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The Impact of Agricultural Practices on Environmental Sustainability in Ghana: A Review

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Abstract

Agriculture continues to play its role as the backbone of the Ghanaian economy despite that its contribution to GDP has declined by seven-percentage points between 2007 and 2013. The relationship between agricultural practices and environmental sustainability poses serious challenges, yet it has attracted less attention in many developing countries particularly in Ghana. This paper presents a review of the impact of agricultural practices on environmental sustainability in Ghana.

The findings of the study reveal that some of the country's agricultural practices such as deforestation, slash-and-burn agriculture, negative soil nutrients balance, increased dependence on agro-chemicals for both crop and animal production – chemical fertilizers, herbicides, insecticides, vaccines and antibiotics, antimicrobial drugs, biotechnology, etc threaten our environmental sustainability and need to be altered. Besides, degrading the soil, water, air and biodiversity as well as posing health risks to both famers and consumers, the practices also contribute to high carbon-emissions into the atmosphere facilitating climate change. The effects of climate on agricultural production and productivity are devastating and negate farmers' income and livelihoods, health and the environment in general. These agricultural practices are not sustainable; as they degrade the environment and reduce the effective functioning of the essential ecosystem services; and ultimately, undermine the nutritional and health value of foods.

The study recommended sustainable agricultural practices to enhance environmental sustainability through developing resilient/adaptive and low-carbon economy technologies that aim to cope with the vagaries of climate change and reduce the emissions of carbon compounds thereby, protecting the natural resource base of the environment for both present and future generations.

Keywords: agricultural practice, environmental sustainability, climate change, carbon emissions, environmental degradation, health and safety

1. Introduction

1.1 Background and Problem

The impact of agricultural practices on environmental sustainability is relevant to the needs of today and tomorrow judging from the effects of climate change. Today, more than ever, the world needs to re-organize and double its sustainable development agenda to make it function in accordance with principles of environmental sustainability (Kuhlman and Farrington, 2010). Extant literature opines that land use change significantly threaten realization of the object of environmental sustainability (Braimoh, 2004; Potschin, 2009; Kuhlman and Farrington, 2010; Ayivor and Gordon, 2012; Appiah *et al.,* 2014).

The global community supports all stakeholders to adopt sustainable development practices to protect our environment for now and future generations, yet very little work has been examined on the relationship between some agricultural practices and environmental sustainability in Ghana (Clarke, *et al.*, 1997; Dwomoh *et al.,* 2013) which this study seeks to address.

The general objective of the study is to achieve a better understanding about the relationship between agricultural practices and environmental sustainability in Ghana. The study therefore, specifically seeks to identify agricultural practices that threaten the accomplishment of targets and indicators of environmental sustainability; and suggest agricultural innovations that can enhance the achievement of objects of environmental sustainability.

Based on this, the paper is structured along four areas: (a) introduction; (b) results and findings comprising understanding the concept of agriculture, environment, and environmental sustainability, impact of agricultural practices on environmental sustainability; (c) suggestion of agricultural solutions to enhance accomplishment of objects of environmental sustainability; and (d) conclusion, recommendations, limitations and direction for future research agenda.

1.2 Data Analysis and Quality

The review of extant literature on accumulated data involved a systematic, iterative process of browsing, sorting and reading extensively that centered on the key variables or concepts of interest. The main steps adopted in the analysis of the data gathered were to: (a) identify sections of text that relate to the linkage between agricultural practices worldwide and environmental sustainability; (b) identify the full range of these terminologies and concepts which formed themes; (c) align these themes to their source in the relevance of agricultural practices and environmental sustainability (Creswell, 2003).

Reliability and validity are very important feature of every scholarly work and thus, we employed the following strategies to safeguard the integrity of the study: (i) extensive review of the literature to ensure that we had a sound understanding of the body of knowledge that provided an opportunity for delineating the domain and explanation of the constructs under investigation; (ii) ensure that congruence of the purpose, research paradigm, research methods and strategies that we employed to generate and analyze the data; and (iii) carefully planned the coding of the data, definitions, theory and research framework in the light of the critical review study (Creswell, 2003).

2. Understanding the Concept of Agriculture, Environment, and Environmental Sustainability.

2.1 Ghana's Agricultural Sector

Ghana relies heavily on agriculture for her sustenance; as over the last 7 years, agriculture's contribution to the Gross Domestic Product (GDP) has averaged 27.13%; employs around 50% of households in rural communities; and generated 20% of the total foreign exchange earnings by end of 2013 (ISSER, 2013). Even though the agricultural sector's contribution to the GDP has decreased from 29.1% in 2007 to 22% by end of 2013 (GSS, 2013), it is still recognized as the backbone of the Ghanaian economy as the sector accounts for substantial portion of the GDP, export earnings and employs around significant portion of the labour force (IFPRI, 2008) and as such any agricultural practice (s) that undermine the sector's growth and sustainability pose serious risk to socio-economic development of the country.

In Ghana, agricultural sector comprises five (5) sub-sectors: crops, farm animals, cocoa, forestry, and fisheries. Thus, the effective production of agricultural outputs relies on environmental services to transform various raw inputs into the nutritious and diverse food and fibre that Ghanaians rely on for their sustenance, well-being and socio-economic development of the country.

