American Journal of Human Ecology
Vol. 3, No. 3, 2014, 51-71
DOI: 10.11634/216796221403571

Biophysical, Socio-Economic, and Institutional Constraints for Production and Flow of Cereals in Ethiopia

Gemechu Shale Ogato

Department of Rural Development and Agricultural Extension, Institute of Cooperatives and Development Studies, Ambo University, P. Box 365, Ambo, Ethiopia

This article an outcome of a study on "Biophysical, Socio-Economic, and Institutional Constraints for Production and Flow of Cereals in Ethiopia." The findings of the study were based on literature review and secondary data and information collected from different sources. The general objective of the study is to assess the biophysical, socio-economic, and institutional constraints for production and flow of cereals in Ethiopia. The study concludes that there is strong conceptual linkage between ecosystem-based adaptation to climate change and food security in Ethiopia; there is interplay among bio-physical, socio-economic, and institutional constraints for production and flow of cereals in Ethiopia; there are strengths, weaknesses, opportunities, and threats of the current Ethiopian agricultural development policy and strategies in addressing the constraints for production and flow of cereals; there are increasing trends of major cereals' mean annual production in Ethiopia; and the food security situation of Addis Ababa is very much affected by increase of mean annual prices of major cereals in Addis Ababa grain market. Hence, addressing the identified biophysical, socio-economic, and institutional constraints for production and flow of cereals is of paramount importance for sustainable production and flow of cereals and insuring food security in Ethiopia.

Keywords: Cereals, ecosystem-based adaptation, Ethiopia, food Security, price, sustainable production

Introduction

With 85% of the population living in the rural areas and depending on agriculture for livelihood, there is no doubt for the economic importance of the agricultural sector for sustainable development and poverty reduction in Ethiopia. In other words, the agricultural sector accounts for more than 40% of national GDP, 90% of exports, and provides basic needs and income to more than 90% of the poor. Moreover, a better performed agricultural sector has provided growth to the overall economy, improved the food security and reduced poverty in the recent years (Alemu, 2005; Cooper et al., 2008; Ludi, 2009; Diao, 2010).

Ethiopia has been well known for its agricultural development challenge given its large and rapid growing population and limited and deteriorated land resource. Scholars in the field contend that these two factors together have caused extreme land shortage in the highland of Ethiopia, the area most population lives and most agricultural production occurs (IFOAM, 2009; Diao, 2010; Asenso-Okyere & Jemaneh, 2012). For instance, Diao (2010) asserts that population pressure has led to expanded cultivation into forest areas and steep slopes. This creates serious repercussion for the environment, which, together with fluctuation in rainfall, have made agricultural production very vulnerable to weather shock. Odendo et al. (2010) also affirm that soil fertility degradation on smallholder farms has been the fundamental biophysical cause of food insecurity and poverty in sub-Saharan African countries like Ethiopia where most of the people live in rural areas and derive their livelihoods from agriculture.

The rationale for focusing on cereals in this study is the place of cereals in production and consumption in Ethiopia. In other words, cereals are by far the largest group in terms of their share in area cultivated, output, and consumption. Moreover, cereal production and marketing is the single largest sub-sector within Ethiopia's agriculture. It dominates in terms of its share in rural employment, agricultural land use, and calorie intake, as well as its contribution to national income. In other words, the sub-sector accounts for roughly 60 percent of rural employments, about 73 percent of total cultivated land, more than 40 percent of a typical household's food expenditure, and more than 60 percent of total caloric intake of a typical household in the country (Hassan & Nhemachena, 2008; Diao, 2010; Rashid & Negassa, 2011). Barley, maize, teff, wheat, and sorghum are the most important crops for Ethiopian agriculture. According to Diao (2010), while 64% of agricultural value added comes from crops, more than 70% of crop land is devoted to cereal production.

According to World Bank (2011), Global circulation models predict an increase in temperature of 1.7 to 2.1 degrees Celsius for

Ethiopia by 2050. The predictions regarding rainfall for Ethiopia are much less consistent; but increasing unpredictability, together with more frequent and intense patterns of extreme weather, is likely to be the trend. The combination of higher temperatures and more unpredictable rains has negative implications for the length and reliability of the growing season. Parts of Ethiopia have abundant surface water resources, but so far irrigated agriculture is not well developed (World Bank, 2011).

Low levels of socio-economic development, limited infrastructure, lack of institutional capacity and a higher dependency on natural resources result in Ethiopia being highly vulnerable to climate variability and extreme climate events (Cooper et al., 2008; Hassan & Nhemachena, 2008; Colls, et al., 2009; Ludi, 2009; Edame et al., 2011; Shiferaw et al., 2011; USAID, 2011; Asenso-Okyere & Jemaneh, 2012). Moreover, recurrent drought events and political instability in the past have resulted in famines and migration of people. The country is also vulnerable to severe flooding and associated soil erosion of the fertile Ethiopian highlands (Colls, et al., 2009). According to Edame et al. (2011), climate change could lead to increased water stress, decreased biodiversity, damaged ecosystems, rising sea levels, and potentially, to social conflict due to increased competition over limited natural resources.

Food insecurity in Ethiopia is persistently caused by a combination of factors that include recurrent drought; the flooding that has become more frequent in flood prone areas along the main river basins; small land holdings with an average of 0.5 to 2 hectares per household associated with population growth. In addition, factors such as death, job loss, crop damage and animal deaths increase household vulnerability in different regions. The most recent risk phenomenon is the price risk especially of grains which constitute the major diet in Ethiopia. These hazards and shocks increase the vulnerability of both most rural and some of the urban households. Added to this is the economic shock of increasing food prices. Rural-urban migration is a common phenomenon, further encouraged by land shortages in rural areas and the perception that food, health services and jobs are more easily available in urban centres. These major shocks have important implications for the welfare of both urban and rural households (WFP-Ethiopia, 2009).

Scholars of ecosystem-based adaptation in agricultural sector contend that ecosystem-based adaptation practices like organic agriculture encourage the use of local and indigenous farmer knowledge and observation techniques and recognize the critical role of women throughout the entire food chain, as farmers, consumers and mothers. However, their agricultural systems have attracted little attention from research and development and are usually assumed to be inherently unproductive. Nevertheless, smallholder farmers throughout the world have developed a multitude of practices and innovations that should be seen for what they are; the basis for any realistic development – including productivity improvements (Cooper et al., 2008; Hassan & Nhemachena, 2008; IFOAM, 2009). A major barrier to food security and accessibility in the least developed countries like Ethiopia is lack of adoption of affordable, productive and resilient farming systems by many of their smallholder farmers. Many of these farmers are relatively poor and unproductive and highly vulnerable to climate change and other biophysical constraints (Cooper et al., 2008; Hassan & Nhemachena, 2008). Scholars of ecosystem-based adaptation in agricultural sector contend that optimizing productivity and building resilience of these farms is critical for improving local food security and accessibility. For instance, IFOAM (2009), attest that local food production in smallholder farms can often be increased significantly through improving the use of locally available resources and agro-ecological methods for soil fertility building and pest prevention. In other words, eco-functional intensification increases productivity and enhances food security especially in challenging environments such as water scarce regions (IFOAM, 2009).

Several studies have been undertaken to assess constraints for production and flow of cereals in Ethiopia. Research in this area has predominantly focused on independent assessment of biophysical, socio-economic or institutional constraints for production and flow of cereals in Ethiopia. Comprehensive studies on the biophysical, socio-economic, and institutional constraints for production and flow of cereals and the interaction among these constraints were given less attention. Hence, this study assessed the bio-physical, socio-economic, and institutional constraints for production and flow of cereals and forward strategic measures to address them in a sustainable manner. Such analysis can contribute to a better understanding of the relevant growth process and, as a consequence, to the design of sustainable agricultural development policy and strategy in Ethiopia.

The study answered the following research questions: 1. what are the bio-physical, socio-economic and institutional constraints associated with cereals' production and flow in Ethiopia? 2. What are the strengths, weaknesses, opportunities, and threats of Ethiopian policy and strategy in agricultural sector in responding to bio-physical, socio-economic, and institutional constraints? 3. What does the trends of major cereals' annual production in Ethiopia looks like? 4. What does the trends of major cereals' annual prices in Addis Ababa grain market looks like?

The general objective of the study is to assess the bio-physical, socio-economic, and institutional constraints for production and flow of cereals in Ethiopia and forward strategic measures to deal with these constraints. The specific objectives of the study are: To assess bio-physical, socio-economic, and institutional constraints associated with cereals' production and flow in Ethiopia; To analyse the weaknesses, strengths, opportunities, and threats of the current Ethiopian agricultural development policy and strategies in dealing with constraints for production and flow of cereals; To analyse the trends of major cereals' annual production in Ethiopia; and To analyse the trends of major cereals' annual prices in Addis Ababa grain market.

Research Methodology

A comprehensive review of the existing literature was made in order to obtain both theoretical insights and secondary data on the review themes. The secondary sources or existing literatures in reference to the review themes conceptualized in the study were carefully selected and consulted for secondary data and information. In other words, robust secondary sources on the review themes in the context of Ethiopia were identified for the purpose of this study. The selected review themes were: the conceptual linkage between ecosystem-based adaptation to climate change and food security in Ethiopia; biophysical, socio-economic, and institutional constraints for production and flow of cereals in Ethiopia; strengths, weaknesses, opportunities, and threats of the current Ethiopian agricultural development policy and strategies in dealing with constraints for cereals' production and flow; trends of major cereals' annual production in Ethiopia (2000-2013); and trends of major cereals' annual prices in Addis Ababa grain market (2005-2010).

Finally the collected secondary data were analysed through both qualitative and quantitative techniques and presented under relevant themes. Qualitative data were analysed through narration and description. On the other hand, quantitative production and price data collected through secondary method of data collection from the Ethiopian Grain Trade Enterprise and Central Statistical Agency of Ethiopia were analyzed in computer with the help of SPSS-Version 20 software and Micro-Soft Excel 2007 version. Accordingly, simple descriptive statistics like frequencies and percentages, mean, and standard deviations were employed. The results of the analyzed data were presented with the help of line graphs, bar graphs, pie charts, and tables.

Results and Discussion

This section of the seminar paper analyses and discusses the conceptual linkage between ecosystem-based adaptation to climate change and food security in Ethiopia; biophysical, socio-economic, and institutional constraints for production and flow of cereals in Ethiopia; strengths, weaknesses, opportunities, and threats of policies and strategies in the Ethiopian agricultural sector in dealing with constraints for cereals' production and flow; trends of major cereals' annual production in Ethiopia (2000-2013); and trends of major cereals' annual prices in Addis Ababa grain market (2005-2010).

