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RESEARCH ARTICLE

IMPACT OF CLIMATE CHANGE ON FOOD AND NUTRITION SECURITY IN KENYA

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ABSTRACT

The soaring food prices and new challenges of climate change pose a threat to the already existing food and nutrition insecurity in a number of developing countries, including Kenya. These have culminated in political unrest and food riots in some African countries like Mauritania, Morocco, Cameroon, Senegal and more recently Kenya. Over the years, Kenya has experienced environmental degradation due to urbanization, development and deforestation. This has contributed to climate change and food insecurity in some parts of the country. Currently, over ten million Kenyans suffer from chronic food insecurity and poor nutrition, and between two to four million people require emergency food assistance at any given time. Nearly 30 per cent of children are undernourished and micronutrient deficiencies are widespread. This has been compounded by the post-election violence experienced in the country at the beginning of 2008. Whereas the country has the capacity to mobilize its resources for the production of adequate food and surplus for export, this has remained elusive due to lack of concrete implementation of environment, agriculture and food nutrition policies. This paper reviews some of the current developments in the relationship between climate change, food security and the policy roles.

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INTRODUCTION

The spectre of climate change, together with other global environmental changes such as water unavailability, reduced land cover, altered nitrogen availability and cycling that are all strongly influenced by human activities, has increased concerns about achieving food and nutrition security, especially among the poor people (Gregory *et al.*, 2005). In recent times, there have been concerns in meeting the global demand for food resulting from higher population and changing dietary preferences (Tilman, 2001). This is expected to further degrade the environment both through additional destruction of native vegetation and intensification of cropped areas, thereby undermining the food system upon which food security is based (Ellis, 2003; Tilman, 2001). The links between climate change and food security have to-date been explored in relation to impacts on crop productivity and hence food production (Gregory *et al.*, 1999). Food security is concerned not only with food availability but also with access to and utilization of food, so that studies, which focus only on food production, provide only a partial assessment of food security climate change relationships (Gregory *et al.*, 2005). Over 75 per cent of Kenya's population earns its living from agriculture, which in turn depends on rainfall (UNEP & GOK, 2000). Due to the vast areas being prone to drought, Kenya's vulnerability to food insecurity is highest among pastoralists and small-scale agriculturalists in the Arid and Semi-Arid Lands (ASALS) of the country. Extreme weather and climate changes influence the entire economy, which depends majorly

on agricultural products like cash crops, food crops and animals (Republic of Kenya, 2003). The country faces tremendous development challenges in nearly all the sectors: poverty is endemic, deforestation is continuing, food insecurity is rampant, malnutrition and infant mortality rates remain high (Thaxton, 2008). Over the years, the Government and Non-Governmental Organizations have focused resources and expertise on particular areas rather than integrating interrelated concerns into a holistic approach (Population Research Bureau, 2008). While a number of policies and programmes linking agriculture, food security and environment have been tried, an assessment of the overall integration and implementation strategies has not been tried. The purpose of this paper is to: review some of the existing environment, agriculture and food and nutrition policies; their integration and legal frameworks and institutional capacity to carry out policy mandates and recommendations. The paper makes suggestions on harmonization and integration of the policies.

Impacts of Climate Change across Africa

Although climate change is a threat to all countries, developing countries are the most vulnerable. The World Bank (2009) estimates that they will have to shoulder some 75 to 80 percent of the costs of damages caused. A global 2°C warming above pre-industrial temperatures could result in permanent reductions in GDP of 4 to 5 percent for Africa. The African continent warmed by about 0.5°C last century. This century average annual temperatures are projected to rise by 3 to 4°C. Climate models concur that many arid areas will become drier

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and humid areas wetter. The Inter-governmental Panel on Climate Change (IPCC) Fourth Assessment report (4AR) has assessed various future trends based on climate projections using different emissions related scenarios. The IPCC reports that it is likely and in some cases virtually certain that there will be fewer cold days and nights over most land areas, there will be warmer and more frequent hot days and nights over most land areas. In addition, the frequency of warm spells/heat waves will increase, as will the frequency of heavy precipitation events. Also likely is an increase in areas affected by drought, the intensity of tropical cyclone activity and the incidence of extreme high sea-levels.

