Challenges for nutrition in sub-Saharan Africa

Background documents for the SUNRAY regional workshops
Background

Only nine out of the 46 countries in sub-Saharan Africa are on track to achieve the MDG 1 (eradicate extreme poverty and hunger). Despite this, investment in nutrition and in nutrition research has been grossly insufficient. Recent events including the food price crisis, global recession and climate change are having a profound global influence on hunger, health and agriculture. Future environmental, economic, technological, socio-cultural and political changes are likely to present new challenges to the field of nutrition. Changes in climatic and demographic patterns, water and land availability, the stability of national food reserves, food and oil prices, migration and resettlement patterns, urbanization, health care systems and emerging conflicts will all affect food and nutritional security in new ways. Future research needs for nutrition in Africa may be very different from current research needs and will require the development of new conceptual thinking accompanied by innovative research methods.

Within the next decade, new nutritional problems and nutritionally vulnerable groups will emerge and as a result pose new challenges for nutrition research and programming. It is essential to understand the future environmental, economic, socio-cultural and political landscape in order to predict their impact on nutrition and identify emerging research needs as well as immediate research challenges.

The SUNRAY project will develop a nutrition research agenda for sub-Saharan Africa.

The present document presents a series of papers that aim to identify emerging research challenges for the nutrition research community. These documents were used as background material for three regional workshops (Tanzania, Benin, South Africa), organized to build consensus between stakeholders, develop a coherent research agenda and outline the conditions and actions required to implement it.

Sunray, 2012
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1. Introduction

Climate change represents a major threat for the coming decades particularly in Africa which has more climate sensitive economies than any other continent. It has often been identified as one of the most vulnerable regions to climate variability and change because of multiple stresses and low resilience, arising from endemic poverty, weak institutions, as well as complex disasters and associated conflicts. Climate-related risks have significant impacts on African populations and economies and drive large allocations to emergency resources.

Climate change exacerbates the existing undernutrition problem in Africa and will further undermine current efforts to reduce poverty and undernutrition, particularly in Sub-Saharan countries. Undernutrition in turn undermines the resilience of vulnerable populations decreasing their ability to cope and adapt to the consequences of climate change and their ability to grow economically. The current drought in the Horn of Africa that triggered famine in Somalia and spurred food crises in others countries is probably an indication of what may come as such incidents become more commonplace, with extreme weather events having a higher probability of occurring as a result of climate change.

The objectives of this paper are to:

(1) Review the existing research and information on the impacts of climate change and variability on nutrition security in Africa and the adaptation and
mitigation strategies to address these challenges. Particular focus is in Sub-Saharan countries.

(2) Identify the research needs for the nutrition and related sectors to effectively address the impacts of climate change on nutrition security in Africa in the next 10-15 years.

2. **Methodology - Framework for Analysis of Climate Change Challenges to Food and Nutrition Security**

This paper analyzes the existing research on the impacts of climate change on the key elements related to nutrition security in Africa and the adaptation and mitigation strategies to address these challenges according to the elements described in the framework presented in Figure 1. This framework combines food security and nutrition security and livelihoods factors as affected by climate change.

In order to identify the existing research on impacts, vulnerabilities, adaptation, mitigation issues in the various African and sub-Saharan African countries a literature review has been conducted using queries including the key three determinants of nutrition security highlighted in the framework below (see Figure 1). An analysis of existing projects at the World Bank, FAO, and World Food Program addressing climate change and nutrition security has been prepared to provide a snap-shot of the current situation in African countries.

A gap multi-sectoral analysis has been undertaken according to the three key determinants of nutrition security highlighted in the framework below in order to identify the research needs on impacts, vulnerabilities, adaptation and mitigation measures to address the challenges of climate change on nutrition security in Africa in the next 10-15 years.
The conceptual framework used in this background paper (Figure 1) has been adapted from UNICEF (1991) and Black et al. (2008). It recognizes that poor household access to sufficient, safe and nutritious food; inadequate maternal and child care and feeding practices; and poor household access to health services and unhealthy environment are the underlying causes of maternal and child undernutrition (including both chronic and acute malnutrition) in developing countries. The framework further identified the underlying and basic causes of malnutrition including environmental, economic and socio-political contextual factors with poverty playing a central role. The framework also acknowledges that shocks, trends and seasonality have considerable effects on undernutrition and its causal pathways.

