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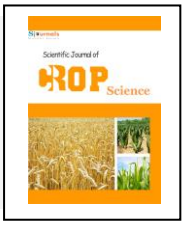

Review article

The nexus between agriculture, food security and climate change in Ethiopia

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ABSTRACT

This paper focuses mainly on assessing the food security-agriculture-climate change nexus and provides multidisciplinary scientific assessment and recommendations for sustainable agro ecological solutions in the quest of humanity to sustainable development. While agriculture tend to support the overwhelming majority of the population in every part of Africa in general and in Ethiopia in particular, climate change in itself will very likely affect four key dimensions of the food security including availability, accessibility, utilization and sustainability of the food, due to close linkage between food and water security and climate change. The impacts of climate change and increases in climate variability on agricultural systems and natural-resource-dependent households, as well as on food security and the future vulnerability of already hungry people in Ethiopia and of course in most of the developing countries in Africa, are highlighted in the paper. It is also worth mentioning that, the role of climate-smart agriculture can be used for mitigating and adapting the impacts of projected climate change. CSA brings together practices, policies and institutions that are not necessarily new but are used in the context of climatic changes. Furthermore, it addresses challenges faced by triple interplay of agriculture, food security and climate change simultaneously and holistically.

1. Introduction

Various studies indicate that some 70% of the food insecure people in the world are rural, directly or indirectly dependent on agriculture for income as well as food (IFAD, 2011). The largest share goes to African countries. This is why now a days, agricultural development is becoming a rule than exceptions, and prescriptions than of consultations. Agriculture represents the overwhelming part of the Ethiopian economy and provides food and livelihood activities for about eighty five percent of the Ethiopian population. However, the sector remained contributing what is termed as 'contribution with no regrets' for so long. One of the pressing obstacles is the impact posed by climate change. While the magnitude of impact varies greatly by region, climate change[1] is expected to impact on agricultural productivity and shifting crop patterns. The policy implications are far-reaching, as changes in agriculture could affect food security, trade policy, livelihood activities and water conservation issues, impacting large portions of the population. The following picture depicts the interplay between agriculture and climate change.