The Conceptual Linkage between Ecosystem-Based Adaptation to Climate change and Food security in Ethiopia

Vulnerability to climatic change may refer to inability among households to engage in strategies to cope with and adjust to extremes such as droughts that form part of current climate variability and which may increase in frequency and/or intensity in future (Eriksen et al., 2007). Climate change is already causing severe problems of drought, flooding and unpredictable weather, creating losses in food production and destroying peoples' livelihoods (Eriksen et al., 2007; Gebre-Egziabher, 2007; Nærstad, 2007; Cotter & Tirado, 2008; Edame et al., 2011). Causes for vulnerability of Ethiopia to climate variability and change include very high dependence on rain-fed agriculture which is very sensitive to climate variability and change, under-development of water resources, low health service coverage, high population growth rate, low economic development level, low adaptive capacity, inadequate road infrastructure in drought prone areas, weak institutions, lack of awareness, etc (Georgis et al., 2009). According to Lamboll et al. (2011), agriculture is a cause of climate change – as it is a major emitter of GHGs – but will also be affected by it. Impacts will not be felt evenly. For instance, smallholders' crops and animals, production and livelihoods will be affected directly and indirectly through off-site impacts and as a result of climate change responses. Moreover, climate change impacts will be greatest where they interact with other shocks, stresses and vulnerabilities (Lamboll et al., 2011).

Vulnerability assessment based on existing information and rapid assessments carried out indicated that the most vulnerable sectors to climate variability and change are Agriculture, Water and Human health. In terms of livelihood approach smallholder rain-fed farmers and pastoralists are found to be the most vulnerable. The arid, semi-arid and the dry sub-humid parts of the country are affected most by drought (Georgis et al., 2009). Climate change worsens the living conditions for many who are already vulnerable, particularly in developing countries because of the lack of assets and adequate insurance coverage.

According to Edame et al. (2011), climate change impacts the four key dimensions of food security – availability, stability, access, and utilization. For instance, availability of agricultural products is affected by climate change directly through its impacts on crop yields, crop pests and diseases, and soil fertility and water-holding properties. It is also affected by climate change indirectly through its impacts on economic growth, income distribution, and agricultural demand. In addition, stability of crop yields and food supplies is negatively affected by variable weather conditions. Physical, economic, and social access to food would be affected negatively by climate change as agricultural production declines, food prices rise, and purchasing power decreases. Last but not least, climate change poses threats to food utilization through effects on human health and the spread of diseases in geographical areas which were previously not affected (Cotter & Tirado, 2008; Ludi, 2009; Edame et al., 2011).

Responses to climate change and climate variability are usually grouped into two main categories: mitigation (addressing causes) and adaptation (addressing effects). In agricultural adaptation there is a need for new technologies and farm-level innovations, but also changes in broader institutional arrangement (eg, greater equity in land ownership, adaptive management in relevant organisations). There is a range of options to generate incremental changes at farm level – eg, adaptation of agricultural practices, adapting livestock, pasture and rangeland management, farm-level climate change mitigation practices, and diversification of species and varieties (Cotter & Tirado, 2008; Ludi, 2009; Lamboll et al., 2011).

Adaptation covers reactive and proactive actions taken on different levels by individuals, communities, private companies and public bodies such as governments. Given the close linkages between climate change and the MDGs, it must also be noted that sustainable poverty reduction is a key adaptation strategy, with regard to food security but also in general (Ludi, 2009). Some of the appropriate adaptation strategies for African smallholder farmers include: crop diversification; using different crop varieties; varying the planting and harvesting dates; increasing the use of irrigation; increasing the use of water and soil conservation techniques; shading and shelter; shortening the length of the growing season; diversifying from farming to non–farming activities; increasing diversification by planting crops that are drought tolerant and/or resistant to temperature stresses; taking full advantage of the available water and making efficient use of it; and growing a variety of crops on the same plot or on different plots, thus reducing the risk of complete crop failure since different crops are affected differently by climate events (see also Box 1).

Box 1: Climate Change Adaptation Strategies for African Smallholder Farmers

List of appropriate adaptation strategies for African smallholder farmers include:

- Intensification of food production by smallholders through better access to improved seed, soil fertility management (eg, fertilizer application) and reliable water supply;
- Improved agricultural water management (AWM) (smallholder irrigation, rainwater harvesting, sustainable extraction of groundwater and other underutilized water resources), conservation agriculture and improved on-farm water use efficiency;
- Shifts towards crop and livestock types/varieties/breeds with greater drought and heat tolerance and improved pest and disease resistance;
- Enterprise diversification towards higher value crops, value adding (processing), off-farm employment, and marketing infrastructure;
- Grain storage improvements (from household to national levels) to ensure security of carryover stocks and access to surpluses;
- Climate forecasting and provision of timely advice to governments, private sector (agro-dealers), extension services and farmers;
- Weather-related crop and livestock insurance;
- A more efficient use of water through drip irrigation and the choice of high yielding and high-value crops;
- Bunds, agroforestry, crop rotation and rainwater harvesting;
- Agricultural diversification such as the integration of livestock and crops (mixed farming);
- Migration to wetter regions (from drier to wetter regions), in pursuit of wetter and more fertile lands; and
- Engagement in off-farm activities

Source: (Cotter and Tirado, 2008; Hassan & Nhemachena, 2008; Ngigi, 2009; Shiferaw et al., 2011).

Ecosystem-based adaptation may be defined as the adaptation policies and measures that take into account the role of ecosystem services in reducing the vulnerability of society to climate change, in a multi-sectoral and multi-scale approach. Moreover, it involves national and regional governments, local communities, private companies and NGOs in addressing the different pressures on ecosystem services, including land use change and climate change, and managing ecosystems to increase the resilience of people and economic sectors to climate change (Vignola et al., 2009). In other words, it integrates the use of biodiversity and ecosystem services into an overall strategy to help people adapt to the adverse impacts of climate change. Furthermore, it includes the sustainable management, conservation and restoration of ecosystems to provide services that help people adapt to both current climate variability, and climate change. For instance, it contributes to reducing vulnerability and increasing resilience to both climate and non-climate risks and provides multiple benefits to society and the environment (Colls, et al., 2009; Ludi, 2009). In a nutshell, the ecosystem approach to climate change adaptation involves the integrated management of land, water and other resources that promote their conservation and sustainable use in an equitable way (Cotter & Tirado, 2008; Ngigi, 2009; Ludi, 2009).

According to Ngigi (2009), one of the important characteristics of an adaptation strategy is that it should reflect the needs and aspirations of the society or community it is meant to benefit. Thus, the most effective mechanisms are flexible and relatively independent of scale. In other words, adaptation efforts must be coordinated across sectors and between agencies, which is a challenge in practice. In most cases, measures will mean a strengthening of existing policies, emphasizing the importance of basing climate change policies on existing coping mechanisms and the necessity of integrating them into national development plans (Ngigi, 2009; Ludi, 2009).

Vignola et al. (2009) contend that ecosystem degradation and vulnerability to climate change should be considered as development issues rather than strictly environmental problems. In other words, as the loss of natural capital and the associated vulnerabilities are a threat for sustainable development, national development policies should integrate ecosystem management and adaptation to climate change (Cotter & Tirado, 2008). For Nærstad (2007) agriculture and environment are inseparable. In other words, preservation of biodiversity and other natural resources is a prerequisite for long term food security and to eradicate hunger and poverty. Despite the aforementioned connection, the loss of forests and biodiversity, and the destruction of other natural resources like watersheds, pastures, soil and mangrove, are causing hunger, poverty and the destruction of livelihoods for millions of people, and are undermining the very basis of life for future generations in least developed countries like Ethiopia (Nærstad, 2007; Cotter & Tirado, 2008).

Agro-biodiversity provides ecosystem services which can contribute to the improvement of agricultural productivity (MEA, 2005; Cotter & Tirado, 2008; Hadgu et al., 2009). These ecosystem services include: yield improvement by intercropping; mixed cropping, and soil fertility enrichment (e.g. soil nitrogen) by perennial plants in agricultural landscapes; and insurance for agricultural production by increasing resilience, i.e. speedy recovery from a disturbance or stress, and decreasing the risk of crop failure (Vernooy & Song, 2004; Hadgu et al., 2009).

The agro-ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. In other words, the application of the ecosystem approach will help to reach a balance of the three objectives of conservation, sustainable use, and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources. Moreover, an ecosystem approach is based on the application of appropriate scientific methodologies focused on levels of biological organization, which encompass the essential structure, processes, functions and interactions among organisms and their environment. It also recognizes that humans, with their cultural diversity, are an integral component of many ecosystems and requires adaptive management to deal with the complex and dynamic nature of ecosystems and the knowledge or understanding of their functioning (Vernooy & Song, 2004; MEA, 2005; Stroud & Khandelwal, 2006; Cotter & Tirado, 2008; Colls, et al., 2009).

Ecosystem-based Adaptation reduces vulnerability to both climate and non-climate risks and provides multiple economic, social, environmental and cultural benefits, including (Cotter & Tirado, 2008; Ngigi, 2009; Colls, et al., 2009; Ludi, 2009): disaster risk reduction; livelihood sustenance and food security; biodiversity conservation; carbon sequestration; and sustainable water management.

Ecosystem-based agricultural practices like organic agriculture plays vital role for ensuring local and national food security (IFOAM, 2009). Organic agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. It also combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved (IFOAM, 2009). Some scholars of sustainable agriculture claim that organic farming produces higher crop yields than chemical-intensive farming. It can also lead to environmental benefits such as improved soil fertility, better water retention and resistance to drought (Vernooy & Song, 2004; Stoop & Hart, 2005; Cotter & Tirado, 2008; Clements, 2009; Hadgu et al., 2011).

Among other factors, climate change, increasing population and food security highlight the importance of various ecosystem services and the finite nature of land resources (Lamboll et al., 2011). According to Jones & Thornton (2003), the impacts of climate change on agriculture may add significantly to the development challenges of ensuring food security and reducing poverty. Thompson et al. (2010) contend that the importance of ecological and climatic processes for food production, and sensitivity of African food systems to climate, makes climate change a concern for food security. In other words, the ability to achieve food security has broader implications for development and health, and is thus vitally important for future considerations of international development in the region.

Given the multiple demands placed upon agriculture, a number of potential synergies and trade-offs are emerging between agricultural production and climate change adaptation and mitigation objectives. Where there are trade-offs rather than synergies, governments, farmers and other agricultural innovation system (AIS) actors will need to prioritise actions and climate resilience will be a key factor in future agricultural systems (Lamboll et al., 2011).

Improving food security is recognised within the Sustainable Development Poverty Reduction Paper (SDPRP) of Ethiopia as a central concern of government. In other words, the poverty reduction strategy has ‘agricultural development-led industrialisation and food security’ as one of its four key pillars or building-blocks. Moreover, food security programmes are acknowledged to be a ‘subset of poverty reduction interventions’. The food security strategy in turn claims to address the ‘supply and demand side’, at national and household level, ‘taking into account the diversity of the national economy’. The three pillars of the strategy are: increasing the availability of food through domestic (own) production; ensuring access to food for food-deficit households; and strengthening emergency response capability (Haan et al., 2006).

However, both the poverty reduction strategy and food security strategy fails to recognize the connection between food security and ecosystem-based adaptation to climate change. In other words, ecosystem-based adaptation to climate change is not mainstreamed in the aforementioned strategies. Moreover, the current agricultural production and food security initiatives in the country are heavily dependent on industrially produced chemical fertilizers with many negative environmental impacts (MEA 2005; Hutton, 2010).