It is important to stress that so far, there is no broadly accepted and comprehensive analytical framework for the analysis of the impacts of climate change on food and nutrition security. The framework used for this analysis (Figure 1) probably represents a suitable framework to analyze, in a comprehensive manner, the multiple linkages between climate change and nutrition security. This framework should be further strengthened along with an appropriate set of nutrition-sensitive indicators in the future.
In a changing environmental climate, it is critical to address the proximal causes of food security and health and the more intermediate and distal processes related to nutrition security while utilizing a framework of action to adapt to and mitigate adverse consequences in the household, care, and health-related areas. A framework with which to assess the impacts of climate change on food and nutrition security and to review current research and projects that identify adaptation and mitigation strategies is most appropriate for food and nutrition security.

Key terms used in the paper related to climate change and nutrition are included in Annex 1.

3. The impacts and threats of climate change on food and nutrition security in Africa

3.1. Overall Climate Change Impacts and Vulnerability in Africa

Climate change is happening now and it represents a major threat for the coming decades (Pachauri and Reisinger, 2007). Climate change has environmental and human and socio-economic impacts from a global down to a local level. Climate Change is considered the biggest predictor of and having the greatest impact on international development and food and nutrition security in the coming decades.

**Environmental Impacts**

Climate projections for Africa suggest that the continent will experience a stronger warming trend than the global average (Boko et al., 2007). Additional projections suggest that Africa overall will experience increased water stress as a result of decreased precipitation and increased evapotranspiration, and will experience increased desertification. Factors that will likely exacerbate the negative outcomes of these climate change projections are that the countries of Africa and in particular sub-Saharan Africa have to cope with high levels of poverty and have little adaptive capacity. Water-stress is one consistently cited factor that will dramatically impact food and nutrition security.

Most climate models predict a rise in global and atmospheric temperatures that will have mixed effects on agricultural production. Sea level rises will drown coastal agriculture and contaminate the soil. Reductions in glacier cover will dramatically change the hydrology of rivers that are crucial for irrigating large agricultural areas around the world, including the Nile River that flows through 11 African countries. Temperature changes may increase or re-distribute pest and disease incidence throughout the world (Brown, 2011).
Changes in rainfall patterns are hard to predict, but all the combined effect of droughts, floods, poor water infrastructure, and increasing temperatures, and rising waters in the sub-Saharan Africa region, are predictive of decreasing agricultural production, increased food prices, and loss of livelihoods, increasing food and nutrition insecurity (NOAA, 2011; Boko et al., 2007). As temperatures increase, precipitation is becoming more variable over most of Africa. For some regions, rainfall variability and unpredictability has been substantial in the past forty to fifty years. According to Boko et al. (2007), however, there has been an overall annual decline in rainfall observed since the end of the 1960s over Africa with some regions experiencing greater declines than others. Variability is demonstrated by the significant increase in the number of heavy rainfall events and also by longer drought periods. Even during heavy rainfall, most of the water does not adequately penetrate the soil, is lost to runoff, and is unable to be stored for future agricultural purposes. Moreover, since the 1970s, the Sahel region of Africa has been drying as a likely result of the increase in equatorial Indian Ocean sea-surface temperatures. Increased temperatures deplete land of its moisture more rapidly and can lead to regional water scarcity, salinization of agricultural lands, and to the destruction of crops.

Drought will continue to be a primary concern for many African populations. The frequency of weather- and climate-related disasters has increased since the 1970s, and the Sahel and Southern Africa have become drier during the twentieth century. Water supplies and agricultural production will become even more severely diminished. By 2020, in some African countries agricultural yields could be reduced by as much as 50%. By the 2080s, the area of arid and semiarid land in Africa will likely increase by 5-8% (UNISDR, 2008).

