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A comprehensive review on relationship between climate change and agriculture

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Abstract
This paper reviews various articles and documents on relationship between climate change and agriculture. The two-way relationship of climate change and agriculture is of great significance in particular to developing countries due to their large dependence on agricultural practice for livelihoods and their lack of infrastructure for adaptation when compared to developed countries. Agricultural activities are affected by climate change affects due to their direct dependence on climatic factors. In high latitude areas with low temperature, increased temperature due to climate change could allow for longer growing season. Agriculture affects climate through emissions of greenhouse gases (GHGs) such as carbon dioxide, methane and nitrous oxide. These emissions come directly from use of fossil fuels, tillage practices, fertilized agricultural soils and livestock manure in large proportion. Conversely, agriculture could be a solution for climate change by the widespread adoption of mitigation and adaptation actions. This happens with the help of best management practices such as organic farming, agro forestry practice and manure management etc.

Keywords: adaptation, agriculture, climate change, greenhouse gas emissions, mitigation

Introduction

Globally, climate change (CC) is the most serious environmental threat that adversely affects agricultural productivity [1]. According to inter-governmental panel on climate change [2] (IPCC) report, climate change refers to any change in climate over time, due to natural variability or as a result of human activity. This climate change mainly caused by greenhouse gases (GHGs) accumulation in the atmosphere, which results in increased greenhouse effect. Climate change and agriculture are interrelated processes, both of which take place on a global scale and their relationship is of particular importance as the imbalance between world population and world food production increases. Based on some projections, changes in temperature, rainfall and severe weather events are expected to reduce crop yield in many regions of the developing world, particularly sub-Saharan Africa and parts of Asia [3]. The impact and consequences of climate change for agriculture tend to be more severe for countries with higher initial temperatures, areas with marginal or already degraded lands and lower levels of development with little adaptation capacity [4].

On the other hand, various studies indicate that current agricultural activities are a significant source of GHGs that aggravate climate disruption [5]. The practice of agriculture is very different between developing and developed counties, which results in variation of agricultural contribution to climate change. In developing countries, GHG emission from agriculture sector is much more because of large number of cattle and inadequate manure management, improper use of agro-chemicals and mismanagement of the land. In turn, CC impact becomes more serious in developing countries due to their dependence is on agriculture. In Ethiopia, agriculture supports the livelihoods of the majority of people by providing 80% of employment and it contributes 43% of the (gross domestic product) GDP [6]. This could be a typical example of the impact of climate change on the vulnerable rural communities in the developing world. On the other side, agricultural sector has large potential to mitigate and adapt climate change. According to IPCC [2], mitigation is an intervention to reduce the emissions sources or enhance the GHG sinks, whereas adaptation is the adjustment in natural or human systems in response to actual or expected climatic change or their effects, to reduce harm or exploit beneficial opportunities. Sustainable and organic agricultural systems can help reduce agricultural GHG emissions through energy conservation, lower levels of carbon-based inputs, lower use of synthetic fertilizer and other features that minimize GHG emissions and sequester carbon in the soil. During mitigation and adaptation of climate change through different agricultural activities, there might be many challenges or barriers such as financial, policy and implementation barrier etc. In general, Agricultural activity could be a source of GHGs as well as a sink, notably through the storage of carbon in the soil organic matter and in biomass and influenced by CC [7].

Climate change and agriculture

Agriculture is an economic activity that is highly dependent upon weather and climate in order to produce the food and fiber necessary to sustain human life. Not surprisingly, agriculture is deemed to be an economic activity that is expected to be vulnerable to climate variability and change. It involves natural processes that frequently require fixed

proportions of nutrients, temperatures, precipitation, and other conditions [8]. Agriculture represents less than 2 percent of GDP in high-income countries, and 2.9 percent for the world as a whole. It is more important for low-income countries, contributing large GDP [9]. This is particularly so for countries like Ethiopia; contribute about 43%GDP [6].