2.2 Environmental Management and Its Impact on GDP

The definition of environment and the relationship between Ghana's socio-economic development and environmental stresses have also received attention. The Environmental Protection Agency, Ghana (EPA) defines the environment to "include natural resources, social, cultural and economic conditions as well as the institutional environment in which decisions are made". Taking cognizance role the environment play in our sustainable development, several jurisdictions across the globe now place premium on environmental consideration in decision making interventions on all policies and projects because of increasing threat of environmental sustainability (UNEP, 2004)

Ghana's environment has been degraded in the last half century and thus, receiving serious attention by various stakeholders of the economy. Due to the environmental degradation, the cost imposed on the economy is presently estimated over 10% of Ghana's GDP i.e. USD 850 million (World Bank, 2006); increasing from 4% of the GDP in 1988 (USD 128.3 million), and was projected to grow annually at 2% (Osei and Tutu, 1990). The authors added that out of the total cost of the degradation, agriculture imposed the greatest cost accounting for 69% (USD 88.5 million) followed by the forestry sub-sector, 26.04% (USD 33.4 million). In another study, Diao and Sarpong (2007) posited that land degradation reduces agricultural income by a total of USD 4.2 billion over

the period 2006-2015, which is approximately five percent of total agricultural GDP in these ten years.

2.3 Climate Change and its Effects on the Economy

The world has entered an era of rapid global climate change, which is due to high concentration of greenhouse gases (GHG) emissions (carbon dioxide, methane and nitrous oxide) and as a result, is raising the earth's temperature (IPCC, 2007). The consequences of the rising level of the greenhouse gases include varied amount and distribution of precipitation (rainfall), more extreme weather events and shifting seasons. According to the latest greenhouse gases inventory (EPA, Ghana, 2010), Ghana was a carbon sink until the mid-1990s, as its carbon was absorbed by the country's forests. However, as a result of changing land use system, growing population and the dynamics of the economy, especially urbanization, the concentration of greenhouses gases (GHG) emissions has increased but, comparatively lower than the global standards.

The greenhouse gases inventory conducted in Ghana revealed that in 2000, the total direct greenhouse gas emission (including Land Use Change and Forestry (LUCF) emissions) in Ghana was estimated at 12.2MtCO_2e (based on carbon dioxide, methane, nitrous oxide and perfluorocarbons). This is 173% above 1990 levels of 16.8MtCO_2e and 96% lower than 2006 levels of 23.9MtCO_2e. This change amounted to 242.3% increase from 1990 to 2006. Ghana's emission represents about 0.05% of the total global emissions and is ranked 108 in the world, which represents a total per capita emission of nearly 1MtCO_2e per person as of 2006. Though Ghana's emission is lower than other major developing economies, the trends clearly indicate a strong growing potential in the near to medium term horizon as the economy continues to grow and expand its economic development (EPA, Ghana, 2011).

The buildup of the greenhouse gases has led to the country experiencing an increase in extreme weather conditions characterized by temperatures which have gone up by about 1 degree Celsius over the past three decades in all the agro-climatic zones; and rainfall has reduced and becoming increasingly erratic (EPA, 2011; Olesen *et al.*, 2013; Mawunya and Adiku, 2013). The predicted changes in climate have adverse socio-economic, agricultural productivity, environmental and health impacts on Ghana (Olesen *et al.*, 2013; Mawunya and Adiku, 2013). Specifically, in Ghana, rising temperature, irregular rainfall and increasing concentration of carbon dioxide in the atmosphere have led to crop failure, low production and productivity levels as well as low animal production and productivity level (Akudugu *et al.,* 2012; Obiri-Opare and Onumah, 2014). Rainfall variability and its impact on food security in terms of agricultural productivity is a huge setback on the economy of many developing countries and continues to attract scientific research especially in many parts of the tropics (Sivakumar *et al,.* 1979; Dennett *et al*., 1982; Sivakumar 1988; Mawunya and Adiku, 2013).

2.4 Environmental Sustainability

The accelerating pace of climate change, combined with global population and income growth, threaten food security, economies and ecosystems everywhere (Kuhlman and Farrington, 2010). This development has necessitated the need to adopt environmental sustainability practices as they are recognized as the key pillar of sustainable development, an integral component of the Millennium Development Goals (MDGs) and the heart of MDG 7. Based on this, world leaders are now demanding a "new ethic of conversation, conservation, stewardship and respect for nature" as a fundamental value required in the 21stcentury for enhancing the achievement of environmental sustainability (Kuhlman and Farrington, 2010).

Consequence to this, each country is required to implement and evaluate action plan that has targets and indicators aimed at achieving environmental sustainability. The targets and indicators must enhance the institutionalization of environmental management programmes in the economy; reverse loss of environmental resources (soil, air, water); reduce biodiversity loss; increase land area covered by forest; reduce carbon emissions; reduce ozone-depleting substances; reduce fish stock within safe biological limits; reduce water resources used; reduce terrestrial and marine areas protected; reduce species threatened with extinction as well as improve drinking water sources and sanitation (MDG 7, 2010).

Therefore, environmental sustainability means "meeting the resources (soil, water, forest, air) and services (recycling) needs of the current and future generations without compromising the health of the ecosystems that provide them" (Kuhlman and Farrington, 2010). More specifically, environmental sustainability means maintaining the "natural capital' made up of soil, forests and biodiversity, water, wetlands, atmosphere and man and his/her businesses, including agriculture so that they are not depleted to be able to provide a continuous flow of useful goods and/or services to exceed the expectation of society today and in the distant future.

3. Impact of Agricultural Practices on Environmental Sustainability

3.1 Relationship between Agricultural Practices and Environmental Sustainability

Agriculture is the oldest form of environmental management by humans and as a result, careless and inappropriate agricultural activities can have devastating effects on the environmental sustainability, or otherwise. The under listed agricultural practices have significant impacts on the achievement of the targets and indicators of environmental sustainability:

- Deforestation;
- Land clearing for agricultural use;
- Slash-and-burn agriculture;
- Soil nutrients mining;
- Soil and water management;
- Irrigation practices;
- The use of agro-chemicals;
- Livestock and poultry production;
- Animal health and the use of growth promoting hormones;
- Agricultural biotechnology;
- Animal production and climate change; and
- Management of farm workers' rights and safety.