According to Gebre-Egziabher (2007), the intensification of agricultural production in Africa and Ethiopia can take place without the use of industrially produced chemical fertilizers. For instance, preparing compost from household and farm waste and using it to raise soil fertility has been found to be as effective as, and in the case of crops by smallholder farmers to be more effective than, using chemical fertilizers to raise agricultural productivity. In other words, eco-functional intensification increases productivity and enhances food security especially in challenging environments such as water scarce regions (MEA 2005; Cotter & Tirado, 2008; IFOAM, 2009; Hutton, 2010).

Adapting to climate change will entail adjustments and changes at every level from community to national and international. Communities must build their resilience, including adopting appropriate technologies while making the most of traditional knowledge, and diversifying their livelihoods to cope with current and future climate stress. Local coping strategies and traditional knowledge need to be used and integrated with government and local interventions. In a nutshell, to enable effective adaptation measures in Ethiopian agricultural sector, governments as well as non-government organizations, must consider integrating climate change in their planning and budgeting in all levels of decision making (Georgis et al., 2009; World Bank, 2011; Mekonnen, 2012).

Bio-physical, Socio-Economic, Institutional Constraints for Production and Flow of Cereals in Ethiopia

Biophysical Constraints for Production and Flow of Cereals in Ethiopia

Geographically, Ethiopia can be subdivided into five agroecological zones, based on moisture and land use: 1) drought-prone highlands with insufficient rainfall; 2) rainfall-sufficient highlands dominated by enset-based farming; 3) rainfall-sufficient highland areas mainly planted with cereal-based crops; 4) generally dry, pastoral lowland areas (bordering on Eritrea); and 5) humid lowland areas further inland that primarily support crop farming (Gebreegziabher et al., 2011). USAID (2011) also identified three agroecological zones (high rainfall, low rainfall, and pastoralist).

The principal biophysical constraint for production of cereals in Ethiopia is land degradation in the form of soil erosion, gully formation, soil fertility loss and severe soil erosion

(Ringler et al., 2010; Ali & Surur, 2012; Schmidt & Tadesse, 2012). According to Shiferaw (2011), the rate of soil erosion is severe in the highlands of Ethiopia. Rapid population growth, cultivation on steep slopes, clearing of vegetation and overgrazing are identified as the main factors that accelerate soil erosion in Ethiopia (Shiferaw, 2011; Ali & Surur, 2012).

Another critical biophysical constraint for the production and flow of cereals in Ethiopia is climate change. In other words, the production and flow of cereals is very much affected biophysically by meteorological variables, including rising temperatures, changing precipitation regimes, and increased atmospheric carbon dioxide levels. Biophysical effects of climate change on production of cereals are claimed to be positive in some agricultural systems and regions, and negative in others, and these effects are claimed to vary through time (Parry et al., 2004; Harmeling et al., 2007; Alcadi et al., 2009). The negative effects are attributable to increasing temperature and decreasing precipitation (Deressa, 2007; Georgis et al., 2009; Ludi, 2009; FDRE, 2010; Ringler et al., 2010; World Bank, 2010; Gebreegziabher et al., 2011; Mekonnen, 2012; Schmidt & Tadesse, 2012; AfDB, 2013).

Climate variability and change have been implicated to have significant impacts on global and regional food production particularly the common staple food crops (cereals) performance in tropical sub-humid climatic zone. For example, the most food insecure regions and most climate change vulnerable regions in Ethiopia are those that experience both the lowest and most variable rainfall patterns (Mekonnen, 2012).

Ringler et al. (2010) assert that climate change affects crop area, yield, and production of cereals in Ethiopia. The negative effects on crop area, yield, and production are attributable to the indirect effects of climate change like changes in soil moisture, land and water condition, change in frequency of fire and pest infect and the distribution of diseases (Mekonnen, 2012). Changes in rainfall pattern are also likely to lead to severe water shortages and/or flooding. Rising temperatures also will cause shifts in crop growing seasons which affects food security and changes in the distribution of disease vectors putting more people at risk from diseases such as malaria (Gebreegziabher et al., 2011; Mekonnen, 2012). In a nutshell, The direct and indirect effects of climate change on agriculture play out through the economic system, altering prices, production, productivity, food demand, calorie availability, and, ultimately, human well-being (Ringler et al., 2010).

Socio-Economic Constraints for Production and Flow of Cereals in Ethiopia

The production and flow of cereals in Ethiopia is constrained by socio-economic constraints like poor infrastructure (constraining access to both agricultural inputs and markets for outputs), dominance by small-scale resource-poor farmers**,** shortage of draft power, low level of modern farm inputs; inefficient working habit (less working days per week) of the peasants; substantial increase in food prices; and endemic poverty, limited access to capital and global markets, ecosystem degradation, complex disasters like war and conflicts; population growth (FDRE, 2010; Gebreegziabher et al., 2011; Mekonnen, 2012; MOA, 2012). For instance, the availability of financial services is constraining the capacity of smallholders and emerging commercial farmers to adopt improved agricultural practices. This includes both short term seasonal credit for crop inputs and medium-longer term finance for capital investments (FDRE, 2010).

Institutional Constraints for Production and Flow of Cereals in Ethiopia

The critical institutional constraints for the production and flow of cereals in Ethiopia are: tenure insecurity**;** weak agriculture research base and extension system; lack of appropriate financial system**;** imperfect agricultural markets; lack of appropriate pricing and incentive policies; and insufficient information dissemination mechanism (Parry et al., 2004; Tefera, 2009; FDRE, 2010; Ringler et al., 2010; Gebreegziabher et al., 2011; Mekonnen, 2012; MOA, 2012).

There are systemic capacity limitations at all levels and in all of the sectoral institutions, but the problem is most severe at the district level. Capacity limitations include human resources, working premises, equipment, communications, machinery, furniture and other facilities (FDRE, 2010). There are also identified institutional gaps related to sector-wide linkages, relationships and synergies. Specific issues include lack of communication among ministries and between Ministries and CSOs and parastatals; inadequate vertical and horizontal collaboration among research institutes; weak research-extension-farmer linkages; and lack of communication and collaboration with the private sector (FDRE, 2010). In summary, there is interplay among the aforementioned biophysical, socio-economic, and constraints for production and flow of cereals in Ethiopia. For instance, the biophysical effects of climate change on the production and flow of cereals is claimed to induce changes in prices, which is claimed to play out through the economic system as farmers and other market participants adjust autonomously, altering crop mix, input use, production, food demand, food consumption, and trade (FDRE, 2010; Ringler et al., 2010; Gebreegziabher et al., 2011; Mekonnen, 2012).

Strengths, Weaknesses, Opportunities and Threats of Current Ethiopian Agricultural Development Policies and Strategies in Addressing Constraints

The author was able to analyze the strengths and weaknesses of the internal environment (Table 1) and the opportunities and threats for the external environment (Table 1) of the current Ethiopian agricultural development policies and strategies in dealing with constraints of production and flow of cereals.

Table 1: SWOT Analysis for the Current Ethiopian Agricultural Development Policy and Strategies in Dealing with Constraints of Production and Flow of Cereals

Internal Environments	
Strengths: • Government's commitment to improving agricultural productivity; • ensuring food security and gender equality; • inclusion of a significant number of Ecosystem-based Adaptation activities within National Adaptation Programme of Action; • nationally appropriate mitigation actions developed; • increasing irrigated cropland and investing in agricultural research and development; • Major emphasis by the government strategy in agriculture to support the intensification of marketable farm products by both small and large farmers; • Major investments like the construction of farm-to-market roads and area irrigation through multipurpose dams; • measures to improve land tenure security; • reforms to improve the availability of fertilizer and improved seeds, and specialized extension services for differentiated agricultural zones and types of commercial agriculture; • implementation of Sustainable Land Management Program (SLMP); • strong commitment of the government to continued agricultural growth (a three-pillar approach - food security and drought resilience, agricultural productivity, and sustainable land and water management); • Commitment of the government to achieve longer term green growth through focusing on improved land and water management; • Government's support for land registration to clarify land tenure; and • Government's commitment to a major landscape re-greening program.	**Weaknesses:** • There is little explicit mention of climate change in agricultural development policies and strategies; • Policies are generally supportive of agricultural practices that focus on increasing short-term production (eg, expansion of agricultural land, increasing mechanisation, increasing use of fertiliser and other inputs); • The Policies and strategies are generally less supportive of practices which can improve food production, enhance adaptive capacity and address mitigation (eg, restoration of degraded land, improving soil macro and micro nutrients); • Weak market linkages both on the input and output side; • Farmers either cannot afford improved inputs or lack the knowledge to use them; and • Weak linkages between agricultural outputs producers and processors.

Table 1. Continued...

External Environments	
Opportunities: • decentralisation of decision making on climate change adaptation; • new investment in agricultural development; • existence of the climate resilient green economy strategy (CRGE) and growth and transformation plan (GTP); • development and promotion of agricultural and pastoral innovations by agricultural research and development initiatives; • huge potential in agricultural sector to take advantage of mitigation opportunities through adopting improved land, water, agriculture and agro-forestry management practices; • existence of numerous indigenous land management practices; • Existence of national policies and strategies protecting indigenous knowledge and rights; and • Presence of traditional administration and social institutions.	**Threats:** • lack of finance; • land use conflict and community opposition; • lack of information about the costs and benefits of ecosystem-based adaptation measures**;** • insufficient funding to properly implement National adaptation plan of actions (NAPAs); • insufficient packaging and storing; • inability of Ethiopian products to meet international market standards; • restrictive trade regulations; • limited availability and usage of irrigation and improved seed and fertilizer; • poor land management practices resulting in severe land degradation; • government-controlled cooperatives managing the input supply system; • low agricultural investment and productivity; • insufficient access to credit by smallholder farmers; • heavy dependence on rainfed agriculture (highly erratic, and most rain falls intensively); • ever-growing human population and food demand; • high exposure of agricultural sector to climate variability, and in particular to drought and related heat stress; • limited national policies and strategies to promote, develop, conserve and use at greater scale indigenous knowledge; • absence of accurate or reliable information database about the extent and location of the past and present natural forest and woody vegetation cover in Ethiopia; • absence of appropriate land-use classification and land-use policy; • lack of appropriate pricing and incentive policies; and • insufficient information dissemination scheme.

Sources: (Cooper et al., 2008; Colls, et al., 2009; Georgis et al., 2009 ; Kato et al., 2009; World Bank, 2010; Lamboll et al., 2011; Shiferaw et al., 2011; USAID, 2011; World Bank, 2011; Ali and Surur, 2012; Schmidt & Tadesse, 2012).

Trends of Major cereals' Annual Production in Ethiopia (2000-2013)

For the purpose of this study, seven major cereals in Ethiopia were selected and the trends of their mean production area in hectares, mean estimated total production in quintals (1 quintal=100 Kgs), and mean yield in quintals/hectare were analysed.

With regard to area production, Teff has scored the largest mean area production (2411586 hectares). This was followed by 1703866 hectares, 1508176 hectares, 1398004 hectares, 983831 hectares, 873361 hectares, and 34042 hectares for Maize, Sorghum, Wheat, Barely, Millet and Oat respectively (see figure 1).