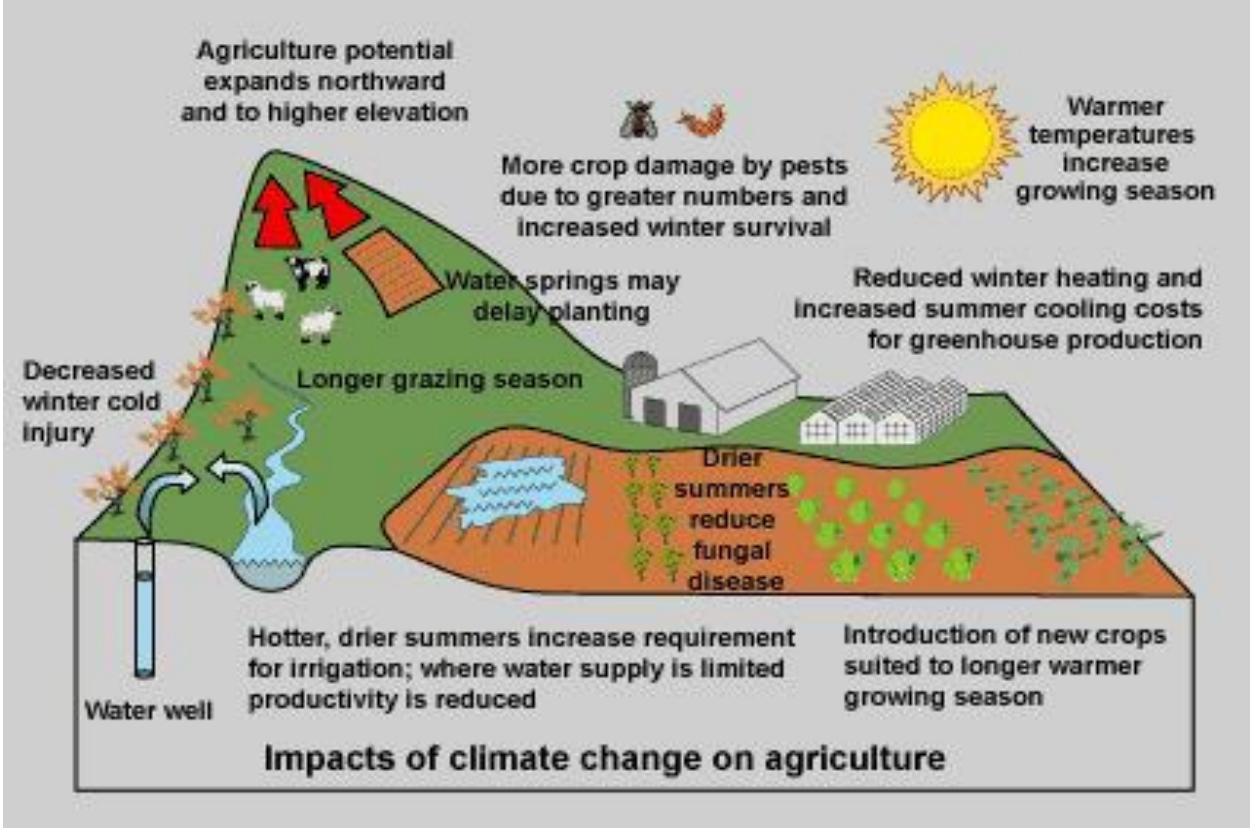


Fig. 1. Predicted climate change impacts on agriculture.
Source: Taken from Environment Management Forest Research Institute University, Dehradun.

2. Climate change and food

The vast majority of Ethiopians live in rural areas, with small-scale agriculture as the main livelihood for millions of impoverished people. The central problem of Ethiopian agriculture is its low productivity, (Eshetu , 2004) which is in substantial part a function of extreme hydrological variability, estimated to cost the economy about a third of its growth potential. Ethiopian farmers are disproportionately dependent on rainfall, which is notoriously erratic across the territory (Arsano and Tamrat, 2005); even during good-on-average precipitation

[1] Any change in climate over time, whether due to natural variability or as a result of human activity.

years, there are often huge regional discrepancies that devastate rural livelihoods in one area while producing plentiful harvests elsewhere. Drought strikes every 3–5 years, a pattern which is expected to worsen as climate change further increases the unpredictability of the water cycle and the likelihood of extreme weather events (Ibid).

With increasing in the number of population and highly variable rainfall, the agricultural land could not provide the food required for sustaining a relatively huge population. Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life (World Food Summit, 1996).