3.1.1 Deforestation

Forests and biodiversity play a vital role in the economy of Ghana in meeting our socio-cultural, economic and environmental needs. However, Ghana's forest cover since 1900s covering 36% of the total land area (84,000 sq.km) has been depleted at an annual loss of 20,000 hectares, thus, leading to the loss of 90% of the original forest cover (Forestry Commission, 2005). The cause of deforestation is due to multiple factors including unsustainable agro-sivilcultural practices (Clark, 2012), accounting for 48% of the deforestation as cited by the United Nations Framework Convention on Climate Change UNFCCC (2002) Secretariat.

Deforestation is a contributory factor towards climate change as it affects water cycle, soil erosion and fertility loss, biodiversity, carbon-equivalent emissions, economic growth and GDP of a country (Angelsen and Kaimowitz, 2001). Tropical deforestation generates 18.0% of the total global carbon emissions and the huge loss of the Ghana's forest cover to its present state correlates positively with effects of climate change conditions experienced in recent times – reduced precipitation, high temperatures, outbreak of strange agricultural diseases and pests as well as human diseases (EPA, Ghana, 2011).

3.1.2 Land Clearing for Agricultural Use

About 57% of the total land area of Ghana is suitable for agriculture and the continuous clearance of the vegetative cover for food crops, cash crops (cocoa, oil palm and coffee) and animal production exposes the soil resources to problems such as erosion, salinization, sodification, and fertility depletion. The UNEP (2011)'s report estimates that owing to poor farming practices, 38% of active farmland suffers from soil loss and fertility depletion (Angelsen and Kaimowitz, 2001). In Ghana, Diao and Sarpong (2007) estimated that effect of soil loss on poverty is also significant at the national level, equivalent to 5.4 percentage point increase in the poverty rate in 2015 compared to the case of no soil loss.

Land clearance for farming contributes to climate change because they lead to increased concentration of greenhouse gases in the atmosphere. In 2005, agriculture and land use change together contributed a third of global carbon dioxide emissions, and agriculture alone accounted for 60% of nitrous oxide and half of methane emissions (IPCC, 2007). Finally, land clearing and unsustainable method of harvesting of medicinal plants is also associated with the loss of the medicinal plants, biodiversity and microbes that have the potential effects on the advancement of medical research (Bukuluki *et al.*, 2014).

3.1.3 Slash-and-Burn Agriculture

Worldwide, about 240 to 300 million subsistence farmers practise slash-and-burn agriculture (Dove, 1983) and this farming system is reported to cause deforestation substantially (Southgate, 1990). Slash-and-burn agriculture accounts for 70% of deforestation in Africa, 50% in Asia and 30% in Latin America of the 14 million hectares of

tropical moist forests currently destroyed annually (Dove, 1983). This traditional cropping system has both positive and negative impacts on the environment. Positively, shifting cultivation facilitates nutrient cycling mechanism to enhance soil fertility, and thus, serves as a useful technology for understanding sustainable land use management system in the tropics (Angelsen and Kaimowitz, 2001).

Nevertheless, slash-and-burn agriculture through accelerated decomposition of soil organic matter releases half of the nitrogen, most of the sulphur and carbon into the atmosphere, thus contributing to the build-up of greenhouse gases (Angelsen and Kaimowitz, 2001). These repercussions signify soil nutrients depletion, contribute towards climate change and subsequently, adversely affect farm productivity and economic livelihoods of the farmers (Angelsen and Kaimowitz, 2001).

3.1.4 Soil Nutrients Mining

Generally, African soils have relatively lower soil fertility status due to negative soil nutrients balance, which is occasioned by soil nutrients mining. Soil nutrients mining takes place when farmers after continuous crop harvest fail to replenish the depleted soil nutrients. Extant literature reveals that negative soil nutrients balance have serious implications for reduced crop yield, increased poverty, food insecurity, environmental degradation, social and political instability (van der Pol and Traore, 1993; Drechsel and Gyiele, 1999; Gruhn *et al.,* 2000; Diao and Sarpong, 2007).

The impact of soil nutrient mining on crop yield has been acknowledged extensively in Ghana. Thus, according to Henao and Baanante (2006) during the 2002-2004 cropping season, Ghana's average level loss of nitrogen, phosphorus and potassium was 58kg/ha/year. The authors suggested that based on these nutrients loss, total soil nutrients mined in the sub-Saharan Africa region is estimated at 8 million tons of NPK per year. Thus, current intensification of agriculture on these fragile soils, low in plant nutrients with low fertilizer use further degrade the soil fertility status to levels unsustainable to support meaningful economic crop production. Nevertheless, an attempt to incorporate inorganic fertilizers to enhance the soil nutrients balance may also lead to remnants of climate change – buildup of greenhouse gases (Kim and Dale, 2008; de Urzedo *et al.,* 2013).

3.1.5 Soil and Water Management

The capacity of soils to be productive depends on the physical, chemical and biological characteristics of a soil as well as soil and water management practices (Delaney, 2012; Nata *et al.,* 2014). Mismanagement of the soil and water resources can lead to degradation of the soil through erosion, compaction, salinization, acidification, and pollution by heavy metals. Some of the mismanagement practices include preparation of the soil tilth susceptible to soil erosion and loss, over application of inorganic fertilizers and other agro-chemicals, continuous exposure of soil to agents of erosion, etc (Delaney, 2012; Nkegbe and Shankar, 2014). However, good soil and water management practices such as cover crops, zero-tillage, use of organic fertilizers, mulching, agroforestry, crop rotation as well as planting of drought-pest-disease resistant varieties can render the soil less susceptible to degradation as well as reduced buildup of agro-chemicals in the environment (Delaney, 2012; Nata *et al.,* 2014).

