scale farms are also more environmentally friendly. A way to take advantage of the yield and durability benefits of GMOs without the perceived risk is to use evolutionary plant breeding; this involves creating hearty and resistant crop strains using human-assisted selection without the use of biotechnology. In order to increase the yields of organic production systems, nutrient-use efficiency, water-use efficiency, and soil fertility must be increased. These enhancements can be facilitated by planting crop strains appropriate to local conditions, increased use of cover crops and crop rotations, synchronizing manure application with times of greatest crop demand, low-impact tillage and landscape management, evolutionary plant breeding, and increased soil organic matter. A more controversial solution is to change the way we eat, namely reverting to a mostly vegetarian diet and ceasing mass production of livestock. For example, for the average US resident, switching to a vegetable-based diet just one day per week could have the same impact on climate as buying all household food from local providers (Weber & Matthews, 2008).

To a large extent it is the industrialization and globalization of organic food production that has made it unsustainable, not so much the specific (individual) farming practice. Market concentration in the organic food industry and the global sourcing and trade networks of TNCs have created barriers to trade for small farmers and those in developing nations, influenced policy, and affected social and institutional attitudes toward organic farming. These consequences can be alleviated by additional research on alternative farming practices, their benefits, and how they can be incorporated into the organic production model. It is essential for policy makers, agribusiness, and conservation advocates to work together toward a common goal instead of trying to pull organic agriculture in several different directions. Public funding for research, consumer education, and support of organic conversion can increase the adoption rate of organic production processes. In addition to greater adoption of organic agriculture, it is important that consumers advocate a change in organic production and processing that concentrates more on sustainable practices and less on the inclusion or exclusion of specific inputs. People may be more likely to pay attention to the consequences of their food choices and advocate for change if they knew the reality behind the corporate narrative of organic food.

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