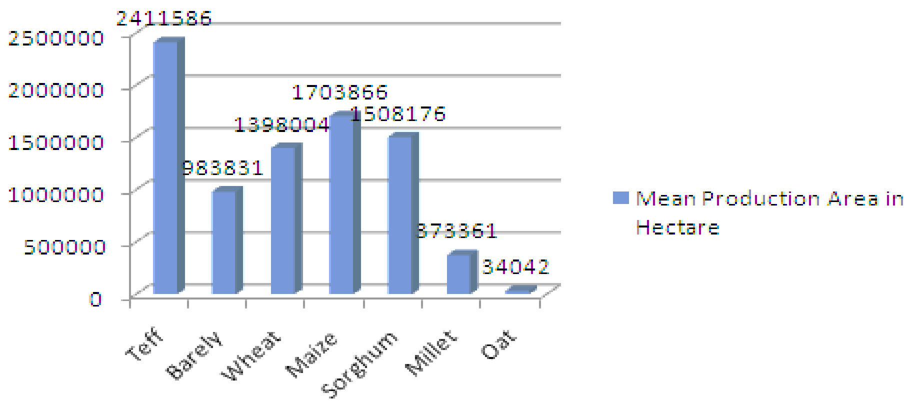

Figure 1: Mean production area in hectares for major cereals in Ethiopia (2000-2013),Source: Computed from CSA data by author].

With regard to total production, Maize has scored the largest mean total production (38756460 quintals). This was followed by 26431205 quintals, 25514706 quintals, 23659564 quintals, 13677339 quintals, 4838731 quintals, and 431223 quintals for Teff, Sorghum, Wheat, Barely, Millet and Oat respectively (see figure 2).

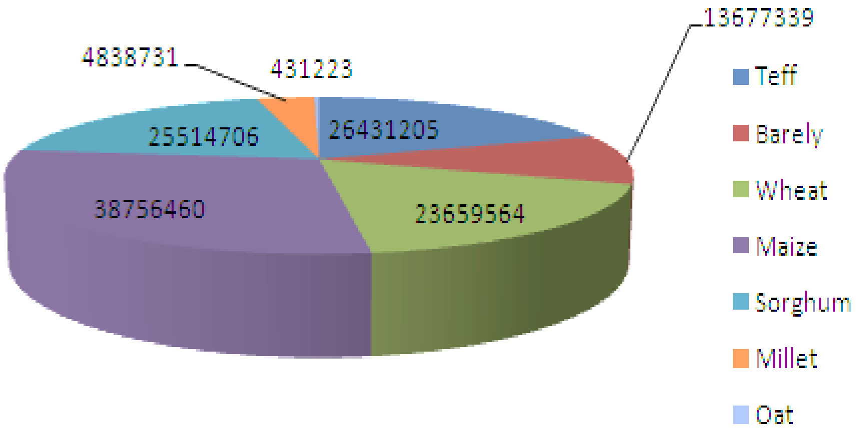

Figure 2: Mean estimated total production in quintals for major cereals in Ethiopia (2000-2013), Source: Computed from CSA data by author.

With regard to yield, Maize has scored the largest mean yield (22 quintal/hectare). This was followed by 17 quintal/hectare, 17 quintal/hectare, 14 quintal/hectare, 13 quintal/hectare, 13 quintal/hectare and 11 quintal/hectare for Wheat, Sorghum, Barely, Millet, Oat, and Teff respectively (see figure 3).

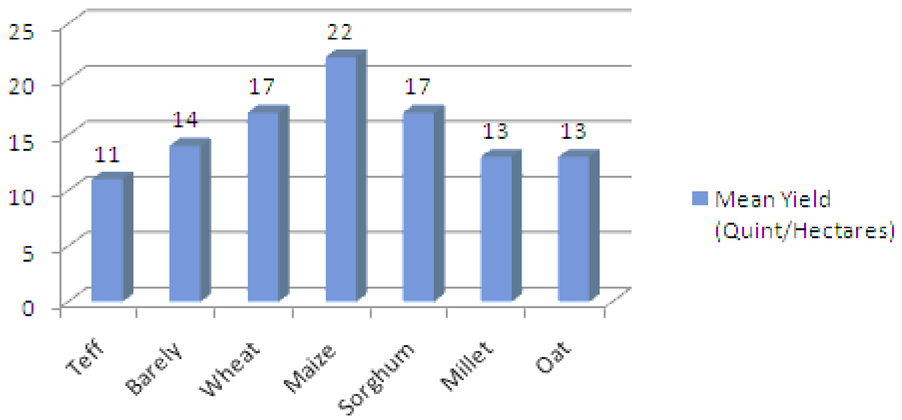

Figure 3: Mean estimated Yield for major cereals in Ethiopia (2000-2013), Source: Computed from CSA data by author.

Ethiopia has experienced large increases in agricultural output in recent years in part due to increased sector support (e.g., the extension system) and in part due to increased cultivation areas (e.g., over the last five years, the area under cereal crop cultivation increased by 63 percent), as opposed to significant productivity increases. However, for Ethiopia to continue the agriculture sector growth required to reduce poverty and meet the country's ever-growing food demand in the coming years, new sources of growth must be found, and greater attention must be placed on productivity enhancement (Georgis et al., 2009; USAID, 2011).

Cereal production and marketing plays a vital role in Ethiopia's economy (Rashid & Negassa, 2011). However, production and flow of cereals in Ethiopia is constrained by biophysical, socio-economic, and institutional constraints (Deressa, 2007; Georgis et al., 2009; Ringler et al., 2010; Gebreegziabher et al., 2011; Mekonnen, 2012; Schmidt & Tadesse, 2012). For instance, Harmeling et al. (2007) assert that climatic conditions are the predominant factors affecting agricultural productivity, and changes in these conditions may have different severe effects. To avert this situation, Edame et al. (2011) contend that developing climate-smart agriculture is crucial to achieving future food security and climate change goals. Georgis et al. (2009) contend that developing drought resistant, early maturing and heat tolerant crop species and varieties is of paramount importance to cope to adapt to climate change in agricultural sector of Ethiopia. Furthermore, IFOAM (2009) asserts that organic agriculture builds soil fertility and structure and is more efficient in using resources, including well adapted local resources such as local seed varieties, which are often limited in areas with extreme poverty and food insecurity. In other words, the eco-functional intensification of organic agriculture systems is claimed to increase productivity and enhance food security especially in challenging environments (IFOAM, 2009).

Production and value chain of four cereals in Ethiopia are discussed hereunder. The four cereals identified for this purpose are Maize, Wheat, Sorghum and Millet.

Maize Production and Value Chain in Ethiopia

The findings of this study indicate that Maize is second to teff in terms of area, but it ranks first among cereals in production. Previous study by USAID & COMPETE (2010) also confirmed the same. Because of its large geographical coverage and the scale of production, maize plays a critical role in the food security of the country and particularly the poor. It is a widely grown crop in Ethiopia; although the extent of cultivation varies, maize is cultivated in some 74 important maize producing administrative zones, of which 20 contribute almost 80% of the national production (Georgis et al., 2009; USAID & COMPETE, 2010).

The largest surplus producers of maize in Ethiopia previously identified by USAID & COMPETE (2010) were: West Gojam (11.3%), Jimma (7.9%), East Shoa (7.8%), East Wellega (6.4%), West Wellega (5.5%), Illubabor (4.3%), Arsi (4.3%), West Shoa (4.2%), East Hararghe (3.5%), Agewawi (3.4%), West Hararghe (2.9%), and Sidama (2.9%). The other important maize producing zones are West Arssi, East Gojam, North Gondar, Horo Gudru, Bale, South Gondar, Silti and Kelem. These zones produce about 80% of national maize production (USAID & COMPETE, 2010).

Maize constitutes about 24%-31% of national cereal consumption and is mainly covered by domestic production. Maize is consumed as a staple food in different forms, including: *injera* (alone or mixed with teff), porridge, and bread. It is also consumed roasted or boiled (especially at green stage). Moreover, it brewed into *tella, araki* and other local drinks (USAID & COMPETE, 2010).

The maize value chain that connects producers and consumers throughout Ethiopia has three key actors: assemblers, wholesalers and retailers. As mentioned earlier the producer assembler wholesaler retailers consumer channel is the most important in terms of the magnitude of the marketed maize that flows from producers to consumers (USAID & COMPETE, 2010).

Previous studies confirmed that production and flow of cereals is affected by biophysical, socio-economic and institutional factors (Deressa, 2007; Georgis et al., 2009; Gebreegziabher et al., 2011; Mekonnen, 2012; MOA, 2012). This is specifically true for Maize. The major constraints previously identified by USAID & COMPETE (2010) were: Shortage of certified maize seeds varieties suitable for different agroecological zones; Inadequate supply and marketing of maize seed; Nonexistence of export market and agro-industries that use maize as a raw material and diversify the utilization of the crop; Inadequate transport infrastructure and high cost of transport; Lack of reliable and timely market information; Inadequate access to credit facilities by grain traders; Lack of storage and marketing facilities in both the surplus producing and the consumption centers; Lack of universally acceptable and enforceable quality standards that reduce transaction costs; and Weak producers' organizations and limited participation in maize seed production, distribution and marketing of members' output.

Wheat Production and Value Chain in Ethiopia

The findings of our study indicate that wheat is the fourth major cereal produced in Ethiopia both in terms of production area and total annual production, but it ranks second together with Sorghum among cereals in yield. Unlike other cereal crops, wheat is an important industrial crop. In other words, it is used as an input for the country's modern food processing factories (USAID & COMPETE, 2010).

The most important wheat producing areas in Ethiopia previously identified by USAID & COMPETE (2010) were: Arsi with (14.7%) share of total wheat production, Bale (13.2%), North Shoa (8.3%), West Shoa (8.1%), East Shoa (6.6%), East Gojam (5.9%), South Wello (5.0%), West Arssi (4.0%), South West Shoa (3.5%), Southern Tigray (3.0%), South Gondar (2.8%), Hadiya (2.8%), and West Gojam. These zones produce more than 85% of national wheat production (USAID & COMPETE, 2010).

The wheat value chain that connects producers and consumers throughout Ethiopia has three key actors: grain wholesalers, processor, and bakery.

The producer Grain wholesaler Processor Bakery Consumer channel is the most important in terms of the magnitude of the marketed wheat that flows from producers to consumers (USAID & COMPETE, 2010).

Previous studies confirmed that production and flow of cereals is affected by biophysical, socio-economic and institutional factors (Deressa, 2007; Georgis et al., 2009; Gebreegziabher et al., 2011; Mekonnen, 2012; MOA, 2012). This is specifically true for Wheat also. The constraints in the value chain of wheat in Ethiopia previously identified by USAID & COMPETE (2010) were: Weak seed production and distribution, lack of participation by private firms and farmers' organizations in the production and distribution of improved wheat varieties; High seed cost due to high transport and handling costs; Inadequate coordination between research, seed multiplication and extension; Lack of market information for traders, producers and farmers' organizations; Lack of access to appropriate storage and marketing facilities and infrastructure; Non-existent of forward contractual agreement between producers and millers; Lack of access to bank credit; and Inadequate road infrastructure and high cost of transferring wheat from surplus areas to consumption centres.