The impacts of climate change across Africa will vary:

- At mid- to high latitudes, crop productivity may increase slightly for local mean temperature increases of up to 1–3°C, depending on the crop, while at lower latitudes crop productivity is projected to decrease for even relatively small local temperature increases (1–2°C) (IPCC, 2007).
- In the tropics and subtropics in general, crop yields may fall by 10–20% by 2050 because of warming and drying, but there are places where yield losses may be much more severe (Jones & Thornton, 2003).

Nearly two-thirds of sub-Saharan Africans depend on livestock for some part of their livelihood. Climate change will affect the productivity of rain-fed crops and forage, reduce water availability and increase widespread water shortages, and change increase the severity and distribution of significant crop, livestock and human diseases. As a result, major changes can be anticipated in livestock systems, related to livestock species mixes, crops grown and feed resources and feeding strategies.

Poverty, Climate Change and Food Security

Food security is a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. Observed effects of climate change across Africa have been reported and reviewed in the Africa chapters of the IPCC 4AR and in the 2008-'09 Human Development Report by UNDP. Anderson (2008), in a report to the Africa Partnerships Forum, collated evidence from observations and projections of climate change effects on the achievement and sustainability of Millennium Development Goals for Africa. Climate change will affect different dimensions of food security - including food availability (i.e., production and trade), stability of food supplies, access to food and food utilization. Agricultural output in developing countries is expected to decline by 10-20 percent by 2080. Globally, the potential for food production is projected to grow with increases in local average temperature over a range of 1-3°C, but above this it is projected to decrease. In seasonally dry and tropical regions, even slight warming (1-2°C) reduces yield. Temperature increases of more than 3°C may cause food prices to increase by up to 40 percent. Temperature increases are leading to changes in the distribution of marine fisheries. Increases in atmospheric CO₂ are raising ocean acidity. Rising seawater temperature is associated with increased densities of *Vibrio* spp in shellfish,

which is a major cause of diarrhoea. Table 1 below illustrates how climate change will affect the determinants of food security. Recent attention on the issue of global environmental change has focused on the potential Agricultural impact and global and regional food security implications. Food supplies in smaller nations are likely to be affected more by climate change than those of the larger nations. Kenya is one of the poorest countries in the world having been ranked 172 by World Bank (2001) based on Gross Domestic Product per capita (GDP/Capita) and 123 by UNDP (2001) based on Human Development Index (HDI). The country is subject to several environment related worrying trends, which put overall sustainable development at risk (World Bank, 1991). Poverty levels have increased during the last couple of years. This is particularly true in the most densely populated central highlands, which constitute the high potential areas where the most fertile soils and the most intensive agriculture are found. Poverty in Kenya is closely linked, in a complex way, to rural households' large dependence on natural resources (mainly soils, biological and forest resources), inefficient agricultural practices, land degradation, declining food production, rapid population growth, land fragmentation and limited access to markets, credit facilities and public services. Since the 1970s, food production in Kenya has failed to keep up with the rapidly increasing population.

Annual agricultural production growth rate increased from 4.8 per cent in 1970s to 3.3 per cent in 1980-90, to 1.9 per cent in 1990-2000, which is more than the current growth rate of about 1.7 per cent. Around 65 per cent of Kenya's population live in the rural areas and depend on agriculture, biological and forest resources for their survival. Since only seven per cent of the country's area is arable land (World Bank, 2001), subdivision of land into smaller units is a growing problem. Arable land area per capita decreased from 0.23 ha in 1980 to around 0.14 ha in 1988 (World Bank, 2001). Consequently, the country is plagued by food insecurity and has problems feeding its population, compounded by recurring droughts, occasional floods and the adverse effects of the post-election crisis of December 2007 and early 2008. Reliance on food aid has also been increasing (USAID, World Food Programme & GOK, 2008). Food insecurity and resource scarcity have resulted in malnutrition. Due mainly to poverty, lack of food and other essential resources for survival, 33 per cent of children under the age of five are stunted (low-height-for age), 22 per cent of these children are wasted (low-weight-for age) while 43 per cent of the total population is chronically undernourished (UNDP, 2001).