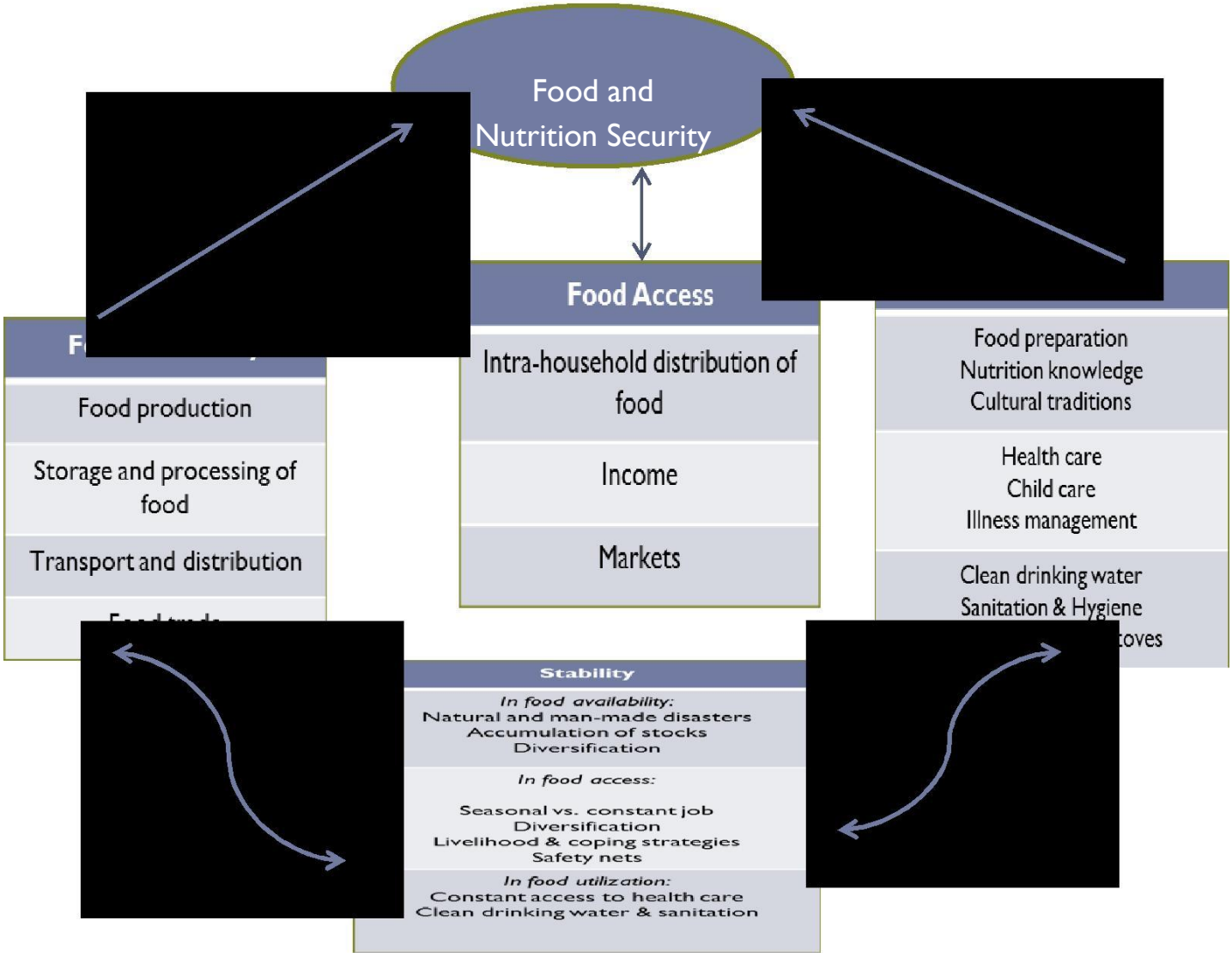


Fig. 2. Elements of Food Security
Source: Burchi et al., (2011).

3. Food Security

Defining food security in a way that is operationally useful is a daunting task. However, the prevailing definition describes food security as the condition that "exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life"(FAO, 1996). This definition is debatable one in that, it is not possible and in fact has gone beyond shortage of food. For much of the Africans, the term 'food preference' is almost nonexistent. The

definition is nevertheless useful in that it hints at several potential manifestation of what we may be term food insecurity,(Cafiero, 2012) which would exist: a) When people cannot access food, simply because food is not physically available where and when it is needed; b) When people do not have economic access to food, meaning that they lack the means to acquire the food even if the food would be at their physical reach; c) When people can only afford to procure and eat combinations of foods that do not meet their preferences, are not safe, or are nutritionally unbalanced; d) When any one of the above conditions holds even occasionally. Four dimensions or pillars of food security – commonly referred to as availability, access, utilization and stability

– have thus been conceptualized (Ibid) as a way to provide better guidance to policy aimed at addressing the problem.

There is also some overlap between areas of food insecurity and climate change hotspots (Ericksen et. al. 2011) We know that GDP growth originating in agriculture has been found to be almost three times more effective in reducing poverty than growth in other sectors of the economy due not only to the direct poverty reduction effect but also from its potentially strong growth linkage effects on the rest of the economy (De Janvry and Sadoulet, 2010). Thus, the next 20 years are a critical window of time for accelerating the rate of agricultural growth in least developed countries to achieve food security and development for agriculturally-dependent populations. Reducing poverty and food insecurity over this period is in fact, an essential element of adapting to climate change, since it is the key means of reducing vulnerability and increasing the resilience of people to withstand and respond to climate change. However the agricultural growth for poverty reduction and food security needed for the next two decades requires departing from past models of development – due to the exigencies of adapting to, and mitigating climate change (See How does climate change alter agricultural strategies to support food security? Draft, 11 March 2013, Background paper for the conference "Food Security Futures: Research Priorities for the 21st Century", 11-12 April 2013, Dublin). Much of what is called for in strategies for sustainable agricultural development and intensification are highly relevant in the context of agricultural growth for food security under climate change.