Sorghum Production and Value Chain in Ethiopia

The findings of our study indicate that Sorghum is the third major cereal produced in Ethiopia both in terms of production area and total annual production, but it ranks second together with Wheat among cereals in yield.

The most important sorghum producing areas previously identified by USAID & COMPETE (2010**)** were: North Gondar with 10.6% share in national sorghum output, North Shoa (9.5%), East Hararghe (7.9%), West Hararghe (7.2%), West Shoa (4.8%), South Wello (4.3%), Jimma (4.2%), and North West Tigray (4.0%). Other important sorghum areas include North Wello, East Wellega, Illubabor, South Tigray, Central Tigray and West Tigray, each contributing 2-3% of national production.

In Ethiopia a major part of sorghum is produced for human consumption and the production is largely based on small-scale farming (Georgis et al., 2009; USAID & COMPETE, 2010). Sorghum is consumed in various forms, including *enjera*, porridge and local drinks such as *tella* and *arekie.* The principal use of sorghum, however, is enjera, prepared alone or mixed with teff. Consumption of sorghum is partly determined by the availability and price of teff in the market. There are different varieties of sorghum in the market, but the varieties most demanded are the white and yellow sorghum that are mostly in North Gondar, South Wello, East and West Hararghe, North Shoa, and Southern Tigray (USAID & COMPETE, 2010).

The Sorghum value chain that connects producers and consumers throughout Ethiopia has three key actors: assemblers, wholesalers and retailers. The producer assembler wholesaler retailers consumer channel is the most important in terms of the magnitude of the marketed Sorghum that flows from producers to consumers (USAID & COMPETE, 2010).

Previous studies confirmed that production and flow of cereals is affected by biophysical, socio-economic and institutional factors (Deressa, 2007; Georgis et al., 2009; Gebreegziabher et al., 2011; Mekonnen, 2012; MOA, 2012). This is specifically true for Sorghum also. The most important constraints in the value chain of sorghum in Ethiopia previously identified by USAID & COMPETE (2010) were: Serious problems of Striga, a parasitic weed, in many parts of the country; Non-acceptance of some of the released varieties by farmers for various reasons, including susceptibility to bird attacks and low biomass; Lack of improved seed varieties to meet the demand of farmers, because of the limited government capacity to multiply and distribute certified sorghum seed; Lack of strong linkage among research, extension system and producers; Lack of access to market information; High transport and transaction costs; Lack of storage and market infrastructure; Lack of access to bank credit by traders; Weak organization of producers; and Lack of diversified use of the crop apart from subsistence.

Millet Production and Value Chain in Ethiopia

The findings of this study indicate that Millet is the sixth major cereal produced in Ethiopia both in terms of production area and total annual production, but it ranks fourth together with Oat among cereals in yield. According to USAID & COMPETE (2010), Finger millet (a variety of millet produced in Ethiopia) production is insignificant; it accounts for only 3-3.5% of total cereal production.

The most important millet producing areas in Ethiopia previously identified by USAID & COMPETE (2010) were: West Gojam (14.8%), North Gondar (10.8%), North West Tigray (10.6%), West Welega (10.6%), Agewawi (10.2%), and South Gondar (8.9%) that together have some 66% share of national millet production.

Finger millet has high nutritional value and is consumed in different ways, including as staple food (porridge and *enjera*) and as local brews (*tella* and *araki*). About 41% of the millet supply is used as direct food and the balance for other uses, including local brews.

The finger millet value chain that connects producers and consumers throughout Ethiopia has two key actors: wholesalers and retailers. The producer wholesaler retailers consumer channel is the most important in terms of the magnitude of the marketed that flows from producers to consumers (USAID & COMPETE, 2010).

A Case Study on the Trends of Major Cereals' Annual Prices in Addis Ababa Grain Market (2005-2010)

For the purpose of this study, five major cereals in Addis Ababa market were selected and the trends of their mean annual prices were analysed.

Teff white scored the largest mean annual price (584 birr/quintal). This was followed by 536 birr/quintal, 436 birr/quintal, 409 birr/quintal, 381 birr/quintal, 374 birr/quintal, 369 birr/quintal, 334 birr/quintal, 328 birr/quintal, and 253 birr/quintal for Teff mixed, Teff red, Sorghum white, Barely white, Sorghum mixed, Wheat white, Wheat mixed, Barely mixed, and maize respectively (see figure 4, figure 5, figure 6, figure 7, figure 8, and figure 9).

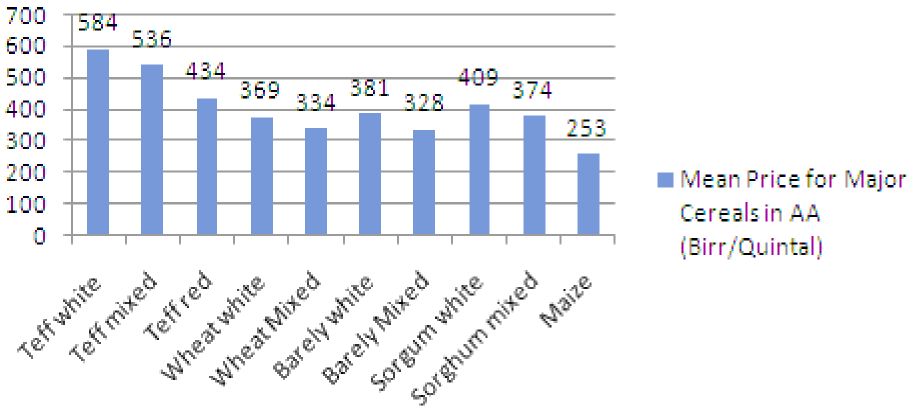

Figure 4: Mean price for major cereals in Addis Ababa market (2005-2010). Source: Computed from EGTE data by author.

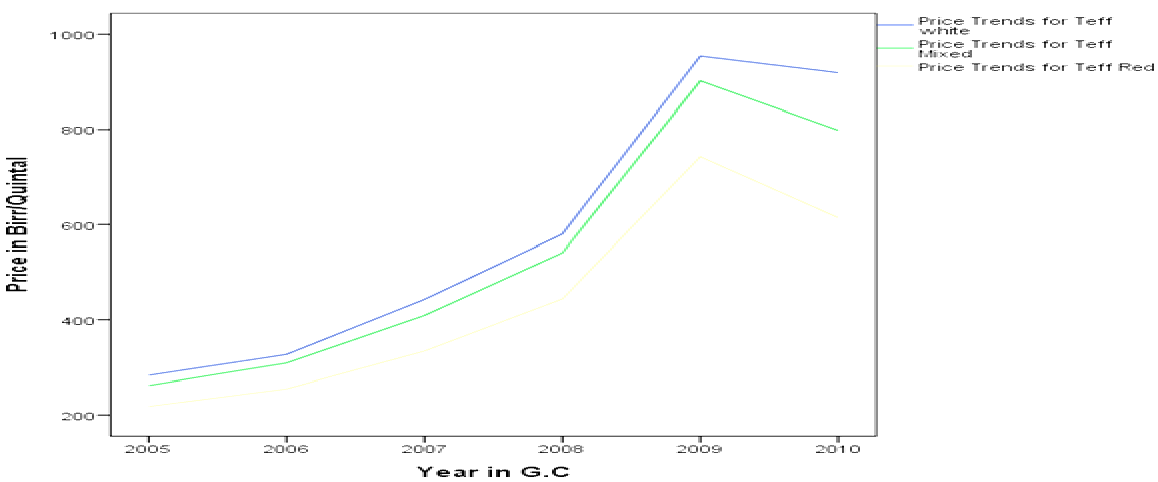

Figure 5: Trend of mean price for Teff in Addis Ababa market (2005-2010). Source: Computed from EGTE data by author.

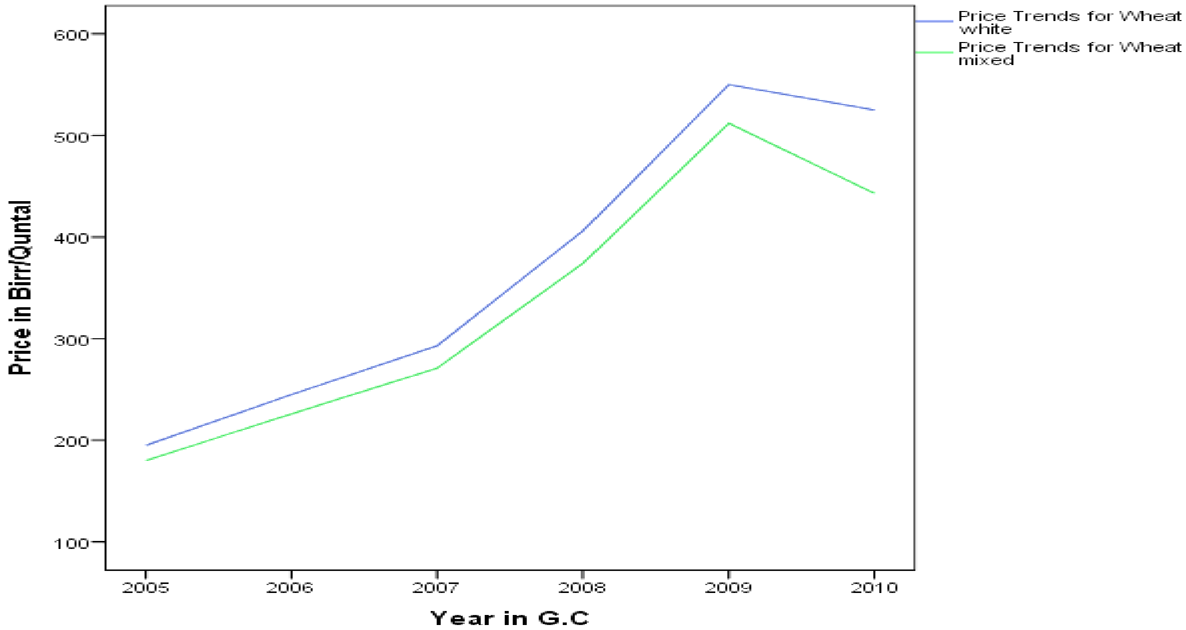

Figure 6: Trend of mean price for Wheat in Addis Ababa market (2005-2010). Source: Computed from EGTE data by author.