Current Food Situation Analysis

According to CARE International (2011), food security is a growing concern throughout the developing world, particularly for poor women and children. The commentator adds that estimates suggest that in 2010, approximately 925 million individuals were undernourished. A recent study on the future of food and farming identified six drivers of change affecting the global food system: a growing global population; changing diets, notably an increase in demand for resource-intensive meat products; food system governance, including globalisation of markets, subsidies and trade restrictions; competition for resources, particularly land, water and energy; consumer values and ethics, and impacts of climate change

Table 1: Factors Affecting food Security and Climate Change as Multipliers

Components of Food Security	Determinants	Climate Change Effects
Physical availability at national level	Is there potentially enough food available nationally to feed all people?	Both sudden and slow onset climate change effects can reduce physical availability, e.g. stochastic events, such as droughts and trends of decreasing or increasing sporadic rainfall combined with higher temperatures
Physical availability at local level	Is food in local markets or local fields?	Climate change will bring about increased frequency of extreme weather events. These tend to have effects across parts of countries and hence local scale differences will increase.
Economic access	Does the household generate enough income to purchase food and/or have sufficiently diversified production to satisfy requirements?	Climate change effects will affect not just food production, but other economic activities also. So incomes and food production will be subject to reduction.
Social access	Do all household members have access to food?	It is important to understand how climate change shocks and trends affect aspects of social access through response measures, coping and adaptation
Food quality and safety	Is food of sufficient diversity and quality to promote good health?	Increased temperatures and increasingly unpredictable rains will affect both what can be grown and food storage methods
Physiological utilisation	Are the care and health/sanitation/drinking water environments sufficiently good so that ingested food can be absorbed and contribute to growth and development?	The water sector and water resources are particularly sensitive to climate change effects of temperature rise and too much and too little water
Risk of loss of access	How sensitive are any forms of access to shocks and cycles (e.g. seasonality, drought and conflict)?	Climate change will increase the frequency of shocks and introduce trends that change cycles
Access as a human right	What is the capacity of the food system to deliver and what is the capacity of individuals to realize their rights to food?	The exacerbation of stresses to food security will tend to make the exercise and extension of access rights more difficult

Source: Anderson, Gundel & Vanni, 2010

Table 2: Climate Change Impacts and Consequences for Food Systems

Climate Change Impact	Direct Consequence for Food Systems
Increased frequency and severity of extreme weather events	<ul style="list-style-type: none"> • Crop failure and reduced yields • Loss of livestock • Damage to fishes and forests • Destruction of agricultural inputs, such as seeds and tools • Either an excess or decrease of water • Increased land degradation and desertification • Disruption of food supply-chains • Increased costs for marketing and distributing food
Rising temperatures	<ul style="list-style-type: none"> • Increased evapotranspiration, resulting in reduced soil moisture • Greater destruction of crops and trees by pests • Greater threats to human health (e.g. disease and heat stress) that reduce the productivity and availability of agricultural labour • Greater threats to livestock health • Reduced quantity and reliability of agricultural yields • Greater need for cooling/refrigeration to maintain food quality and safety • Greater threat of wildfires
Shifting agricultural seasons	<ul style="list-style-type: none"> • Reduced quantity and quality of agricultural yields and forest products • Either an excess or shortage of water • Greater need for irrigation
Sea level rise	<ul style="list-style-type: none"> • Damage to coastal fisheries • Direct loss of cultivable land due to inundation and salinisation of soil • Salinisation of water sources