3.1.6 Irrigation Practices

Agriculture is the largest user of water for irrigation purpose in the world and alters, depletes, contaminates, and eutrophies water bodies – all of which have implications for human health. Ghana, intends to increase irrigable crop field by 11,000 hectares, and rehabilitate other existing dams to support all year-round cropping and increased farm outputs (METASIP, 2010). Farmers shall benefit in terms of increased yield of harvest, food security and enhanced economic livelihoods, but at the expense of environmental sustainability. The continuous tillage practices for planting, continuous flooding of the irrigated fields, decomposition of crop debris and intensive application of agrochemicals, including nitrogenous fertilizers, all together emit substantial amount of carbon dioxide, methane and nitrous oxide into the atmosphere, hastening climate change (Sainju *et al.,* 2012; Zou *et al.,* 2015). Thus, in China, Zou *et al.* (2015) reported that in 2010 the total carbon dioxide (CO_2) equivalent (CO_2-e) emission from agricultural irrigation was 36.72 – 54.16 Mt. In a study on pesticide use by irrigation workers in Ghana, Clarke *et al.* (1997) posited that farmers and consumers risk their health (poisoning and other symptoms of blood cholinesterase) through consumption of highly contaminated food harvest, fertilizers and agrochemicals – due to misapplication of the insecticides and poor handling of the agro-chemicals.

Furthermore, irrigation systems can facilitate increased habitat and breeding sites for vectors that transmit malaria and schistosomiasis (Ampadu *et al.,* 2015). Again, the use of polluted water in irrigation may enhance the spread of viruses and parasites and consequently diarrheal diseases. Dam and irrigation projects results in the increase in the prevalence of schistosomiasis, malaria, encephalitis, hemorrhagic fevers, gastroenteritis, intestinal parasites, and filariasis (including onchocerciasis and bancroftosis) in the surrounding communities (Webbe,

1981; WHO, 1985; Ofoezie, 2002). Water-associated infectious diseases kill approximately 3.2 million people per year (Webbe, 1981) and a significant fraction can be traced back to agriculture-imposed changes in vector habitat and water quality (Ofoezie, 2002). From a nutritional standpoint, irrigated rice production system compromises access to fish by local populations (Webbe, 1981).

3.1.7 The Use of Agro-Chemicals

The Ghanaian agriculture relies extensively on chemical inputs, and as a result, has registered a sharp increase in the importation of agrochemicals between 2007 and 2013 (Table 1). Insecticides, herbicides and fertilizers registered increase of 533%, 2,232% and 131% respectively; however, fungicides registered a reduction of 33% of the import within the same period under review.

Table 1. Importation of agro-chemicals in Ghana, 2007 and 2013

Type of Agrochemical	2007	2013	Percentage Change
Insecticides (liters)	969,944	6,137,965	532.82
Herbicides (liters)	1,581,190	36,869,578	2,231.76
Fertilizers (MT)	335,186	772,890	130.59
Fungicides (liters)	965,100	637,564	(33.93)

Source: ISSER (2013).

The health impacts of these agro-chemicals are a function of their degree of accumulation in environmental sinks –soil, air, water, plants and animals – and the degree and form in which humans are exposed to them. It is estimated that, only 0.1% of pesticides actually reaches pests, while the remainder stays in the environment or on food (Pimentel, 2005; Kumar *et al.,* 2013). Extant research findings reveal that continuous use of agrochemicals in farming poses health implications, as millions of agricultural workers suffer ill-health effects every year that manifest in intestinal, respiratory, gastrointestinal, neurological, reproductive, and endocrine disorders, birth defects, and mutagenicity as well as cancers and poisoning in humans (Pimentel, 2005; Bhandari, 2014). The authors maintain that long-term exposure to pesticides leads to the development of worker's respiratory diseases such as asthma, reduced sperm quality and sperm count causing sterility.

In Ghana, pesticides poisoning among farmers leading to skin irritations, headaches, general body weakness, difficulty in breathing, dizziness and even death of farmers has also been reported (Clarke *et al.,* 1997; NPASP, 2012). Besides, the report further posited the presence of the organochlorine pesticides residues (above tolerable daily intake) in breast milk and human blood of vegetable farmers and concluded that pesticide residue levels are probably in virtually everything we consume from our farms.

Furthermore, ingestion of fertilizers in the form of nitrate is toxic to humans and animals, which may lead to goiter, birth defects, heart disease and stomach, liver and esophagus cancers (Conway and Pretty, 1991; Pimentel, 2005; Bhandari, 2014). Based on these deleterious effects of agrochemicals on humans and the environment, Bhandari (2014) advocated several stringent measures such as integrated pest management, farmer extension and education, pesticide management through legislation and regulation, etc to minimize the poisoning of the applicants and other stakeholders.

3.1.8 Livestock and Poultry Production

Ghana intends to increase production heads by at least 20% of farm animals by 2015 and this objective has implication on the environment (METASIP, 2010). Between 2008 and 2013, cattle, sheep, goats, pigs and poultry heads have increased by 11.81%, 17.76%, 30.56%, 26.10% and 68.03% respectively (Table 2) as reflected in an increased value of the stock and economic livelihoods (ISSER, 2013).

Negatively, farm animals' operations impact on all major environmental media, including water, soil and air (Orheruata and Omoyakhi, 2008; Ilea, 2009). Of most concern are the pollution of ground and surface water resources with animal droppings and nutrients, industrial (sludge from slaughter house) and agricultural chemicals (vaccines, antibiotics and antimicrobial drugs), and micro-organisms such as viruses, bacteria, and parasites. Unsustainable use of freshwater resources for feed production, animal health, and slaughterhouses contributes to water scarcity and is depleting precious resources needed by future generations (Orheruata and Omoyakhi, 2008; Ilea, 2009).