Impact of climate change on agriculture

Climate change affects agriculture in a number of ways; including through changes in average temperatures; rainfall and climate extremes with an important impact on soil erosion (i.e. floods, drought, etc): changes in pests and diseases, changes in atmospheric carbon dioxide, changes in the nutritional quality of some foods, changes in growing season, and changes in sea level [10]. Crop yields show a strong correlation with temperature change and with the duration of heat or cold waves, and differ based on plant maturity stages during extreme weather events [11]. Modified precipitation patterns will enhance water scarcity and associated drought stress for crops and alter irrigation water supplies. They also reduce the predictability for farmers' planning [12]. In an indirect way, a change in temperature and moisture levels may lead to a change in the absorption rate of fertilizers and other minerals, which determine yield output. In short, the rise in temperature along with the reduction in rainfall reduces agricultural productivity if both are beyond the threshold that is suitable for crop production [13]. According to Ignaciuk and Mason-D'Croz [14], climate change currently decreases the yield of maize, rice, wheat, potatoes and vegetables and continue to reduce seriously by 2050 globally.

Climate change is also likely to affect the livestock sector both by affecting the quantity and quality of feed and by affecting the frequency and severity of extreme climate events. There is a limited body of literature that deals with climate change impacts on livestock, but livestock sector may be particularly vulnerable to the effects of climate change [11]. Climate change regional impacts are likely to be substantial and variable, with some regions benefiting from an altered climate and other regions adversely affected. Generally, food production is likely to decline in most critical regions (e.g. subtropical and tropical areas), whereas agriculture in developed countries may actually benefit where technology is more available and if appropriate adaptive adjustments are employed [15]. In relation, crop productivity is projected to increase slightly at mid to high latitudes for local mean temperature increases of up to 1-3°C depending on the crop, and then decrease beyond that in some regions. At lower latitudes, especially seasonally dry and tropical regions, crop productivity is projected to decrease for even small local temperature increases (1-2°C), which would increase risk of hunger [16].

Agriculture is central to the survival of millions of people in many countries of sub-Saharan Africa (SSA). It is the number one provider of employment and livelihood in developing countries [17]. The impacts of climate change on agriculture have significant consequences on livelihoods, food production, and the overall economy of countries, particularly those with agriculture-based economies in the developing world because agriculture contributing 29 percent of developing countries' GDP and 65 percent of developing countries' populations, [18]. As Lobell *et al*. [19] study in 12 food-insecure regions of the world reported that climate change could significantly impact agricultural production and food security up to 2030 particularly for sub-Saharan Africa and South Asia due to both changes in mean temperatures and rainfall as well as increased variability associated with both. The study from Nigeria done by Okoloye *et al*. [20], shows that in recent years the climatic elements are extremely changed and flood and drought frequency are increasing. According to Guiteras [21], climate change is likely to impose significant costs on the Indian economy by affecting crop yield. From African countries, Ethiopia is one of the most at risk from climate change impacts on agricultural productivity and food security [22]. Gebreegziabher *et al*. [23] reported that its low adaptive capacity, geographical location and topography make the country highly vulnerable to the adverse impacts of climate change. In addition, dependency of most population on climate sensitive sectors for livelihood i.e. worsens Ethiopia's vulnerability to the impacts of climate change [24]. Over the last decades, the temperature in Ethiopia increased at about 0.2°C per decade, on the other hand, precipitation remained fairly stable over the last 50 years when averaged over the country. However, the spatial and temporal variability of precipitation is high [25]. MacDonald and Simon [26] also reported that farmers living in Ethiopia's semi-arid and arid lowlands that have less diversified assets and are heavily reliant on rain-fed agriculture are, along with their livestock, particularly vulnerable to climate change. It is estimated that the 1984-85 climate induced drought reduced Ethiopia's agricultural production by 21 percent, which led to a 9.7 percent fall in the GDP [27]. Bezabih *et al*. [28] also point out that climate variability and change in Ethiopia has significant impact in different crop yield. Particularly, Bayrau *et al*. [29], study shows that change in climate will likely have an overall significant impact in reducing the productivity of sugarcane and cotton in Ethiopia.

According to Afar National Regional State (ANRS), 2010 [30] report, all pastoral regions in Ethiopia are highly prone to the adverse impacts of climate change, while the problem is more prevalent in the North Eastern lowlands of the country mainly Afar region. Many studied done in different part of Ethiopia reported that climate change has tremendous impact in livestock resources [31, 32]. Likewise, According to Gebreegziabher, [33] 2014 study in Nile basin of Ethiopia, Changing rainfall and temperature patterns due to climate change have different effects on crops and livestock.