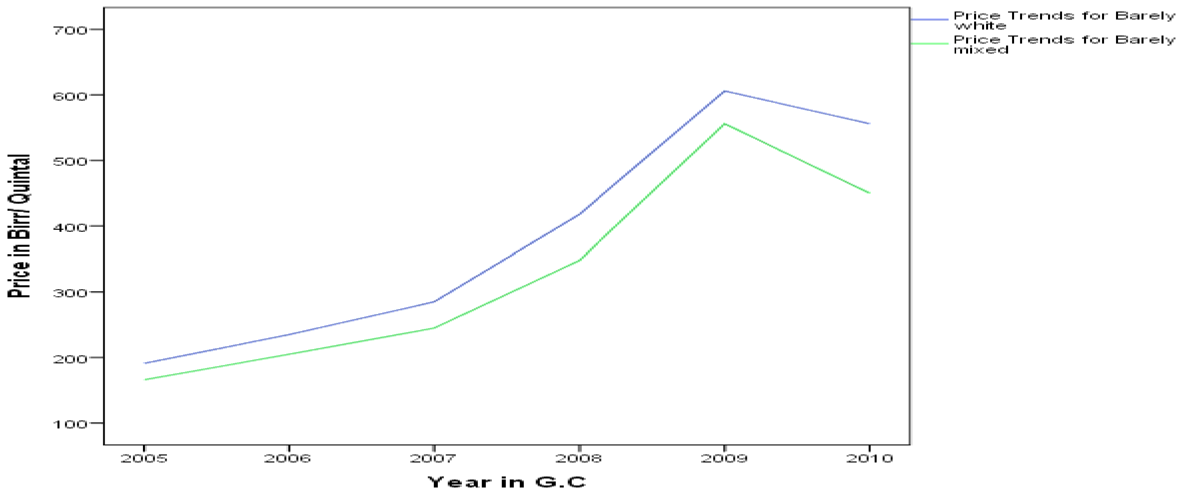

Figure 7: Trend of mean price for Barely in Addis Ababa market (2005-2010). Source: Computed from EGTE data by author.

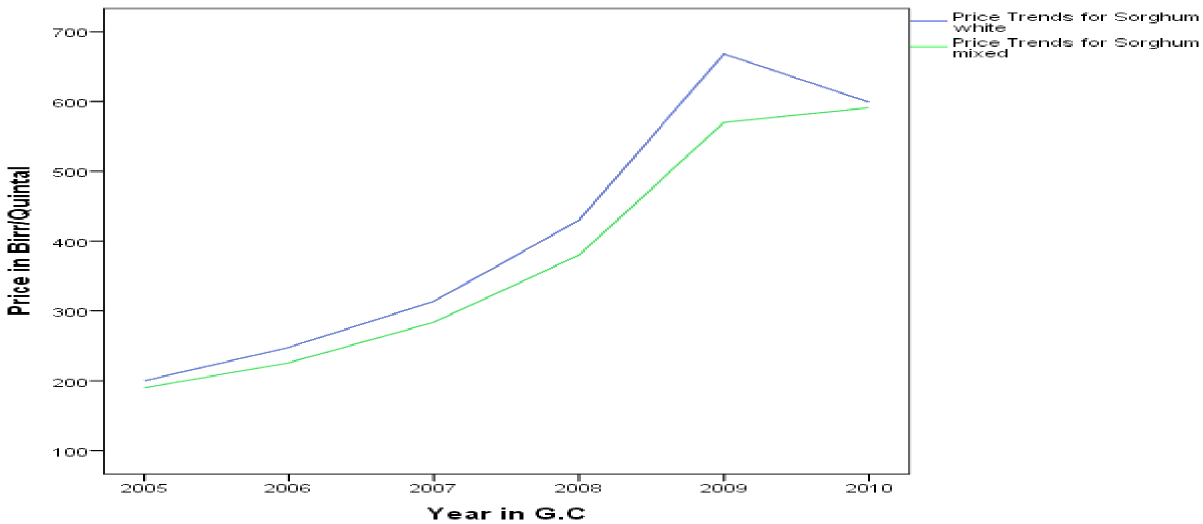

Figure 8: Trend of mean price for Sorghum in Addis Ababa market (2005-2010), Source: Computed from EGTE data by author.

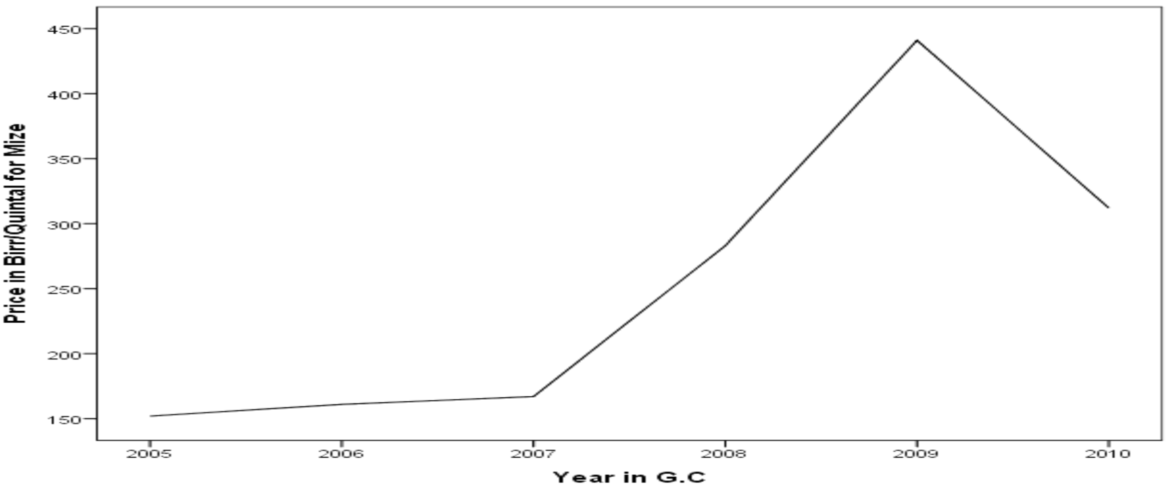

Figure 9: Trend of mean price for Maize in Addis Ababa market (2005-2010). Source: Computed from EGTE data by author.

Rising food prices in Ethiopia has been the outcome of monetary policy misalignment, the balance of payment problems resulting from sharp increases in fuel prices, as well as overestimated cereal production. For instance, according to an IFPRI-EDRI study, official estimates of cereal production were around 30 percent higher (Rashid, 2010). Another case in point is the impact of inflation as one key element that has resulted in increased food insecurity in urban areas of Ethiopia.

Worako (2012) contends that there has been unprecedented high rate of inflation in Ethiopia during 2005-2008 mainly driven by food price inflation mainly of cereal prices. Moreover, the puzzling price trend may account for an over-estimation of cereal production (Worako, 2012). The findings of this study reveal that there are increasing trends in prices of major cereals (Teff, Sorghum, Barely, Wheat, and maize in Addis Ababa grain market between 2005 and 2009. However, decreasing trends in prices of cereals in Addis Ababa grain market were observed between 2009 and 2010 due to increase in production and government's intervention in marketing system. Though this study could not get reliable data for recent years (2011, 2012, and 2013), previous study by WFP-Ethiopia (2009) asserts that the prices of cereals increased by more than 100% since mid 2005 when the country faced a spiral of price increases. Worako (2012) asserts that the food price in Ethiopia is not only high but also relatively more volatile. As result, this abnormal food price surge put millions of rural and urban net food buyer at risk. This is specifically true for Addis Ababa city.

The puzzle is that the increase in inflation in the recent years coincided with relatively favourable harvests, whereas in the past inflation in Ethiopia had typically been associated with agricultural supply shocks due to droughts (Deressa, 2007; Georgis et al., 2009; Gebreegziabher et al., 2011; Mekonnen, 2012; Schmidt & Tadesse, 2012). Moreover, malfunctioning market at different levels and lack of adequate increase in food production due to structural factors are considered as major causes. Although agricultural production has shown drastic growth as stated in the government's official statistics, high cost of transportation limited its movement from food surplus to deficit area is considered as underlining cause (Worako, 2012). These aforementioned major and underlining causes have seriously affected the food security situation of Addis Ababa city.

According to Worako (2012), instead of stimulating economic growth, inflationary pressure in Ethiopia seems to be on the verge of distorting the allocation of resources and is likely to be a deterrent to undertaking productive investments. Moreover, consumers in general and civil servants in particular are at verge of crisis (Worako, 2012).

If the cause of the inflation is clearly determined, it will be trouble-free to manage. For instance, if the cause of inflation is demand-pull which is initiated by high aggregate demand due to high money supply, it can be managed through monetary policy by increasing interest rate which helps to increase saving and decrease consumption, decreasing money supply, imposing tax can be good instruments. On the other hand, if it is known that the cause of inflation is cost-push which is manifested by low aggregate supply due to scarcity of factors of production, high prices of inputs, low production can be equilibrated by reducing input prices through subsidizing and so on. If it is resulted from malfunctioning marketing system, reform in market institutions, building market infrastructure, and enhancing competition are partly means for improving the situation (Rashid & Negassa, 2011; Worako, 2012).

High fuel prices make agricultural production more expensive by raising the cost of fertilizers, irrigation, and transportation (Worako, 2012). Food security depends on availability of food, access to food, and utilization of food (Edame et al., 2011). Climate variability directly affects agricultural production, as agriculture is inherently sensitive to climate conditions and is one of the most vulnerable sectors to the risks and impacts of global climate change. Many factors impact the type of policies implemented at a national level (such as domestic politics, redistribution of land/wealth, exchange rates, and trade issues, etc.). According to Edame et al. (2011), climate variability should be factored into these policies, as these policies can impact the availability of staple foods, for example, by providing incentives to grow crops appropriate for the climate conditions.

To address the current crisis in cereal markets in Ethiopia in general and Addis Ababa in particular, Worako (2012) suggests Prudent macroeconomic and fiscal policy management; Deeper understanding of current marketing structure and designing alternative and competitive marketing system, mainly for wholesale markets; Investing more on agricultural production and productivity, or pursuing more substantive policy on food production and marketing (more incentive and support for private sector to engage in agricultural production); and Promoting diversification in staples consumption(changes in food culture).

Factors that determine whether people will have access to sufficient food through markets are considered to include: income-generating capacity, amount of remuneration received for products and goods sold or labour and services rendered, and the ratio of the cost of a minimum daily food basket to the average daily income (Edame et al., 2011; Worako, 2012). In other words, if climate change creates other more urgent claims on public resources, support for food distribution schemes may decline, with consequent increases in the incidence of food insecurity, hunger and famine related deaths (Edame et al., 2011; Rashid & Negassa, 2011). Moreover, climate impacts on income-earning opportunities can affect the ability to buy food, and a change in climate or climate extremes may affect the availability of certain food products, which may influence their price. Furthermore changes in the demand for seasonal agricultural labour, caused by changes in production practices in response to climate change, can affect income-generating capacity positively or negatively. For instance, mechanization may decrease the need for seasonal labour in many places, and labour demands are often reduced when crops fail, mostly owing to such factors as drought, flood, frost or pest outbreaks, which can be influenced by climate (Edame et al., 2011).

The price effects from climate change on key cereals is that food prices increase for all staple crops because climate change acts as an additional stressor on the already tightening price outlook (Gebremedhin & Hoekstra, 2007; Ringler et al., 2010; Edame et al., 2011).