Contamination of soil is another problem caused by unsustainable, year-round deposition of excess nutrients from droppings, chemicals and pathogens on land in the vicinity of industrial feeding operations (Orheruata and Omoyakhi, 2008; Ilea, 2009). Poor air quality (pollution) is caused by localized release of significant toxic gases and odorous substances as well as particulates and bio-aerosols containing micro-organisms and pathogens in the atmosphere. Animal manure and other agricultural waste result in water and air degradation, which in turn, impact both the aquatic and the terrestrial ecosystems surrounding the farming operations (Ilea, 2009). Farmers, workers and their families as well as consumers risk their health by contamination or consumption of chemical residues (antibiotics and antimicrobials) on the food and feed (Kumar *et al.,* 2013).

Table 2. Livestock and poultry production, 2008 – 2013

Type of Farm Animal	2008	2013	Percentage Increase
Cattle	1,422	1,590	11.81
Sheep	3,529	4,156	17.76
Goats	4,405	5,751	30.56
Pigs	506	638	26.10
Poultry	40,310	67,731	68.03

Source: ISSER (2013).

Water use is more significant in these systems because it is often used for cleaning the animals, buildings and in the waste management systems. Enormous quantities of both water and petroleum-based pesticides may be used in the production of feed, leading not only to the depletion of water resources or river health system (Ayivor and Gordon, 2012), but also to soil erosion and pollution with pesticides. Pesticide residues may remain in the animal feed, leading to the possibility of toxic residues in the animals themselves and the humans if consumed as food (NPASP, 2012).

3.1.9 Animal Health and the Use of Growth Promoting Hormones

Agro-chemicals such as antibiotics, vaccines and related antimicrobial compounds are widely administered to treat farm animal diseases and control insect pests, promote growth and improve feed efficiency (Kumar *et al.*, 2013). Between 30% and 90% of the initial dose of the chemicals ingested by the stock is excreted and find their way back into the environment – soil, water, air, plant and humans as either the parent compound or as a metabolite (Steinfield *et al.,* 2006). In the US, animal farming is estimated to account for 55% of soil erosion, 37% of nationwide pesticides usage, 80% of antibiotic usage, and more than 30% of the total nitrogen and phosphorus loading to national drinking water resources (Steinfield *et al.,* 2006).

Though, growth promoting hormones, both natural and synthetic is a key component of commercial livestock production across the world, their continuous use has generated controversy, acrimony and dispute in beef trade between USA and EU (Johnson, 2015). Whilst USA promotes the use of growth promoting hormones in the production of farm animals to facilitate an increased feed use efficiency, a leaner carcass and reduced greenhouse gas emissions per pound of beef produced; EU, however, maintains that there is "possible risk to human health" associated with hormone-treated meat and meat products. Subsequent to this, the European Food Safety Authority has banned the use of growth hormone in livestock management because they claim that growth promoting hormones pose endocrine, developmental, immunological, neurobiological, immunotoxic, genotoxic, and carcinogenic risk and effects on people, especially children and consumers (Stretcher, 2011; Johnson, 2015).

As the controversy goes on between the USA and EU, it is reasonable that policymakers, environmentalists, scientists and consumers in Ghana gather evidence on the dangerous effects of growth hormones on the human body and other environmental media (Stretcher, 2011). By gathering ample evidence on relationship between growth hormones and human well-being and health, the nation can promulgate the appropriate regulatory, standards and policy framework on the use or otherwise of growth hormones in Ghana's agricultural sector. It is expected that consumers, civil society organizations and consumer protection bodies jointly will lobby the government to provide financial support and technical assistance to scientists to gather the evidence as soon as possible.

This has become very vital in the country, taking cognizance of the fact that the Fast Track High Court, Human Rights Division has ordered a temporary halt on the promotion and use of genetically modified organizations in

Ghana dated 3rd March, 2015 (www.foodsoverightyghana.org). Apparently, the Food Sovereignty Ghana (FSG), a civil society organization has sued the National Biosafety Committee for unlawfully operating in place of National Biosafety Authority and is in clear breach of the provisions of the Biosafety Act 2011 Act (831) as regards the need for public awareness and participation in decisions affecting the release of genetically modified organisms into the environment (www.foodsoverigntyghana.org).

3.1.10 Agricultural Biotechnology

Biotechnology offers us the opportunity to create organisms with new genetic diversity or desirable traits that cannot be obtained through normal sexual reproduction (Verma *et al.,* 2011). Such newly created organisms are known as "transgenes" or "genetically modified organisms" (GMOs) are useful to man, but also pose risks to animal and human health as well as the environment (Krimsky, 2002; Snow *et al.,* 2004; Verma *et al.,* 2011). In terms of the benefits, GMOs grow relatively faster, resist diseases, pests or to anthropogenic stresses such as heavy contamination, tolerate cold or extreme hot weather, produce organs for transplant, or produce biologically active and therapeutic proteins (Krimsky, 2002; Snow *et al.,* 2004; Verma *et al.,* 2011).

Environmentally, other benefits of GMOs include reduced use of agro-chemicals, improvement of crops and farm animals against viral diseases (Krimsky, 2002; Snow *et al.,* 2004; Verma *et al.,* 2011). Furthermore, genetically modified viruses, bacteria, fungi, algae, etc are used to control agricultural insect pest; manufacture biologically-based products for medicine, food processing and serve as substrate for the production of vaccines, vitamins and growth hormones for commercial farm animal production (Snow *et al.,* 2004).