4. The impact of climate change on livelihood

According to ONRS (2011), climate change and variability in Ethiopia poses particular risks to poor farmers and pastoralists who have an immediate daily dependence on climate sensitive livelihoods and natural resources. In addition to the physiological effects of higher temperatures on individual animals, loss of animals as a result of droughts and floods, or disease epidemics related to climate change may thus increase. Indirect effects may be felt via ecosystem changes that alter the distribution of animal diseases or the supply of feed. As reported by ANRS (2010) 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. The afar region is home to pastoral and agro-pastoral people who largely depend on livestock production for their livelihood but due to climate variability the people exposing to the risks of several climate related disasters. Similarly, a study by Kassaye (2010) accounted that livestock production in already marginal ecosystems in Ethiopia is severely affected by climate change induced disasters. MacDonald and Simon (2011) 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. Unsustainable land use and its resultant land degradation are the two human induced factors responsible for climate change and food insecurity in all parts of sub-Saharan Africa. If the trens continues, they might be responsible for the eventual collapse of the ecology.

The environment-development linkages are highly pronounced in Ethiopia, as it has a number of landscapes and topography. These are the land degradation–food insecurity–climate change nexus. The former includes unsustainable agricultural land management practices and climate change scenarios. The degraded land is also more prone to erosion, leading to loss of fertility in the topsoil and to a reduction in soil depth, both of which can have an adverse effect on crop yields. The consequences of both deforestation and degraded soil structure include less infiltration of rainfall, which diminishes groundwater recharge; more runoff, which contributes to erosion and siltation; and reduced water storage capacity in the soil, which makes crops less able to withstand drought.