In a nutshell, the productive areas of Ethiopia suffer from low capacity and market constraints, preventing these areas from living up to their productivity potential (Rashid & Negassa, 2011; USAID, 2011). Ringler et al. (2010) attest that the substantial increase in food prices has the potential to slow growth in calorie consumption, with both direct price impacts and reductions in real incomes for poor consumers who spend a large share of their income on food. In other words, if current food price situation is not circumvented, it is expected to be the major source of welfare deterioration for the urban and rural poor (net food buyers) (Worako, 2012). This is particularly true for urban hubs like Addis Ababa (WFP-Ethiopia, 2009).

Conclusion

In a nutshell, this study concludes that there is strong conceptual linkage between eco-system based adaptation to climate change and food security in Ethiopia; there is interplay among bio-physical, socio-economic, and institutional constraints for production and flow of cereals in Ethiopia; there are strengths, weaknesses, opportunities, and threats of the current Ethiopian agricultural development policies and strategies in addressing constraints for production and flow of cereals; there are increasing trends of major cereals’ mean annual production in Ethiopia; and the food security situation of Addis Ababa is very much affected by increase of mean annual prices of major cereals in Addis Ababa grain market.

Recommendations

While the policy responses by the government of Ethiopia to adapt to climate change and improve the production and flow of cereals are commendable, this study the following strategic measures to address these issues on sustainable basis:

- Ecoagriculture should be adopted in agricultural sector of Ethiopia as a mosaic arrangement of land uses can yield diversified income sources and conserve biodiversity while providing ecosystem services that sustain agricultural productivity, such as pollination, water purification and soil fertility enhancement;
- Appropriate organic matter management should be employed since it is the foundation for high-quality soil and a more sustainable and thriving agriculture;

- Stronger research systems capable of improving the resistance of crops and animals to biotic stresses, as well as investments in irrigation and water management;
- There should be shifts in policy and institutional arrangements of Integrated watershed management, which broadens the freshwater outlook to address both direct and indirect green and blue water functions in a landscape;
- The relevant United Nations agencies in collaboration with Government organizations and other partners should strengthen support to improve the supply of basic services such as water, sanitation, and health facilities in Addis Ababa and other urban areas;
- The Government market stabilization program should be reviewed so that it can effectively contribute to food security of the urban poor as access to food remains a problem and also stabilize the ever increasing cereal prices;
- An urban monitoring system should be established so as to capture any deteriorating food insecurity conditions in Addis Ababa and other urban areas;
- Any efforts to increase the resilience of Ethiopian agriculture in the face of climate change must involve the development of improved crop varieties and animal breeds, as well as more prudent and integrated management of crops, animals and the natural resource base that sustain their production, while providing other vital services for people and the environment;
- Since small farmers and rural communities are the starting point for efforts to adapt to climate change, the problems and solutions should be defined with their direct and active participation;
- Agroecological farming should be promoted through government support in the form of credit for organic fertiliser and new seed varieties provided for smallholders at relatively low cost;
- Appropriate policy measures and institutional support should strengthen Ethiopian smallholder farmers' capacity to adapt to climate change;
- Sustainable, alternative livelihood options (including building communities' capacity to manage sustainable natural resources and promoting agro-forestry and agro-ecology) in rural communities should be promoted since it is a relatively low-cost and complementary approach to adaptation;
- The development community should encourage the generation of innovations at the local level, accompanied by a framework for evaluating experiments and a political and legal space to transform the lessons learned into large-scale initiatives to reduce hunger and poverty;
- Technological innovations need to target productivity increases and be adapted to the emerging challenges facing food production and producers (especially smallholders);
- The link between climate change and agriculture needs to be exploited through triple-win strategies that improve climate change mitigation and adaptation and agricultural productivity;
- The principle of collective action like building a strong, cohesive network to facilitate adaptation through the community and by individuals should be employed in ecosystem-based adaptation in agricultural sector of Ethiopia;
- Any intervention must recognize that women and men adapt differently to new technologies or production systems;
- Policy direction for climate change mitigation and improved sustained food security and agricultural productivity must among other things include improved land management, adjustment of planting dates, and introduction of new crop varieties, while the mitigation options include improved energy efficiency and crop yields, and land management techniques to increase carbon storage;
- Information and training of farmers in organic farming methods should be an important part of the agricultural policy and practice for African governments and donors;
- Short-term plans to address food insecurity, provide access to water resources, or encourage economic growth must be placed in the context of future climate change, to ensure that short-term activities in a particular area do not increase vulnerability to climate change in the long term; and
- Climate change urgently needs to be assessed at the level of the household, so that poor and vulnerable people dependent on agriculture can be appropriately targeted in research and development activities whose objective is poverty alleviation.

Acknowledgement

I would like to thank Gete Zeleke (PhD) who was a supervisor for a seminar paper written as a partial fulfilment of the requirements for PhD in Environmental Planning at Ethiopian Institute of Architecture, Building Constriction and City Development (EiABC), Addis Ababa University, Ethiopia. I am also thankful to staff members of Ethiopian Grain Trade Enterprise and Central Statistical Agency of Ethiopia for their full cooperation in providing necessary data during data collection process. The sources of funding for the author were Ambo University; and Ethiopian Institute of Architecture, Building Construction and City Development, Addis Ababa University of the Ethiopian Ministry of Education which also deserve great appreciation for their financial support.

References

African Development Bank (AfDB).2013. *African Development Report 2012: Towards Green Growth in Africa.* Tunis-Belvedere, Tunisia: AfDB.

Alcadi, R., Mathur, S. and Rémy, P. 2009. Research and innovation for smallholder farmers in the context of climate change. Discussion Paper for Round Table 3. Rome: IFAD.

Alemu, Z.G. 2005. Causes of instability in cereal production in Ethiopia. Working Paper. Department of Agricultural Economics Faculty of Natural and Agricultural Sciences at the University of the Free State.

Ali, M., and Surur, K. 2012. Soil and water conservation management through indigenous and traditional practices in Ethiopia: A case study. *Ethiopian Journal of Environmental Studies and Management (EJESM)*, Vol. 5 No. 4.

Asenso-Okyere, K., and Jemaneh, S. 2012. Increasing agricultural Productivity and enhancing food security in Africa: New Challenges and Opportunities. Synopsis of an international conference. Washington, DC: International Food Policy Research Institute (IFPRI).

Binswanger-Mkhize, H. 2008. Food security in Africa: Towards a support strategy for Australia. Australia: AusAID.

Butler, L. M. and Mazur, R. E. 2007. Principles and processes for enhancing sustainable rural livelihoods: Collaborative learning in Uganda. *International Journal of Sustainable Development & World Ecology* 14 (2007) 604–617.

Chambers, R. and Conway,G.R.1991. Sustainable Rural Livelihoods: Practical Concepts for 21st Century. IDS Discussion Paper 296. Institute of Development Studies: London.

Clements, R.2009. The Economic Cost of Climate Change in Africa. Pan African Climate Justice Alliance (PACJA).

Colls, A., Ash, N., and Ikkala. N. 2009. *Ecosystem-based Adaptation: a natural response to climate change*. Gland, Switzerland: IUCN.

Cooper, P.J.M., Dimes, J. Rao, K.P.C., Shapiro, B., Shiferaw, B., Twomlow, S. 2008. Coping better with current climatic variability in the rain-fed farming systems of sub-Saharan Africa: An essential first step in adapting to future climate change? *Agriculture, Ecosystems and Environment*, 126: 24–35.

Cotter, J. and Tirado, R.2008. *Food Security and Climate Change: The answer is biodiversity*. A review of scientific publications on climate change adaptation in agriculture. United Kingdom: Greenpeace International.

Deressa, T.T. 2007. *Measuring the Economic Impact of Climate Change on Ethiopian Agriculture: Ricardian Approach.* Policy Research Working Paper 4342. Washington D.C: The World Bank.

Diao, X. 2010. *Economic Importance of Agriculture for Sustainable Development and Poverty Reduction: The Case Study of Ethiopia*. Paris: OECD.

Edame, G. E, Ekpenyong, A. B., Fonta, W. M., and EJC, Duru.2011. Climate Change, Food Security and Agricultural Productivity in Africa: Issues and policy directions. *International Journal of Humanities and Social Science*, Vol. 1, No. 21.

Ellis, F.1998. Household Strategies and Rural Livelihood Diversification. *The Journal of Development Studies*, Vol.35, No.l, pp.1-38.

Eriksen, S., Ulsrud, K., Lind, J., and. Muok, B.2007. *The urgent need to increase adaptive capacities: evidence from Kenyan drylands.* In: Nærstad, A.2007. (ed). Africa can Feed itself. Oslo, Norway: The Development Fund.

Federal Democratic Republic of Ethiopia (FDRE). 2010. Ethiopia’s Agricultural Sector Policy and Investment Framework (PIF) 2010-2020. Addis Ababa: FDRE.

Gebreegziabher, T-B. 2007. Potential of the African Environment for the Intensification of Agricultural Production. In: Nærstad, A.2007. (ed). Africa can feed itself. Oslo, Norway: The Development Fund.

Gebreegziabher, Z., Stage, J., Mekonnen, A., and Alemu, A.2011. Climate Change and the Ethiopian Economy: A Computable General Equilibrium Analysis. Discussion Paper Series, Environment for Development.

Gebremedhin, B. and Hoekstra, D.2007. Cereal Marketing and Household Market Participation in Ethiopia: The Case of Teff, Wheat and Rice. AAAE Conference Proceedings (2007) 243-252.

Georgis, K., Dejene, A., and Malo, M. 2009. *Agricultural based Livelihood Systems in Drylands in the Context of Climate Change: Inventory of Adaptation Practices and Technologies of Ethiopia.*

GeoSAS Consulting Service PLC. 2012. *African Gender, Climate Change and Agriculture Support Program (GCCASP): A program of the NEPAD Planning and Coordinating Agency (NPCA) of the African Union (AU).* Ethiopia Consultation Report. Addis Ababa: GeoSAS Consulting Service PLC.

Haan, N., Majid, N., and Darcy, J.2006. *Review of Emergency Food Security Assessment Practice in Ethiopia.* Rome: WFP.

Hadgu, K. M., Rossing, Walter. A. H., Kooistra, L., and van Bruggen, A. H. C. 2009. Spatial variation in biodiversity, soil degradation and productivity in agricultural landscapes in the highlands of Tigray, Northern Ethiopia. *Food Sec.*, 1:83–97.

Hadgu, K., M., J., M., DP. G., G.S. 2011. Current extent of Evergreen Agriculture and Prospects for Improving Food Security and Environmental Resilience in Ethiopia. *International Journal of Agricultural Sciences*, Vol. 1(1), pp. 006-016.

Harmeling, S., Bals, C., and Windfuhr, M.2007. *Climate Change and Food Security in Africa.* In: Nærstad, A.2007. (ed). Africa can feed itself. Oslo,Norway: The Development Fund.