The contribution of agricultural activities to climate change

According to Hornton and Lipper [34], agriculture contributes 30-40% of anthropogenic GHG emissions. Three-quarters of agricultural GHG emissions occur in developing countries, and this share may rise above 80% by 2050 [35]. According to FAO [36] report in developing countries there is a significant increase in GHGs emission from 2001-2011 (14%), the increase occurred, due to an expansion of total agricultural outputs. In Ethiopia particularly, a GHG emission from agriculture accounts about 80% [37]. As the global population and the demand for food continue to grow, total GHG emissions from the agricultural sector are projected to increase over time [38]. Agriculture creates both direct and indirect

emissions. Direct emissions come from fertilized agricultural soils and livestock manure. While indirect emissions come from runoff and leaching of fertilizers, emission from land-use changes, use of fossil fuels for mechanization, transport and agro-chemical and fertilizer production [35, 39]. The most significant indirect emissions are changes in natural vegetation and traditional land use, including deforestation and soil degradation. Yibekal *et al.* [40] found that deforestation (for agricultural expansion and fuel wood) is the main cause of climate change in Ethiopia. Intensive tillage is also one of traditional land use practices which involve continuously disturb the land. This practice increases CO_2 emissions by causing decomposition of SOM and soil erosion [41]. According to the World Bank [42], agriculture contributes about half of the global emissions of two of the most potent non-CO_2 GHG: nitrous oxide (N_2O) and methane (CH_4). These non-carbon GHGs have powerful greenhouse effects and have greater longevity than CO_2 (Table 1).

Table 1: An overview of agricultural greenhouse gases with the trends as currently predicted (adapted from IPCC, 2009).

	CO_2	**CH_4**	**N_2O**
Atmosphere life time (yr)	120	14.5	120
Direct GWP (Global Warming Potential	1	24.5	320
Pre-industrial concentration	280ppmv	0.8 ppmv	288 ppbv
Current annual increase (%)	0.5	0.9	0.25
Major Agricultural Source	Deforestation	Ruminants	Synthetic N fertilizers
		Wetland rice	Animal Excreta
		Biomass burning	Biological N fixation
Percentage of global source stemming from agriculture	30	40	25
Predicted change 1990-2020	-	+	+

Globally, agriculture contributes to 58 percent of total N_2O emission [35, 43]. It creates 4.5 million tons of nitrous oxide annually [44]. Various management practices in the agricultural land can lead to production and emission of nitrous oxide, range from fertilizer application to methods of irrigation, tillage and cattle and feedlots. The use of synthetic fertilizer for agriculture is a major source of nitrous oxide emissions. Apart from this, large quantities of natural gas are used to make synthetic fertilizers because it is the main ingredient. The production process also takes a lot of energy so their impact on climate change is actually larger when we factor this in. Industrialized farming practices have worsened this loss and the result has been increased emissions. Continuous cropping may result in using of large chemical fertilizer [42]. According to Amdu [45], Study from Ethiopia reported that farmers widely used huge amount of chemical fertilizer to boost their product and considered as one of the main activities to adapt CC. And the study also reported that the farmers consider the negative effect of agro-chemicals only for their crops. This indicates that the farmers only care about their crop and select suitable condition to apply not environmental side effect of fertilizers. Because of this all, agriculture is the most important human source of nitrous oxide emissions. In Ethiopia, GHG emissions in 2010 from fertilizer use and N_2O emission from crop residues reintroduced into the soil are approximately 10 Mt CO_2 equivalent emissions and 3 Mt CO_2 equivalent emissions, respectively [46]. As earlier mentioned, methane is another non-CO_2 GHG which have large contribution in agriculture GHGs emission. Livestock, especially cattle, produce methane as part of their digestion. This process is called enteric fermentation. The sector is responsible for 47 percent of the world's methane emissions. The way in which manure is managed contributes largely. When the manure of livestock is not used as a fertilizer or left in fields during grazing. Many of these systems create conditions that are favorable for nitrous oxide producing bacteria [39].

Ethiopia has the largest livestock population in Africa and the tenth largest in the world [46]. Therefore, it is obvious the impact these large number of livestock for climate change if there is improper management. This reflects the fact that livestock farming goes together with high methane emissions. As earlier mentioned, Ethiopia's GHG emissions are dominated by agriculture, which contributes 80% of the total GHG emissions. On the other hand, According to [47] report, about 50% of Ethiopian GHG emissions is attributed to agriculture sector. According to FDRE, GHG emissions from livestock are estimated to 65 Mt CO_2 equivalent emissions in 2010. Ethiopia's GHG emissions are closely linked to basic needs of the population: Food production (through livestock farming) and heating.