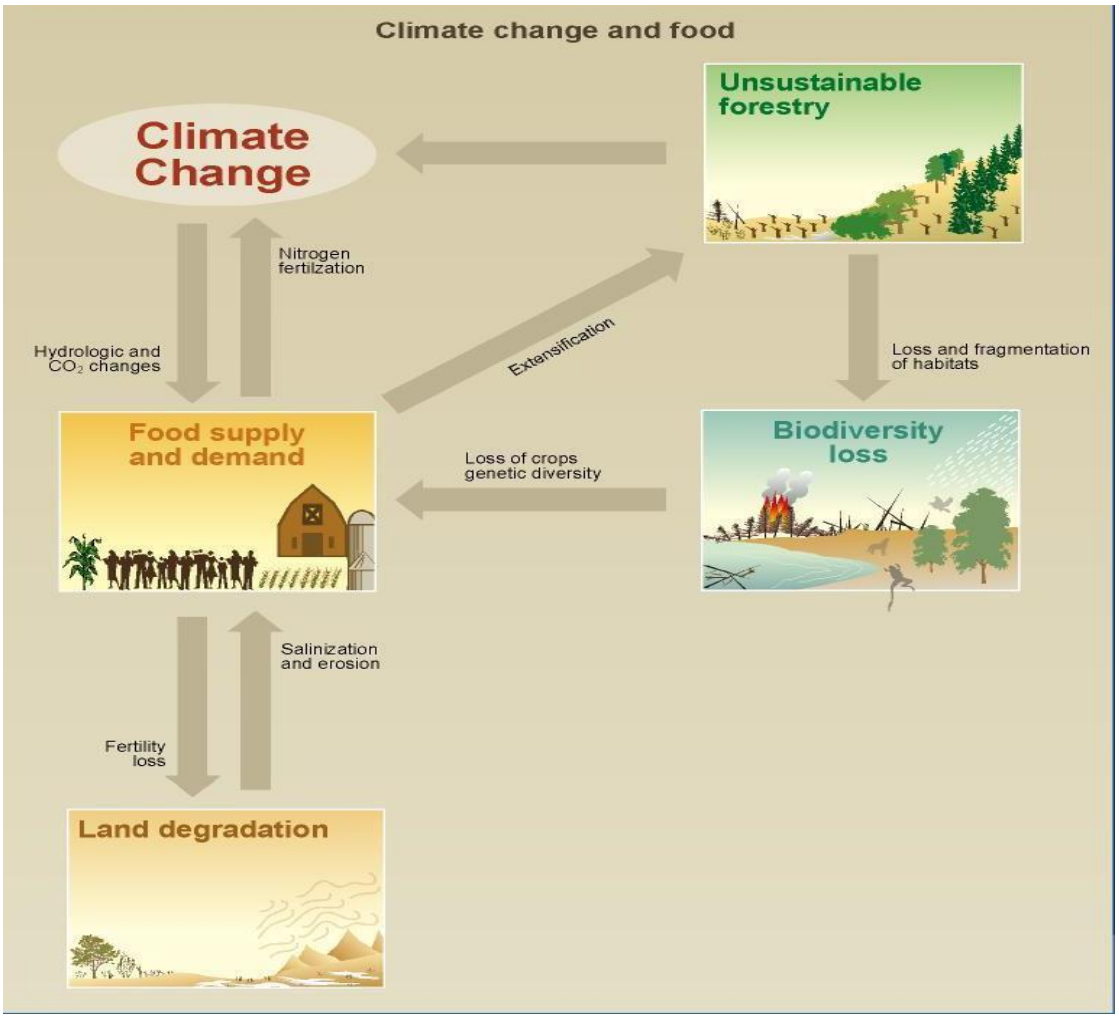


Fig. 3. The linkage between climate change and food security.
Source; Taken from Environment Management Forest Research Institute University, Dehradun.

Agriculture employs 80 percent of the country's population and accounts for almost 50 percent of the gross domestic product (GDP). Small-holder farmers, generally with less than 1hectare of land, account for about 95 percent of the agricultural output (See Managing Water Resources to Maximize Sustainable Growth in Ethiopia; World Bank Report NO. 36000-ET). In times of good weather, roughly 75–80 percent of the annual output is consumed at the household level. Variations in rainfall and weather conditions cause considerable volatility in agriculture growth. Weather variability can both reduce yields and lead to land degradation. Yields typically fall if there is too little rain, but they can also be damaged by excessive rain and flooding. Declining agricultural productivity, in turn, inhibits investments in land management and encourages the extension of agricultural lands rather than intensification of production. This practice can lead to further land degradation, closing a vicious circle that leaves the landscape increasingly vulnerable to drought and rainfall related erosion.

5. Areas Experienced Massive Soil Loss and Land Degradation

Seventy-nine percent of Ethiopia's land has a slope in excess of 16 percent, and at least one-third of this area has a slope of 30 percent or more (Campbell 1991). Torrential or tropical rains, combined with the absence of adequate cover, result in a heavy flush of water that washes away the soil. Crops that have not yet adequately rooted during the early part of the rainy season may also be washed away along with the soil. Farmers cultivating the rugged terrains in the regions of Tigray and Amhara (Wollo, North Gondar, and North Shoa) frequently

abandon their farmland after the topsoil is washed away.7 The soil depth is reported to be 10 centimeters or less in many areas (Hurni 1988.).

Studies indicate that in many areas erosion exceeds soil formation. Soil formation is estimated at about 15 tons per hectare per year. In the highland regions of the Abbay Basin, soil loss in areas cultivated through traditional practices amount to 122–128 tons per hectare per year. This figures more than doubles in the absence of vegetation. In the Baro subcatchment, the upper plateau with 5–60 percent slope produced soil loss of 46–425 tons per hectare per year. In the Tekeze Basin, Quiha subcatchment soil loss amounted to 33 tons per hectare per year (NEDECO 1997).

6. Copping with climate change Impacts

6.1. Climate Smart Agriculture[2], New Avenues for Agricultural Transformation

It addresses the complex interrelated challenges of food security, development and climate change, and identifies integrated options that create synergies and reduce trade-offs. It also recognizes that these options will be shaped by specific country contexts and capacities as well as socio- economic and environmental situations, assesses the interactions between sectors and the needs of different stakeholders. It is also worth mentioning that climate smart agriculture identifies barriers to adoption (esp. for farmers), and provides appropriate solutions in terms of policies, strategies, actions and incentives.