Source: CARE International (2011)

(CARE International, 2011). It is estimated that food production will need to increase by 50 percent by 2030 just to keep up with the demands of growing urban population (ibid.). At the same time, climate change is projected to cause decreases in global cereal production of 1-7 percent by 2060, depending on the climate model used for the projection. Reduced production leads to higher food prices and increased food insecurity, particularly for rural families in developing countries who are net buyers of food. A recent study by World Food Programme (WFP) found that without significant reductions in greenhouse gas emissions, climate change 'will greatly increase hunger, especially in the poorest parts of the

world.' Assuming that current trends in population growth and inadequate distribution of wealth are maintained, WFP estimates that globally, 10-20 percent more people will be at risk of hunger by 2050 than would be without climate change. Of these, almost all will be in developing countries, with 65 percent expected to be in Africa. This has severe implications for nutrition, particularly for children. In sub-Saharan Africa, it is estimated that 10 million more children will be malnourished as a result of climate change. The risk of hunger from climate change is the result of both direct impacts on food systems, and of indirect impacts that affect the different dimensions of food security. Table 1 provides an overview of

Table 3: Indirect Consequences of Climate Change Impacts on the Different Dimensions of Food Security

Dimensions of Food Security	Indirect Consequences of Climate Change
Availability of sufficient food	<ul style="list-style-type: none"> • Reduced agricultural production locally and globally • Decreased availability of fishery and forest products • Increased pressure on food reserves • Decreased exports and increased imports
Access to resources needed to acquire food	<ul style="list-style-type: none"> • Increased food prices • Loss of income due to damage to agricultural production or interruption of livelihood activities • Need to adjust agricultural practices and other livelihood strategies to manage uncertainty of changing hazards and conditions
Utilisation, including nutrition, food safety and quality	<ul style="list-style-type: none"> • Increasing migration to urban and peri-urban areas • Health impacts, including food-borne diseases and malnutrition • Dietary and nutritional changes based on changing availability of or access to preferred foods • Ability to utilise food may be affected by disease • Persons living with HIV/AIDS may experience difficulties in maintaining anti-retroviral therapies and may be more susceptible to infections • Impacts on food safety resulting from water pollution, increased temperatures and/or damage to stored food
Stability of availability and access	<ul style="list-style-type: none"> • Instability of food supplies (affecting both availability and pricing of food) • Insecurity of incomes from agriculture and fisheries • Population displacement and migration • Potential for increased conflict over resources

Source: CARE International (2011)

Table 4: Main Source of Water (%Households)

PROVINCE	Pond/Dam/Lake	Piped	Stream	Spring/Well/Borehole	Jabia/Rain/Harvested	Other
Nairobi	0.3	75.7	0.1	7.2	0.2	16.5
Central	1.6	39.8	26.0	25.1	2.6	5.0
Coast	8.2	46.3	7.1	25.4	0.6	12.3
Eastern	4.1	28.5	28.8	31.1	0.7	6.7
N- Eastern	16.3	11.6	5.1	51.5	2.5	13.0
Nyanza	12.8	8.5	29.9	45.3	0.9	2.5
Rift Valley	4.7	22.8	29.3	36.3	1.2	5.5
Western	1.2	7.0	16.8	73.8	0.4	0.8
Kenya(Total)	5.1	30.0	21.6	35.4	1.1	6.8

Source: The 2009 Population and House Census Results (RoK, 2010)

the potential direct consequences of key climate change impacts for food systems. These are general example – the interactions between the climate and the food system are complex and vary greatly based on local circumstances. Therefore, both the climate change impacts and their consequences need to be analysed at the local level in order to plan appropriate interventions. In turn, the direct effects listed in Table 2 have indirect consequences for all four dimensions of food security: availability, access, utilization and stability, as shown in Table 3.