In respect of environmental risks, the GMOs pose risk as resistant to pest, diseases, antibiotic, pesticide or herbicide; possibility of inter breeding with native populations; harm the non-target hosts; persist indefinitely in cultivated or free-living populations; and alter species population dynamics (Krimsky, 2002; Snow *et al.,* 2004; Verma *et al.,* 2011). The effects of GMOs on agricultural practices have also been documented and include reduced herbicide use, altered abundance and diversity of invertebrates and enhanced conservation tillage practices as well as greater sequestration of atmospheric carbon in the form of soil organic matter (Snow *et al.,* 2004).

The relationship between GMOs and human health and safety risks has also received attention, but with contrasting and controversial results (Krimsky, 2002; Verma, *et al.,* 2011). Whilst the USA claims that GMOs are safe to be consumed and pose no health risk implications to humans; the EU and India, on the contrary, cite that GMOs are linked to toxic and allergenic reactions, sick, sterile and immune problems as well as damage to virtually every organ (gastro intestinal) and system of laboratory animals studied. Thus, GMOs are inherently unsafe, show toxic reactions in the digestive tract, cause liver damage, record higher death rates and organ damage, facilitate reproductive failure and infant mortality, trigger immune reactions and cause allergies in animal laboratory inquiries (Verma *et al.,* 2011).

In respect of effects of safety aspect of GMOs on risk of human health, contrasting and inconclusive results have also been cited (Verma *et al.,* 2011). Whilst Greenpeace and World Wildlife Fund consider that the available data do prove that GMOs food do pose risks to health, and call for additional and more rigorous testing before marketing genetically engineered food, other records (Snow *et al.,* 2004) on the contrary, GMOs have been eaten by millions of people worldwide for over 15 years, with no reports of ill effects (Johnson, 2015).

3.1.11 Animal Production and Climate Change

The relationship between farm animal production and climate change effects has attracted investigation across the globe (FAO, 2013; Moreki and Tsopito, 2013; Obiri-Opare and Onumah, 2014). All farm animals production results in the release of carbon dioxide from the respiration of the animals themselves, secondary methane production from animal waste decomposition and (in the case of ruminants) enteric fermentation, emissions of carbon dioxide from the production of inorganic nitrogen fertilizers used to grow livestock feed grain, and nitrous oxides production from farmland and manure management. These observations reveal that farm animals production is a key source of greenhouse gases worldwide (FAO, 2013). Thus, beef, cattle milk, pig meat and poultry meat contribute 41%, 20%, 9% and 8% of agricultural sector's greenhouse gases emissions, respectively. Again, feed production and processing, enteric fermentation from ruminants, manure storage account for 45%, 39% and 10% of the sector's emissions, respectively. Comparing with the agricultural sector's emissions, consumption of fossil fuel along the sector supply chains accounts for about 20% of the sector emissions far lesser than the former (FAO, 2013).

Besides, the vagaries from the climate change effects such as high temperatures, reduced rainfall pattern, frequent drought coupled with scarcity of both ground and surface water do adversely affect livestock and crop

productivity in Botswana (Moreki and Tsopito, 2013). Furthermore, the incidence of livestock diseases (mastitis and FMD) and parasites have increased owing to adverse climate change patterns being experienced, thus leading to significant decline in milk yield, livestock weight and animal feeds (Moreki and Tsopito, 2013). Similar result of adverse effect of climate change on livestock production has also been recorded in Ghana. Obiri-Opare and Onumah, (2014) in their study in Africa revealed that effect of unfavorable thermal conditions has compromised livestock meat quality and reduced production potential and productivity in Ghana.

3.1.12 Management of Farm Workers' Rights and Safety

In recent times, farm workers' occupational safety, health and their rights violation have received attention by researchers across the globe (Otero, 2010; Robinson *et al.,* 2011; Barnetson, 2012; Dwomoh, *et al.,* 2013; Svensson *et al.,* 2013). As farm workers are highly involved in the production, harvesting, processing, storage and distribution of farm products, their health and safety are at risk characterized by poor hygiene and sanitation, infection from microbial organisms, lack of protective equipment and training programmes, increased longer hours of work, injuries and illness, lack of access to medical facilities, and poisoning from agrochemicals and as such, they must be protected against these hazards (Otero, 2010; NPASEP; Dwomoh *et al.,* 2013; Svensson *et al.,* 2013). In another study on farm workers safety and rights, Svensson *et al.* (2013) reported that migrant farm workers work under very poor working conditions and face numerous health and safety hazards, including occupational chemical and ergonomic exposures, various injuries and illnesses and even death, discrimination and social exclusion, poor pay and long working hours and language and cultural barriers.

Several studies have eluded that poor enforcement of labour laws, lack of training on the farms and medical care and compensation when injured or ill are the biggest threats to sustainable agricultural production (Otero, 2010; Svensson *et al.,* 2013). Robinson *et al.* (2011) also found rights of farm workers trampled as 67.2% of them receive wages that fail to meet the minimum wage standards in North Carolina, thus, the owners of the farms violating wage and labour laws of the country. In some communities such as Alberta Province, Canada, farmworkers are excluded from the ambit of the occupational health and safety laws (Barnetson, 2012). The author continues that consequently, farm workers have no right to know about workplace safety hazards and no right to refuse unsafe work thereby increasing their risk of a workplace injury on the basis of three narratives: (i) education is better than regulation; (ii) farms cannot be regulated; and (iii) farmers don't want and can't afford regulation.