More productive and more resilient agriculture requires a major shift in the way land, water, soil nutrients and genetic resources are managed to ensure that these resources are used more efficiently. Making this shift requires considerable changes in national and local governance, legislation, policies and financial mechanisms. This transformation will also involve improving producers' access to markets. By reducing greenhouse gas emissions per unit of land and/or agricultural product and increasing carbon sinks, these changes will contribute significantly to the mitigation of climate change.

So what's new about it?

- Harmonization and synchronization of practices and policies
- Objective of avoiding contradictory and conflicting policies by internally managing trade-offs and synergies
- CSA is a new approach to guide the needed changes of agricultural systems to address food security and climate change.
- While to address climate change and food security through CSA would depend on practices, policies and institutions that are not new, the harmonization and synchronization needed of practices and policies to address these challenges is new.

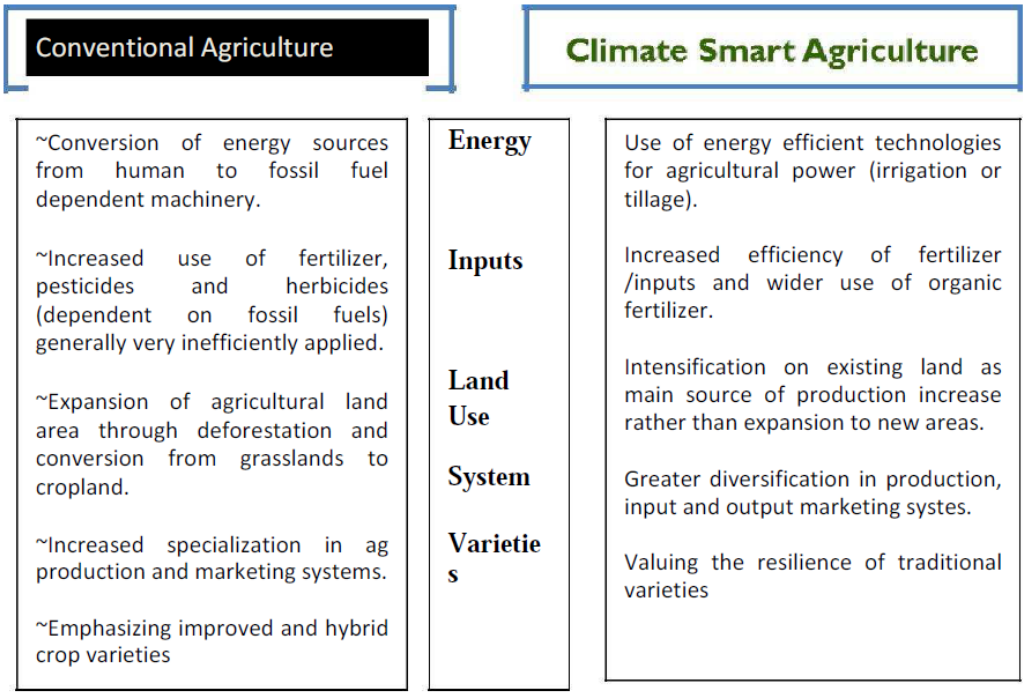
What is also new is the fact that the multiple challenges faced by agriculture and food systems are addressed simultaneously and holistically, which helps avoid counterproductive policies, legislation or financing.

As seen in the diagram above, The Green Economy focuses on the concept of sustainability within each sector whilst GEA has a higher focus upon the agriculture greening role in value chain[3] and food security. GEA and Climate smart agriculture both present a lot of convergences and could be considered as targeting quite similar objectives with a small focus divergence towards Green economy for GEA and towards Climate change for Climate-Smart Agriculture (CSA).

[2] CSA is an approach that requires site-specific assessments to identify suitable agricultural production technologies and practices. It seeks to enhance food security while contributing to mitigate climate change and preserving the natural resource base and vital ecosystem services requires the transition to agricultural production systems that are more productive, use inputs more efficiently, have less variability and greater stability in their outputs, and are more resilient to risks, shocks and long-term climate variability.

[3] A chain of activities that a firm operating in a specific industry performs in order to deliver a valuable product or service for the market.

Does CSA overrun CA (Conventional Agriculture)?



7. Links of the approach to Previous Approaches

CSA shares the objectives and guiding principles of sustainable development, green growth and sustainable intensification.