Government Policies

Since independence, the government has been advocating for conservation and proper environmental management and food and nutrition security. This has been articulated in various policy statements, government directives, denouncements, the Sessional papers and development plans.

African Policy Statements on Climate Change, Agriculture and Food Security (Anderson, Gundel & Vanni, 2010)

Within the context of the UNFCCC, A total of twenty-two African least developed countries have surveyed their own adaptation needs and collated them into the NAPAs. These documents define each African least developed country's adaptation needs. They centre on agriculture, food security and water resources management. Analysis of the national

adaptation programmes of action by least developed countries in Africa shows the types of agricultural research relevant to the adaptation priorities identified. It is important to point out that the majority of NAPAs identify “knowledge sharing” as a key component in climate change adaptation, which shows the countries determination to confront the challenges posed by climate change. In addition, there is the need to systematize existing ARD outputs (from EIARD supported programmes and others) in terms of their relevance to climate change adaptation and mitigation. The Nairobi Declaration on the African Process for Combating Climate Change, made by African Ministers of Environment, following the special session on climate change of the African Ministerial Conference on the Environment in Nairobi from 25 to 29 May 2009 included the following:

- Point 7. To advocate the expansion of eligible categories to benefit from carbon credits and other international incentives in the post-2012 agreed outcome to include sustainable land use, agriculture and forest management, so as to promote agricultural productivity in a way that improves resilience and adaptation to climate change;
- Point 18. To encourage the establishment of a fund to reward or provide incentives for reducing emissions through sustainable land-management practices, including forest conservation, sustainable forest

management, the avoidance of deforestation, afforestation and sustainable agriculture;

- Point 23. To integrate climate change adaptation measures into national and regional development plans, policies and strategies and, where appropriate with a view to ensuring adequate adaptation to climate change, in such areas as water resources, agriculture, health, infrastructure, biodiversity and ecosystems, forests, urban management, tourism, food, land, environment and energy security and management of coastal and marine resources, taking into account cross-sectoral implications;
- Point 28. To agree that other mitigation measures being identified, such as additional measures to complement the United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries, including afforestation and sustainable agriculture and land-use management, should be vigorous, realistic and flexible to ensure the effective participation of African countries, especially smallholder land users;
- Point 33. To call upon subregional, regional and international organizations to develop methodologies for measuring carbon sequestration in agriculture, forestry and agro-forestry systems and accounting methods to be applied for claiming genuine benefits;
- Annex IV - Conceptual framework for African climate change programmes. Point (b) Sectoral planning and implementation: adaptation in key sectors including water, agriculture, coastal zones, health, infrastructure, biodiversity and ecosystems, forests, energy, urban management and tourism, taking into account the cross-sectoral implications.

Economic Policy and the Environment

Kenya's economy is largely natural resource dependent (agriculture, forestry, nature/wildlife, tourism and basic manufacturing). The economic role of agriculture declined from 33 per cent in 1980 to 23 per cent in 1999. This trend may worsen with time if mitigating efforts are not urgently implemented. The same applies to employment in agriculture where more and more people migrate to cities in hope of finding temporary or permanent jobs. Job opportunities in the towns and cities, on the other hand, are not keeping pace with that of the migration from rural areas resulting in large unemployment rate. Land degradation and soil erosion pose one of the most serious threats to sustained food production and Kenya's development in general. Compounded by occasional droughts and floods, environmental factors play a key role the performance of the agricultural sector. There is, therefore, great need to support soil and water conservation.