Major environmental conventions on climate change and agriculture

Since the first world climate conference takes place in 1979 in Geneva, There are different documents that mention about agriculture in various environmental conventions and agreements, even if the attention for this sector is not enough despite its important. Agriculture and food security under a changing climate have come up the international agenda in recent years [48] (FAO, 2014b). Therefore, this review includes some of environmental conventions are presented as follow: Article 4 (c) of UNFCCC [49], describe that all parties should Promote and cooperate in the development, application and diffusion, including transfer of technologies, practices and processes that control, reduce or prevent anthropogenic emissions of GHG in all relevant sectors, including agriculture. Also article 4 (e) of UNFCCC [50, 51] states about the need of cooperation in preparing for adaptation to the impacts of climate change; develop and elaborate appropriate and integrated plans for coastal zone management, water resources and agriculture, and for the protection and rehabilitation of areas, particularly in Africa, affected by drought and desertification, as well as floods.

The linkage between climate change and agriculture is clearly addressed directly in Article 2 of Kyoto protocol which states:

promotion of sustainable forms of agriculture in light of climate change considerations. In Article 3.4 of Kyoto protocol also mentioned about the carbon sink partly be accomplished efficiently by organic agriculture. Article 10 of Kyoto protocol also stated how to mitigate climate change and measures to facilitate adequate adaptation to climate change by concerning different sectors including agriculture [52] (FAO, 2008). The Bali road map, IPCC's 4th assessment (2007) report, indicates that actions aimed at safeguarding food security and rural livelihoods under climate change in the coming decades must focus on interactions between adaptation and mitigation strategies in the agricultural and forestry sectors in order to address climate, environmental, social and economic concerns expressed within both the UNFCCC and the millinium development goals (MDGs). It clearly describes the potential future effects of climate change on agriculture and identified current knowledge gaps to be addressed [49]. Article 2 of UNFCCC, COP14 (in Poznan, Poland), (2008); addresses mitigation and adaptation in the agricultural sector and makes specific reference to food security when it confirms that climate change mitigation should be achieved within a time-frame sufficient to ensure, among other things, that food production is not threatened, ecosystems can adapt naturally, and economic development is pursued in a sustainable manner [53].

In copenhagen accord (2009), there was discussion about how agriculture is seriously affected by climate change. In addition it mentioned that the role of agriculture to mitigate and adapt climate change. It was a good progress but no specific decisions were taken in Copenhagen for agriculture sector with regards to climate change [54]. The cancun agreements in (2010) allow for consideration of agriculture as a driver of deforestation and thus can be considered under adaptation actions. Agriculture already figured prominently in national adaptation programmes of action (NAPAs) formulated by least-developed countries. NAPAs are now to inform the new national adaptation plans, which, in accordance with the Cancun Agreements, are to be prepared by developing countries. Also, following the fifteenth session of the COP, a number of developing countries indicated their intention to undertake nationally appropriate mitigation actions (NAMAs) related to agriculture. In 2014, the IPCC 5th assessment report In 2014, the IPCC 5th assessment report Working Group II published an update of the potential future effects of climate change on agriculture, identifying knowledge gaps and increased urgency for adaptation in the sector [48]. This is a part of Lima international climate change conference agreement.

In 2015 Paris (COP 21) Paris article 1 it is mentioned that recognizing the fundamental priority of safeguarding food security and ending hunger, and the particular vulnerabilities of food production systems to the adverse impacts of climate change. Article 92 explain that to pursue a transformation towards sustainable development that fosters climate resilient and low greenhouse gas emission societies and economies, and that does not threaten food production and distribution [50]. These all conventions and agreements indicate that, there is an increase to concern about agriculture under climate change situation.

Agriculture as a solution for climate change

The agricultural sector holds significant climate change mitigation potential through reductions of GHG emissions and enhancement of agricultural sequestration [7]. In addition, it also has significant role to adapt climate change. Adaptation alone is not enough to offset the effects of climate change, and thus still need to be supplemented by concerted mitigation efforts [8]. Mostly, when we implement adaptation measure, we enhance mitigation capacity of particular area such as practicing different land use managements (soil and water conservation measure, manure and fertilizer management) in the agricultural field will help us to sequester substantial amount of carbon in the field and reduce emission of methane and nitrous oxide which are the main GHG emission means. Therefore, the management activities are interrelated and help us to adapt and mitigate climate change. Agricultural activities are relatively affordable form of mitigation option, for which many technical options are already readily available [55]. Global adoption of organic agriculture (OA) has the potential to sequester up to the equivalent of 32% of all current man-made GHG emissions [56]. OA is a production system that sustains the health of soils, ecosystems and people. In OA, soil fertility is maintained mainly through farm internal inputs (organic manures, legume production, wide crop rotations etc); energy-demanding synthetic fertilizers and plant protection agents are rejected; and there is less or no use of fossil fuel [16]. In relation, improved cropland management (lower use of synthetic fertilizers, reduced tillage etc), Reducing industrial livestock production and improving feeding and grazing land management, Restoration of organic soils and degraded lands to increase soil carbon sinks, Improved water and rice management, Land-use change and agro-forestry, Increasing efficiency in fertilizer production and behavioral changes of food consumers (reducing the meat content) could also be main climate change mitigation measures in agriculture sector [57].