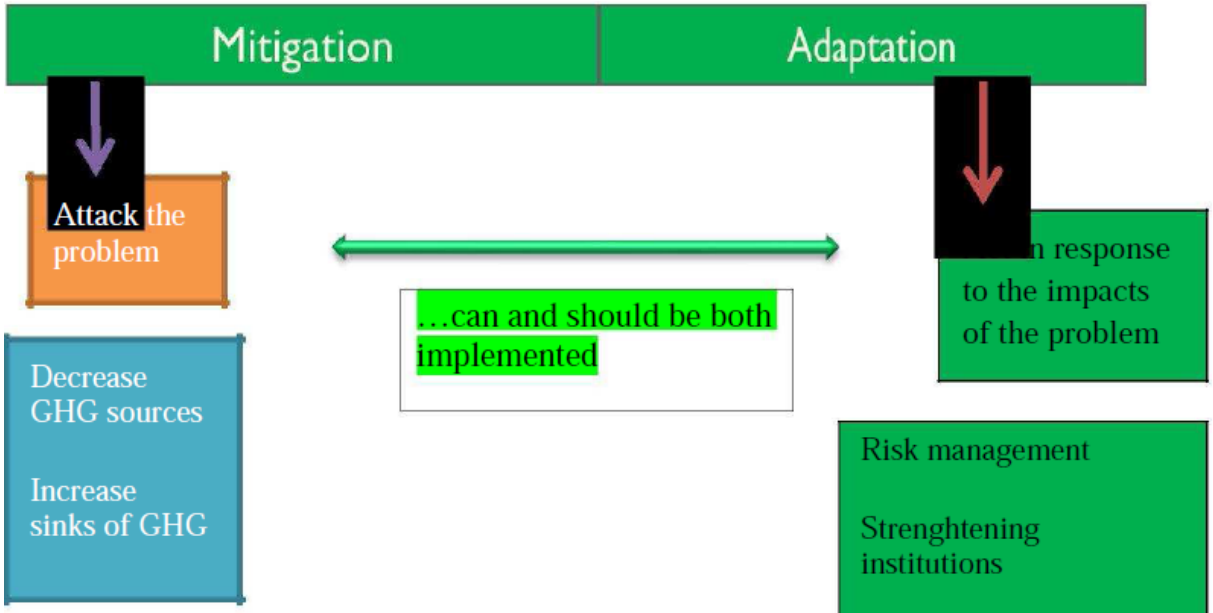
1. Sustainable development: CSA contributes to the achievement of sustainable development goals: economic, social and environmental. According to the Brundtland Commission in Our Common Future– Report of the World Commission on Environment and Development (1987) it is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Recognizing the value of the environment, extending the time horizon and emphasizing the role of equity. The CSA approach is designed to identify and operationalize sustainable agricultural development within the explicit parameters of climate change.

In this regard, 2012 Rio+20 needed more concrete expression on sustainable development, making it more operational and guiding on how to integrate its three dimensions: economic, environmental and social. Therefore, the concept of green economy was developed. Definition is according to UNEP's Green Economy Report:"An economy that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities."

2. Green Economy: Uses green economy's need for more resource efficiency and resilience

3. Sustainable intensification: focuses on availability dimension of food security (CSA covers also accessibility, utilization and stability). It encompassed in "Save and Grow" concept. It is a productive agriculture that conserves and enhances natural resources. Uses ecosystem approach that draws on nature's contribution to crop growth and applies appropriate external inputs at the right time in the right amount to allow crop varieties resilient to climate change use nutrients, water and external inputs more efficiently.

CSA is also tied to accessibility dimension of food security since it has to do with raising and stabilizing incomes of smallholders. CSA adds a more forward-looking dimension than sustainable intensification with more concern about future potential changes and the need to be prepared for them, which reflects CSA's tie to sustainable development.