Population and Environment

The RoK (2009) defines population census as the total process of collecting, compiling, evaluating, analyzing and publishing or otherwise disseminating demographic, economic, and social data pertaining, at a specified time, to all persons in a country or in a well delimited part of a country. The overall objective of census, as outlined in the 2009 census report, is to collect demographic and socio-economic data required for decision-

making. This decision-making involves policy issues of climate change and food security. From the census results, water, the most important of all environmental elements was reported to be sourced from piped sources by the majority of Kenya's populations. Table 4 below shows the results of the 2009 census analysis. This is an indication of a possible reduction of water from the natural sources due to environmental degradation, hence the need to collect and distribute water. Piped water management in terms of hygiene, storage and distribution will also have an impact on food security. Population growth puts scarce rural natural resources under stress. Kenya's population increased from five million in 1948 to reach some 30 million in 2000. The 2009 census results put the country's population at 38,610,097 people, with a registered higher growth rate. It is projected to reach over 40 million by 2015 (UNDP, 2001). The pressure of all of these on rural lands, forests, water and biological resources is overwhelming. The staggering agricultural production in rural areas has worked, in conjunction with widespread poverty, to contribute to massive migration to urban areas. Kenya's urban population increased from 2.7 million in 1980 to around 10 million or 32% in 2000 (Ekbom, 2002; UNDP, 2001). This has put tremendous pressure on the urban environment and infrastructure, particularly in Nairobi, where the quality and coverage of sewage and water management services is very poor, especially in the squatter or slum areas. The government anticipates that the urban centres cannot adequately absorb the underemployed rural population. To achieve food security in the urban areas, there is urgent need to invest infrastructure and logistics of food chain (Mwai *et al.*, 2008).

Food and Nutrition Policies, Legislation and the Environment

The government of Kenya has shown a strong commitment to reduce hunger and malnutrition through a number of policies (Republic of Kenya, 1981, 1994, 2007). Nevertheless, environmental problems and food insecurity still persist, as some of the policies are never fully implemented. Taking the policies from paper to approved policy and from policy to funding and effective programmes is a challenging multifaceted process requiring involvement from many government and non-governmental groups that sometimes consider themselves unrelated. In the last decade, the country has developed environmental policies and capacity to manage the environment. At present, there is good understanding of the nature of key environment problems. However, the main problem seems to stem from the capacity to monitor and enforce the existing legislation, and to implement the current environmental policies. In most parts of the country, land tenure is not an issue as most of the land is in the hands of the small holders who possess title deeds to their plots. There is need to strengthen tenure in the semi-arid lands so as to enhance the capacity in the existing key institutions in charge of environment management, especially on pollution reduction in the industry and transport sector. New initiatives in the country are aimed at strengthening cross cultural collaboration and coordination as reflected in the Kenya Vision 2030 and its economic, social and political pillars (Republic of Kenya, 2006). There is need to include environmental concerns in the development policies. This will help to improve the understanding of the environmental policy linkages. Kenya, *Land grabbing and GMOs* (Gasparis, 2011). On July 1st the

Kenya government enacted the Biosafety Act of 2009 that allows Genetically Modified Organism (GMO) cultivation and consumption. Indeed, it isn't just about how the wrong crops are being cultivated in the wrong place, deforestation, the destruction of bio-diversity and traditional ways of life; we are seeing the very livelihoods of Kenyans endangered by the resell and gifting of their centuries old arable land to corporations in order to produce bio-fuels and foods destined to foreign markets. The Tana River Delta is a prime example of such land grabs. Despite the public outrage, the government has distributed hundreds of thousands of hectares of land for biofuels: sugar cane and *Jatropha*, as well as vegetable and fruit plantations to Canadian, American, Qatari, French and Kenyan firms. Salinisation of arable land, destruction of bio-diversity and the existence of rare and endemic species in the Tana River Delta is happening. The government claims that land within Kenya is being sold because of the recent regional droughts and resulting low crop yields. It is also claiming, together with the National Environmental Management Authority (NEMA), that allowing these land sales and the cultivation of GMOs will increase the food supply and lower Kenya's reliance on imported food products. However, all the evidence seen until now has shown the opposite; the continued use of GMOs will cause further environmental damage and make it harder for the Kenyan population to grow food and make a living off the land. If the Kenyan government wants to protect the environment and local communities, it must put a stop to this land-grabbing. The separation of communities from their land and its transfer to profit-driven companies will rarely result in positive outcomes for the environment or for the Kenyan population. Instead of subsidizing GMOs, selling off land, and encouraging unsustainable farming methods, the government would be wise to repeal the 2009 Biodiversity Act and promote the use of organic farming practices. The issues of food security and land grabbing are ones that are very important to GBM. Wangari Maathai and the Green Belt Movement have long pushed for an approach to issues of food security that relies on traditional knowledge systems and engages local people in sustainable environmental practices. As we are seeing with the devastating drought in the Horn of Africa communities are increasingly vulnerable due to climate change and the international community is struggling to deal with the terrible humanitarian crisis. Attempts to address climate change that remove land and control from local communities will only result in greater susceptibility to future droughts and further crises like the one we are seeing now.