Hassan, R., and Nhemachena, C.2008. Determinants of African farmers’ strategies for adapting to climate

change: Multinomial choice analysis. *AfJARE,* Vol 2, No 1:83-104.
Hutton, J.2010. *Food Security, Biofuels and Agriculture: Major Drivers of Biodiversity Loss and an Opportunity for Sustainability?* MacArthur Foundation Conservation White Paper Series.
International Federation of Organic Agriculture Movements (IFOAM). 2009. Organic Agriculture: *a Guide to* Climate Change and Food Security, IFOAM.
Jones, P.G. and Thornton**,** P. K. 2003. The potential impacts of climate change on maize production in Africa and Latin America in 2055. *Global Environmental Change*, 13: 51–59.
Kato, E., Ringler, C., Yesuf, M., and Bryan, E.2009. Soil and Water Conservation Technologies: A Buffer against Production Risk in the Face of Climate Change? Insights from the Nile Basin in Ethiopia. IFPRI Discussion Paper 00871. New York: IFPRI.
Lamboll, R, Nelson, V and Nathaniels, N. 2011. *Emerging approaches for responding to climate change in African agricultural advisory services: Challenges, opportunities and recommendations for an AFAAS climate change response strategy.* Kampala, Uganda and Accra, Ghana: African Forum for Agricultural Advisory Services (AFAAS) and Forum for Agricultural Research in Africa (FARA) and Forum for Agricultural Research in Africa (FARA).
Ludi, E.2009. *Climate change, water and food security.* ODI Background Notes London: Overseas Development Institute.
Magdoff, F., and Es, H.V. *2009.* Building soils for better crops: Sustainable soil management. Third edition. Waldorf, USA: SARE and USDA.
Mekonnen**,** A.B. 2012. *Analysis of Climate Variability and Its Economic Impact on Agricultural Crops: The Case of Arsi Negele District, Central Rift Valley of Ethiopia.* M.sc.Thesis. Hawassa, Ethiopia: Wondo Genet College of Forestry and Natural Resources, Hawassa University.
Milder, J. C., McNeely, J. A., Shames, S. A. and Scherr, S. J. 2008. Biofuels and ecoagriculture: can bioenergy production enhance landscape-scale ecosystem conservation and rural livelihoods? *Intl. J. of Ag. Sustainability, 6: 105-21.*
Millennium Ecosystem Assessment (MEA). 2005. *Ecosystems and Human Well-being: wetlands and water synthesis*. Washington, DC: world resources institute.
Ministry of Agriculture (MOA). 2012. *Ethiopia Country Programming Paper to End Drought Emergencies in the Horn of Africa.* Addis Ababa: MOA.
Nærstad, A.2007. (ed). *Africa can feed itself*. Oslo, Norway: The Development Fund.
Ngigi, S. N. 2009. *Climate Change Adaptation Strategies: Water Resources Management Options for Smallholder Farming Systems in Sub-Saharan Africa*. New York: The MDG Centre for East and Southern Africa, the Earth Institute at Columbia University.
Odendo, M., Obare, G., and Salasya, B. 2010. Farmers' Perceptions and Knowledge of Soil Fertility Degradation in Two Contrasting Sites in Western Kenya. *Land Degrad. Develop.* 21: 557–564.
Parry, M.L., Rosenzweig, C., Iglesias, A., Livermore, M., and Fischer, G. 2004. Effects of climate change on global food production under SRES emissions and socio-economic scenarios. *Global Environmental Change,* 14: 53–67.
Pinstrup-Andersen, P.2009. Food security: definition and measurement. *Food Sec. (2009) 1:5–7.*
Postel, S.L.2003. Securing water for people, crops, and ecosystems: New mindset and new priorities. Natural Resources Forum, 27:89-98.
Rashid, S.2010. *Staple Food Prices in Ethiopia. Addis Ababa: IFPRI*
Rashid, S. and Negassa, A. 2011. *Policies and Performance of Ethiopian Cereal Markets*. ESSP II Working Paper 21. Addis Ababa: International Food Policy Research Institute (IFPRI) and Ethiopian Development Research Institute (EDRI).
Ringler,C., Zhu T., Cai, X., Koo, J., and Wang, D. 2010. *Climate Change Impacts on Food Security in Sub-Saharan Africa: Insights from Comprehensive Climate Change Scenarios.* IFPRI Discussion Paper 01042. Washington, DC: IFPRI.
Rockstrom, J., Folke, C., Gordon, L., Hatibu, N., Jewitt, G., de Vries, F. P., Rwehumbiza, F., Sally, H. Savenije,H., Schulze R. 2004. A watershed approach to upgrade rainfed agriculture in water scarce regions through Water System Innovations: an integrated research initiative on water for food and rural livelihoods in balance with ecosystem functions. *Physics and Chemistry of the Earth,* 29: 1109–1118.
Sanchez, P. A., Denning, G.L., and Nziguheba, G.2009. The African Green Revolution Moves forward. *Food Sec. (2009) 1:37–44.*
Schmidt, E. and Tadesse, F. 2012. *Household and Plot Level Impact of Sustainable Land and Watershed Management (SLWM) Practices in the Blue Nile*. ESSP II Working Paper 42. Washington, DC: IFPRI.
Shiferaw, A.2011. Estimating soil loss rates for soil conservation planning in the Borena district of South Wollo highlands, Ethiopia. *Journal of Sustainable Development in Africa*,Volume 13, No.3:87-106.
Shiferaw, B., Prasanna, B. M., Hellin, J., and Bänziger, M. 2011. Crops that feed the world: Past successes and future challenges to the role played by maize in global food security. *Food Sec*., 3:307–327.
Shiferaw, A., Hurni, H., Zeleke, G., and Debele, Berhanu. 2011. *Role of indigenous knowledge in land management for carbon sequestration & soil-based ecological services in Damot Sore (Wolyita), Southern Ethiopia.* Report submitted to International start secretariat (report number 3).
Stoop, W. A., and Hart, T. 2005. Research and Development towards Sustainable Agriculture by Resource-Poor Farmers in Sub-Saharan Africa: Some Strategic and Organisational Considerations in Linking Farmer Practical Needs with Policies and Scientific Theories. *International journal of agricultural sustainability,* Vol. 3, No. 3:206-2016.
Stroud, A. and Khandelwal,R.2006. In Search of Substance: *'State of the Art' of Approaches, Strategies and Methods for Improving Natural Resource Management and Livelihoods***.** African highlands initiative (ahi), working PAPERS # 6.

Tefera, M. M. 2009. Causes of rural household food insecurity: A case from kuyu district, central Ethiopia. *Journal of Sustainable Development in Africa,* Volume 11, No.4:286-304.

Thompson, H. E., Berrang-Ford, L., and Ford, J. D. 2010. Climate Change and Food Security in Sub-Saharan Africa: A Systematic Literature Review. *Sustainability, 2*: 2719-2733.

Vernooy, R., and Song, Y.2004. New Approaches to Supporting the Agricultural Biodiversity Important for Sustainable Rural Livelihoods. *International Journal of Agricultural Sustainability*, Vol. 2, No. 1:55-66.

Vignola, R., Locatelli, B., Martinez, C., and Imbach, P.2009. Ecosystem-based adaptation to climate change: what role for policy-makers, society and scientists? *Mitig Adapt Strateg Glob Change*, 14:691–696.

United Nations Framework Convention on Climate Change (UNFCCC). 2007. Impacts, vulnerabilities and adaptation in developing countries. Bonn, Germany: UNFCCC.

USAID. 2011. *The Feed the Future (FTF) Multi-Year Strategies: Ethiopia FY 2011-2015 multi-year strategy. Washington, D.C:* USAID.

USAID and Competitiveness and Trade Expansion Program (COMPETE). 2010. Staple foods value Chain analysis: Country report–Ethiopia. Addis Ababa and *Washington, D.C*: USAID and COMPETE).

Worako, T. K.2012. Dynamics of Food Price Trends and Policy Options in Ethiopia. Addis Ababa: Ethiopian Development Research Institute.

World Bank. 2010. *Economics of Adaptation to Climate Change: Ethiopia.* Washington, DC: The World Bank Group.

World Bank. 2011. *Increased Productivity and Food Security, Enhanced Resilience and Reduced Carbon Emissions for Sustainable Development. Opportunities and Challenges for a Converging Agenda: Country Examples.* Washington, DC: World Bank.

WFP-Ethiopia.2009. Food Security and Vulnerability in Addis Ababa, Ethiopia: Vulnerability Assessment and Mapping (VAM). Addis Ababa: WFP-Ethiopia.

ANNEXES

Annex 1: Descriptive Statistics for Annual Prices (Ethiopian Birr) of Major Cereals in Addis Ababa Grain Market (2005-2010)

Year	Teff white	Teff mixed	Teff red	Wheat white	Wheat Mixed	Barely white	Barely Mixed	Sorgum white	Sorghum mixed	Maize
2005	283	262	218	195	180	191	166	200	190	152
2006	327	309	255	245	226	235	205	248	226	161
2007	443	409	334	293	271	285	245	314	284	167
2008	580	541	444	406	374	418	348	430	380	283
2009	954	902	743	550	512	606	556	668	570	441
2010	919	798	614	525	443	556	450	599	591	312
SUM	3506	3221	2608	2214	2006	2291	1970	2459	2241	1516
Mean	584.333333	536.833333	434.666667	369	334.3333333	381.8333333	328.3333333	409.8333333	373.5	252.6667
SDV	291.777769	262.813559	208.170763	148.2524873	130.010256	172.7696926	152.0061402	190.9161247	172.8580342	114.7043

Source: Computed by author from data base of EGTE,2013.

Annex2: Descriptive Statistics for Mean Area Production, Production, and Yield Estimates for Major Cereals in Ethiopia (2000-2013)

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Teff production Area in Hectare	12	1989068	2761190	2411586.30	270251.548
Teff Total Production in Quintals	12	16773480	37652412	26431204.74	7690875.147
Yield of Teff	12	8	14	10.81	2.074
Barely Production Area in Hectares	12	794000	1129112	983831.01	92266.144
Barely Total Production in Quintals	12	7419000	17816522	13677338.68	3254610.468
Yield of Barely	12	9	18	13.83	2.630
Wheat Production in Hectare	12	1025000	1683565	1398004.39	206369.828
Wheat Total Production in Quintals	12	12126000	34347061	23659564.10	6615583.880
Yield of Wheat	12	12	21	16.75	2.619
Maize Production Areas in Hectare	12	1367115	2054724	1703865.79	239115.254
Maize Total Production in Quintals	12	23941622	61583176	38756460.30	12761076.653
Yield of Maize	12	17	31	22.23	4.355
Sorghum Production Area in Hectare	12	995000	1923718	1508175.91	270163.381
Sorghum Total Production in Quintals	12	11811000	39598974	25514705.69	9418815.342
Yield of Sorghum	12	12	21	16.52	3.250
Millet Production Area in Hectare	12	304758	432561	373361.13	43535.483
Millet Total Production in Quintals	12	3051014	7422972	4838730.57	1494363.076
Yield of Millet	12	9	17	12.81	2.647
Oats Production Area in Hectare	12	24018	45131	34041.59	7153.134
Oats Total Production in Quintals	12	330191	566754	431222.71	67841.887
Yield of Oats	12	9	17	12.99	2.364
Valid N (listwise)	12				

Source: Source: Computed by author from data base of CSA, 2013.