Source: Arslan, 2014 with some modifications

8. Other mitigation measures

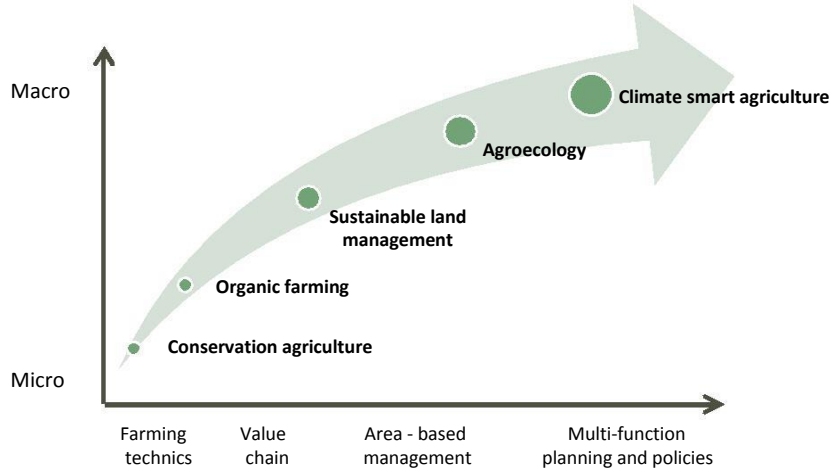
These measures are obviously critical to contain the damage and changing agricultural and land use practices have a major role to play. Forestry, for example, accounted for some 17% of greenhouse gas emissions in 2004, according to IPCC. But if deforestation can be halted, reforestation initiated, and existing forests managed more sustainably by communities, forests could become part of the solution instead of part of the problem. Moreover, soils can be better managed to store carbon, while agroforestry is also an underutilized mitigation option. Biofuels are a complex issue at the moment. They have potential for reducing greenhouse gas emissions by replacing fossil fuels; but their production has its own environmental costs, and may compete with that of food and feed[4]. Research into biofuel development should clarify the issues, and allow production of biofuels in an environmentally sustainable way that also benefits the poor. These, and other promising mitigation options linked to agriculture, land use and natural resources management, are always at the apex of every climate change investigation results.

9. Concluding Remarks

Africa's agriculture must undergo a significant transformation to meet the simultaneous challenges of climate change, food insecurity, poverty and environmental degradation. Food insecurity, persistent poverty, climate change and variability, and environmental degradation are closely interlinked. Each can be both a cause and an effect, and interactions occur between them at local, national, regional and continental scales. The severity of the impact of the former is worth mentioning in the context of sub Saharan Africa. There must be a shift from the traditional conventional agriculture to that of climate-smart agriculture includes practices and technologies that sustainably increase productivity, support farmers' adaptation to climate change, and reduce levels of greenhouse gases. It can also help governments to achieve national food security and poverty reduction goals.

[4] See climate, agriculture and food security: A strategy for change, December 2009.

CSA among Other Concepts of `Green'Agriculture



From farm-based to comprehensive development concepts
Source: www.foa.org/cc/exact;world food organization

The results of mitigation efforts, in terms of reduced emissions and retained carbon and corresponding slowing of temperature rise, will not be evident for decades. But many of the options that relate to developing country agriculture and natural resources management will have immediate development benefits. Beyond 'no regrets', these are win–win opportunities that the world should not miss. Whatever mitigation efforts are made, climate change is already happening, and temperatures will continue to rise during the coming years. The challenge is dynamic and multifactorial; the responses – the adaptation options that will allow people to manage this challenge – will have to match. Transforming from the conventional traditional agriculture to what is known as CSA, climate smart agriculture, which sustainably increases agricultural productivity and incomes of farm household, adapt and build resilience to climate change and reduce and/or remove greenhouse gas emissions, is part of the concluding reflections of the paper.

10. Recommendations for Higher Academic Institutions

The agriculture-food security-climate change nexus is strong enough which could be the causes and consequences each other. This is particularly relevant in the context of developing countries whose livelihood is dependent up on agriculture. In such countries, research based agricultural practices are recommended to be undertaken. For the most part, higher academic institutions are at the apex of stake holders' position. In Ethiopia, some universities are taking steps in playing their part to transform the society around them. They are creating tangible impacts on the life of the community through research based community development in creating opportunities and providing rooms for agricultural researches, particularly in adopting sustainable agricultural practices in the highland areas of the country. In this regard, according to the various sources, the good startings from Mekelle university and others are assumed to be inspirational for other institutions and create new avenues for agricultural development which cannot be easily impacted by climate change and the subsequent improvement in terms of improving food security in the country.

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