Supportive Objectives of Climate Change Adaptation And Food Security

The following are examples of strategies that will contribute to the mutually supportive objectives of climate change adaptation and food security (CARE International, 2011):

- Increasing agricultural productivity, climate resilience and sustainability, particularly for smallholder farmers (for example, by promoting conservation agriculture practices, restoration of degraded soils and agricultural biodiversity)
- Promoting rights of vulnerable people, particularly women, to critical livelihood resources such as land and water

- Integrated water resource management
- Sustainable land use management and ecosystem services
- Technology transfer (irrigation, conservation and sustainable agriculture, biogas technology, etc.)
- Disaster risk reduction strategies
- Enhancing government capacity to implement social protection schemes
- Assessing vulnerability to and impact of climate change on the different dimensions of food security
- Improvement of food security monitoring to incorporate indicators related to gender equality, nutrition and climate variability and change
- Partnerships with other humanitarian, development and environmental organisations, research institutions, governments and the private sector to identify practical and effective responses to climate change and food insecurity
- Knowledge management and sharing across sectors, communications and awareness raising

The key messages raised by the CARE International (2011) brief are:

- Climate change impacts affect all four dimensions of food security: availability, access, utilisation and stability. Design of food security programmes must therefore take climate change into account in order to ensure sustainability and impact
- Food security and adaptation to climate change are mutually supportive approaches. They have shared objectives of reducing vulnerability and increasing resilience
- Transformative activities that promote equity, women's empowerment, rights and appropriate governance must be incorporated in approaches to supporting vulnerable people to achieve food security and climate resilience
- Approaches to food security must recognize climate change and environmental degradation as drivers. By explicitly integrating climate change into food security programming, actions to address food security will also increase capacity to adapt to climate change
- Adaptation approaches must incorporate actions targeted as climate-resilient livelihoods and disaster risk reduction, as well as addressing the underlying causes of vulnerability. In many contexts, strategies to reduce vulnerability to climate change will also increase food security.
- Adopt an integrated approach which addresses resilient livelihoods, risk reduction and the underlying causes of vulnerability and food insecurity in places where people are vulnerable to both climate change impacts and food insecurity.
- Strong and urgent action on mitigating climate change is needed to avoid increasing hunger in the coming decades, particularly for poor and vulnerable people in developing countries.

CONCLUSIONS AND RECOMMENDATIONS

Climate change is a reality and has no respect for borders. It is likely to affect individuals in many ways, particularly the poor in developing countries (Mwai *et al.*, 2008). Given the

increased levels of resource-based poverty, increased degradation of arable land and food insecurity, it is important to undertake comprehensive action that encompasses these issues. There is need to carry out interdisciplinary research and development so as to reduce rural poverty through the innovative management of resources. A natural resource management research approach is suggested.

This may consist of:

- Identifying and quantifying the extent of food insecurity, rural poverty and resource degradation.
- Technological and policy research on economic and environmental functions.
- Optimizing the trade-offs between global environmental benefits and private farmer benefits.
- Extrapolating and disseminating results, including research on policy implementation.
- Assessing the impact and providing feedback.

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