Symptoms of diseases shown by farm workers on irrigation projects in Ghana have been documented by Clarke *et al.* (1997). They reported that several ailments that the farm workers experience are such as headache, burning sensation in eyes/face, fever, watering eyes, dizziness, forgetfulness, male impotence, female sterility, etc. Clarke *et al.* (1997) indicate that nose, skin, mouth, eyes are the main route of entry of agrochemicals into the body, whilst significant number of the farmers store the agrochemicals in their bedrooms, storerooms, and farms. These observations on crop irrigation sites and other farming enterprises predispose the farm workers and their families, including children to chemical hazards in their homes and farms.

Measures known to enhance farm workers' safety and rights on farms have been investigated extensively. According to Otero (2010) the employee health and safety measures include signing employment contract to safeguard the interest and welfare of employees; providing adequate working hours and holidays to minimize exposure of risks; instituting competitive compensation system to meet workers' varied economic and environmental needs; installing occupational safety and health programme such as well-designed and sanitized housing facilities, lunchrooms and laundry facilities; the use of personal protective equipment (PPEs) to reduce exposure to risk factors; and training programme for the prevention of environmental risks and workplace discrimination. The need for governments, agricultural and labour enforcement agencies to enforce international and national labour, agricultural and occupational safety, health and welfare provisions and regulations will go a long way to minimize some health and safety infractions reported across countries (Otero, 2010; Robinson *et al.,* 2011; Barnetson 2012; Dwomoh *et al.,* 2013; Svensson *et al.,* 2013).

From the review of extant literature and analyses conducted, we can deduce that the rampant unsustainable agricultural practices pose serious risk to the global community especially developing countries compromising the accomplishment of the set targets and indicators (soil, water, biodiversity, air, wetlands, man, etc) of environmental sustainability.

4. Suggestion of Agricultural Solutions to Enhance Accomplishment of Environmental Sustainability

4.1 Improving the Environment and Health through Sustainable Agriculture

Although some agricultural practices enumerated have negative environmental, health and safety implications,

sustainable agricultural technologies can also be adopted to reduce the challenges of environmental degradation because they have positive agriculture-environment-health synergies (Smith and Smithers, 1994) as humanity has the ability to meet the needs of the present without compromising the ability of future generations to meet their own needs (Goodland, 1995; Kates *et al.,* 2005). In view of increasing trends of antecedents of environmental degradation globally, sustainable development concept has attracted huge attention in respect of research, advocacy and policy offerings (Goodland, 1995; Kates *et al.,* 2005). Thus, Kates *et al.* (2005) has extensively summarized sustainable development concept in respect of its definitions, goals, indicators, values, practice, institutions, challenges and role of global partners in promoting it across the world.

Extant research increasingly has advocated that good agricultural practice, in the form of sustainable agriculture is one of the promising technologies and practices that have the power to reduce the degradative effect of agricultural practices on the environment (Goodland, 1995; Wall and Smit, 2005). Sustainable agriculture refers to agricultural production systems that aim to reduce, eliminate or mitigate environmental harm while maintaining adequate food and feed production as well as minimize human health risks through reduced degradation and contamination of soil and surface water, reduced greenhouse gases emissions into atmosphere, and increased conservation of biodiversity (Smith and Smithers, 1994; Koohafkan *et al.,* 2011; Pretty *et al.,* 2011). As agricultural systems are both emitter of greenhouse gases (source) and accumulator of carbon in soil organic matter, sink (Pretty and Ball, 2001), sustainable agriculture thrives on two major approaches: first, adaptation/resilient technologies (Wall and Smit, 2005); and, second, low-carbon economy technologies (Pretty and Ball, 2001; Chel and Kaushik, 2011).

The agricultural adaptation solutions aim to cope with and maintain economic, ecological, and social benefits in the face of dramatic exogenous changes such as climate change, risk or price swings. Adaptation strategies require cost-effective investments in soil and water infrastructure to develop new or improved land use and management system; response to extreme weather events in the form of development of resilient crop varieties that tolerate temperature, precipitation stresses and disease/pest-resistant cultivars to improve capacity to face risk; diversify crops to include perennial form, crop rotation, livestock, crop-tree mixture (agroforestry); and water resources management technologies (Wall and Smit, 2005; FAO, 2011).

The second approach is the development of low-carbon economy technologies that hold potential to reduce agricultural greenhouse gases emissions through energy conservation, use of lower levels of carbon-based inputs, and lower use of synthetic agrochemicals as well as the use of soil to serve as a sink for greenhouse gases emissions, through soil carbon sequestration (Pretty and Ball, 2001). Particular forms of sustainable agriculture technologies with potential for low-carbon economy include organic agriculture, integrated pest management and conservation agriculture as well as plant and breeding that promotes biodiversity (Pretty and Ball, 2001; Chel and Kaushik, 2011; FAO, 2011).

Specific farming options that have potential to reduce carbon and other greenhouse gases emissions from farms include conserving fuel and reduce energy use, use conservation tillage systems to reduce carbon dioxide emissions from soils, use grass-based grazing systems to reduce methane emissions from livestock, composting to reduce manure methane emissions, substitute biofuels for fossil fuels, reduce machinery use, reduce inorganic fertilizers and use-targeted and slow-release fertilizers (Pretty and Ball, 2001:9). In addition, the authors added that farming options to increase carbon sinks on farms include reduce ploughing with conservation, - zero-tillage, adopt mixed rotation systems using cover crops and green manures, apply composts and manures to soils to improve pasture and rangelands through grazing and vegetation, use perennial rather than annual grasses, restore and protect wetlands, convert agricultural land to woodlands, adopt agroforestry in cropping systems and cultivate crops for biofuels (grasses, coppiced trees, etc).