As earlier mentioned, the agricultural sector has also a potential to adapt to climate change in many areas. Climate change adaptation is a continuous process requiring location-specific response. Adaptation should enable agricultural systems to be more resilient to the consequences of climate change [58]. Farming systems and farmers will differ enormously in their capacities to respond to climate change. Differentiated adaptation strategies and enhanced climate risk management support to agriculture and farming households are critical to counter the impacts of climate change [17]. These adaptation measures could include in particular the choice and change of species and varieties, the adaptation of the fieldworks to the calendar (more flexibility), the adaptation of plant production practices (i.e. fertilization, plant protection, irrigation, etc.) or the adoption of plant production practices that increase the soil organic matter content or the soil coverage by plants, manure management and agro- forestry practices. Some of them discussed below how these practices serve as adaptation means.

Change crop variety

It involves switching from one crop variety to another in response to climatic stresses and changes. Study done by

Komba and Muchapondwa [59], in Tanzania explained that Tanzania's farmers try to adapt climate change by using drought resistance crops. Introducing Avena species (Ingedo) species in Ethiopia as fodder crop and through time it replace the dominant stable crop i.e., barley in the highland and serve as one means to adapt CC [45].

Change in cropping pattern

Application of changes in how crops are cycled within a season. Farmers in the drought-prone semi-arid areas of Brazil have realized that several varieties of a single crop species can occupy a common land area, incorporating several bean varieties, maize and sorghum, among others, to increase harvest potential arid climate stresses [60]. Likewise, In Ethiopia farmers try to adapt CC by planting diversifies crops (homestead maize and other crops).

Change in cropping calendar

It is another common adaptation to climate change at the farm level, which largely involves altering the timing of farm activities to suit climatic variations or changes. In Philippines, farmers adapt to the early onset of rainy season through early cultivation of upland farms, which results in high agricultural production for the season and higher household income from farm activities [61]. Tanzania's farmers also used planting date changing practice to adapt CC [62]. In addition, according to Rhodes *et al.* [63] most West Africa counties such as Burkina Faso, Niger and Senegal already develop and implement a mathematical model for different crops to plant under changed climate by shifting planting date to adapt CC. Changing planting dates of crops helps greatly for the farmers live in East Gojam (Choke mountain in Ethiopia) and East Hararghe for CC adaptation respectively.

Farm management practices

Change in current farm management practices such as OA practice focus on maintaining diverse farming systems (i.e. planting different crop species) also helps diversify potential sources of income for farmers, making the farming household more resilient to adverse impacts of climate on agricultural production [63]. According to Rhodes *et al.* [62], also crop residue management practice is considered one of the best climate smart actions. In addition, Smallholder farmers in sub-humid Southwestern Cameroon have been adapting to variations in rainfall through different soil and water conservation practices. Ditch and check dam constructions are the major soil and water conservation (SWC) practice that helps to adapt CC in Ethiopia. Similarly, study in Ethiopia revealed that terracing and Different water harvesting practices widely used to adapt the changed climate.

Livestock management

It related to livestock and their waste management. Particularly to adapt climate change farmers from central Africa implement different adaptation strategies such as Breeding locally adapted livestock species, diversifying livestock types, proper resource management practices and alternative feed production technologies (use of agricultural by-products or household and industrial waste products are needed to produce feed) [64]. In Ethiopia (East Gojjam), farmers has made different local adjustment of avoid the impact of CC such as planting trees that serve as a shed for their livestock, locate their livestock near to the clinic (due to pest and disease infestation increased) and keep their animals in home and feed them through cut and carry system in times of feed and water scarcity.