4.2 Global efforts on Environmental Sustainability: Corporate Social Responsibility

The importance of environmental sustainability and as a key component of several corporate social responsibility programmes among global companies has been documented (Rondinelli, 2004; Nugent and Drescher, 2006; Malovics *et al.,* 2008; Forster, 2013; Sezen and Yildiz, 2013). Global corporate brands such as Unilever, Nestle, PepsiCo, BMW, etc have all incorporated the concept of environmental sustainability in their strategic direction: vision and mission statements, production and technology strategy as well as key performance indicators on their competitiveness drive (Toffel *et al.,* 2003; Nugent and Drescher, 2006; Forster, 2013; Sezen and Cankaya, 2013). Thus, over 50 of the world's top 200 companies have set carbon intensity reduction goals in line with a 6% per year reduction target and they also planned to reduce significantly the volume of water consumption and waste water generation from their manufacturing processes (Toffel *et al.,* 2003; Malovics *et al.,* 2008; Forster 2013; Sezen and Cankaya, 2013; *Business & Financial Times, 2014*).

Consequently, the global brands are adopting technologies that substantially reduce energy consumption, greenhouse gases emissions, air acidification, ozone depleting substances, as well as increase re-use, recycling and energy recovery to minimize impact of their products and packaging materials on the environment thereby enhancing safety of consumers and workers that in turn, affect sanitation to the general public (Toffel *et al.,* 2003; Malovics *et al.,* 2008; Forster 2013; Sezen and Cankaya, 2013).

Furthermore, bilateral and multilateral international development organizations such as United Nations, World Bank, USA, EU, DFID of the UK, etc have all recognized relationship between unsustainable agricultural practices and environmental sustainability, and thus sustainability has been a subject of interest among the organizations since 1970s (Sisaye, 2012). As a result, the donor countries community continues to provide financial resources and technical assistance to governments of developing countries in agriculture, forests, fisheries, irrigation, energy and water sectors aimed at strengthening their resilient and/or building low-carbon economy technologies (Mason-Case and Segger, 2010). Through their contributions, these international development organizations have shaped and influenced the policies and programmes of sustainability development in business organizations in developing countries (Sisaye, 2012).

5. Conclusion

Based on the review, we can infer that some agricultural practices such as deforestation, land clearing for agricultural use, slash-burn-agriculture, soil nutrients mining, soil and water management, irrigation, use of agro-chemicals, livestock and poultry production, animal health, use of growth hormones in animal production and agricultural biotechnology pose serious risks and have negative effects on the targets and indicators of environmental sustainability and for that matter, facilitate loss of environmental resources (soil, forest and biodiversity, air, man, etc); enhance loss of biodiversity; reduce forest cover; promote carbon emissions; increase ozone-depleting substances; reduce fish stock; increase water resources used; facilitate species threatened with extinction; as well as reduce sustainable access to safe drinking water and reduce sanitation. In this regard, both present and future generations' agricultural production system, economic livelihoods and ecological well-being are at risk and therefore all stakeholders must play their respective roles to reverse the environmental degradation trend and enhance conservation of the basic resources of the environment.

However, sustainable agricultural technologies have positive impacts on agriculture-environment-health synergies (Smith and Smithers, 1994) and when adopted by the global community through research, advocacy and policy offerings, hold grounds to meet the needs of the present without compromising the ability of future generations to meet their own needs (Goodland, 1995; Kates *et al.,* 2005). Thus, sustainable agricultural systems practised through both adaptation/resilient technologies and low-carbon economy technologies hold bright future for present and future generations on environmental sustainability to address the degradative effects of unsustainable agricultural practices (Pretty and Ball, 2001; Wall and Smit, 2005; Chel and Kaushik, 2011).

6. Recommendations

The literature has provided clear weaknesses, opportunities and threats that characterize the relationship between the agricultural production systems in Ghana and environmental sustainability as enriched in the MDG goals. Therefore, it is recommended that the donor community, the government of Ghana, policy makers, researchers, business enterprises, civil society organizations, and the general public must all work together to undertake these programmes: awareness creation and behavioural change, extension education and services, corporate social responsibility, financial support and technical assistance aimed at building our institutional capacity to minimize the adverse effects of unsustainable agricultural practices on the environment, cope with climate change effects as well as develop and adopt innovative technologies that can have relatively less degradative effects on the environment.

6.1 Limitations and Direction for Future Research Agenda

There are a few limitations associated with this study. First of all, several hundreds of journal articles relating to the topic of sustainability are available for review; nevertheless, due to time constraints and accessibility, few of the information are incorporated into this paper. Currently, Ghana is experiencing varying degrees of environmental degradation coupled with that the information is still fragmented and sparse. There are also numerous companies in the sectors of the Ghanaian economy including NGOs and developing partners that utilize and promote best practice of sustainability, but again, time constraints limit the researchers' ability to access them.

Therefore, future studies can investigate into how environmental sustainability affects individuals, groups and companies in the economy and possibly look into how agricultural system are meeting the sustainable health and

safety demands of consumers in Ghana. Specifically, detail research can be pursued in these areas:

- Behavioural change on environmental sustainability – understanding of key concepts and their importance, cause and effect relationship, action plan focusing on targets and indicators, result-based monitoring and evaluation system, etc;
- Low-carbon agricultural technologies – that have potential to reduce rising level of greenhouse gas emissions (carbon dioxide, methane, and nitrous oxide) in respect of land use change as well as the value chain system of relevant crops and farm animals production system in Ghana;
- Resilient/adaptive "home grown" technologies to mitigate the adversaries and risks of effects of climate change in Ghana in areas of land use systems, soil nutrient mining balance, high dependence on agro-chemicals for farming, farmers and workers' risk to safety and quality issues in agricultural systems, environmental and health risks associated with genetically modified organisms and food, etc;
- Social Corporate Responsibility: involvement of the business community to inculcate environmental sustainability programmes in their operations, etc.

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