In addition, during livestock waste management, manure should be collected as quickly as possible to limit GHG emission and to reach high energy potential from manure. In South Asia and China, some livestock producers are coming up with innovative ways of storing and removing animal waste and produce biogas and the device break down bio-solids in underground fermentation units which produce gas for cooking, lighting and energy for on-farm activities. Solids broken down in fermentation units can also be used as fertilizers in crop production, or sold for cash [65]. In this way, Livestock waste management can serve as both climate change mitigation and adaptation means.

Agroforestry

Given the large contribution of land use conversion and the forestry sector to GHG emissions, agroforestry presents an opportunity to counter the adverse impacts of climate change through the joint action of adaptation and mitigation [66]. Trees on farms enhance the coping capacity of small farmers to climate risks through crop and income diversification, soil and water conservation and efficient nutrient cycling and conservation [61]. Different researches on agroforestry in West Africa related to climate change have focused on its carbon sequestration potential and effect on soil fertility [67]. Similarly, most central Africa countries studies reported that significant crop yield increases for maize, sorghum, millet, cotton and groundnut when grown in proximity to Faidherbia albida tree [64].

Barriers to adapt and mitigate climate change in agriculture sector

According to Smith *et al.* [68] study, the following condition considered as the main barrier to mitigate CC; it need long time (15-60 years) to obtain maximum storage that is carbon sequestration in soils or terrestrial biomass, depending on management practice, management history and the system being modified. Costs that are related to measurement and monitoring and transaction cost (incentive-based system) also another barrier: When there is lack of clear ownership about the land results in less incentive to implement different land management activities become another problem. On the other hand, According to IPCC Fourth Assessment Report, There are often technological and financial limits that prevent the scale of adaptation that we would need. The other barriers mentioned by FAO 2011, are funding and implementation barriers. Nhemachena and Hassan [69], identify the important determinants of adaptation in South Africa, Zambia and Zimbabwe as access to credit and extension and also awareness. Ishaya and Abaje [70] also found that lack of awareness and knowledge about climate change and adaptation strategies, lack of capital and improved seeds, and lack of water for irrigation played an important role in hindering adaptation in Nigeria. Similarly, Okolo *et al.* [71] study finding revealed that policy barrier such as lack of local

context and little attention to local situation, limited capacity to implement the policy, lack of coordination etc. hinder farmers' to practice different adaptation activities. Bryan *et al*. [72] study in Ethiopia and South Africa access to credit is the main barrier that affects CC adaptation by farmers. Another study done by Amdu, in Ethiopia reported that lack of knowledge, improper policy and lack of land use policy implementation, labor and water shortages, and information are the main barriers to CC adaptation. According to Rhodes *et al*., review on west Africa region, lack of scientific research that deliver information this result in limited knowledge to understand adaptation strategies and policy gap are the main barrier to implement effective adaptation measures.

Conclusion

From this extensive review, it is concluded that globally, climate change has relationship with agriculture in one or another way. This relationship becomes strong in developing countries because their livelihood depends on agricultural activities and this activities mostly depend on climatic condition, For instance in Ethiopia, almost all farm activity is rain fed. In relation, the impact of climate change is very serious in developing counties due to their limited adaptive capacity and lack of technology and also they are the main emitter of non carbon GHGs from their cattle and farm management mainly from use of synesthetic fertilizers. Those are the main direct emitters. There are also indirect emitters such as land use change; from runoff and leaching of fertilizers; use of fossil fuels for mechanization; transport and agro-chemical and fertilizer production. On the other hand, by the help of the right farming practice agriculture could be the main solution for climate change by mitigation and adaptation response. Within the current and projected situation of climate change globally, only climate change mitigation is not enough so long term solution is important by combining climate change adaptation in agriculture sector. Such practices could be organic agriculture, manure management, agroforestry practice etc.

Know a days, the significant relation of climate change and agriculture sector become well known. In recent years, even if the attention is not enough, the significant relation of climate change and agriculture sector becomes acknowledged. To happen this, International conventions and agreements has significant role in addition to research role.

Recommendations

Based on this review, the following recommendations are forwarded:

- Agriculture has significant contrition for climate change disruption but the attention given for this situation is low. So, there should be more research and awareness creation on this is important.
- It is obvious that climate change has significant negative role particularly for developing countries farmers. So adequate mitigation and adaptation measure implementation should be widely practices.
- International agreements and convention about climate change and agriculture contribute to distribute information widely over globe still need more focus on this nexus as they worry about CO_2 emission and practical support starting from local farmers is very vital.

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