**Socio-economic impacts**
Additional financial impacts of climate change are predicted to be related to agricultural inputs. Many chemicals used in agriculture are derived from oil, thus, increases in energy prices can also have major effects the types of crops that are grown, the costs of agricultural inputs, and the cost to transport these products. Food price increases are one of the most significant consequences of environmental change that impede food and nutrition security. Food prices are influenced by climate variability, extreme weather events, or major civil disturbances, among other factors (Godfray, 2010). For individuals or households that spend a high proportion of income on food, price spikes as a result of extreme events increase volatility of the global markets, and have adverse effects on their food intake and nutrition security. Food security and health are closely intertwined, and deviations from a healthy diet, for any reason or cause can lead to malnutrition and hunger.
Vulnerability

Africa is particularly vulnerable to the effects of climate change because of multiple stresses and low adaptive capacities, arising from endemic poverty, complex governance and institutional dimensions; limited access to capital, including markets, infrastructure and technology; ecosystem degradation; and complex disasters and conflicts (Boko et al., 2007; UNISDR, 2008). These in turn have contributed to Africa’s weak adaptive capacity, increasing the continent’s vulnerability to projected climate change. These changes are having a dramatic impact on food and nutrition security and health in Africa, and in particular, sub-Saharan Africa (NOAA, 2011; see also Boko et al., 2007; Oxfam International, 2010).

3.1.1. Climate change, shocks, seasonality and trends

Most countries in Africa and particularly sub-Saharan Africa have agriculturally dependent economies. The economies, livelihoods, and livelihood strategies of their populations are very closely linked to climate change. Thus, acute shocks, seasonality, and long-term trends in climate impact on a household’s access to assets and resources. As climate change evolves, seasonal stresses will force households and institutions to adapt their livelihood strategies and diversify their asset base to survive and thrive (DFID, 1999). Additionally, acute shocks, and climate change affect each of the three pillars (food-related, care-related, and health-related) to food and nutrition security.

Climate change is expected to make extreme weather events (droughts, floods, etc.) more frequent, more severe and more in predictable. In conjunction with others factors, climate-related disaster risks will increase, with subsequent impacts on undernutrition. For instance, in Ethiopia and Kenya, two of the world’s most drought-prone countries, studies have found that children aged five or less born during a drought are respectively 36 and 50 per cent more likely to be malnourished that children not born during a drought (Watkins K., 2007). In Niger, children aged two or less born in a drought year were 72 per cent more likely to be stunted (Watkins K., 2007). Data retrieved from the international disaster database ‘EMDAT’ suggest that the total number of African people affected by droughts or floods has been steadily increasing since throughout the past decades.

Table 1 | People Affected by Droughts and Floods in Africa throughout the 3 Past Decades

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Droughts</td>
<td>89,256,067</td>
<td>92,234,246</td>
<td>158,508,578</td>
</tr>
<tr>
<td>Floods</td>
<td>5,583,456</td>
<td>14,358,269</td>
<td>23,331,733</td>
</tr>
</tbody>
</table>

Climate change and nutrition in sub-Saharan Africa
There are some indications that seasonality is changing as well in Africa in the scientific literature (e.g. Boko et al., 2007). These changes can be either positive (increased precipitation) or negative (e.g. shorter rainy seasons). African farmers and herders extensively reported changes in seasonality, as illustrated in the Oxfam publication ‘What happens to the seasons?’ (2009).

Changes in seasonality influence livelihoods, food production, access to water, disease patterns, and ultimately the ‘seasonal peak’ of undernutrition. The importance of the linkages between seasonality and undernutrition is illustrated in the figure below.

**Figure 2 | Seasonality in Undernutrition, Malaria, And Rainfall in Niger (2007)**

![Seasonality Figure]

Source: ACF, 2008. Seasons of Hunger

### 3.1.2. Climate change and water in Africa

Water stress is widespread in Africa. Many nations share transboundary rivers and have high water interdependency. While some urban populations in southern Africa are achieving improved water access in recent years, 35 million people in the region are still using unimproved water sources (Boko et al., 2007). Additionally, when water is available, it is often of poor quality and contributes to a range of health problems, including diarrhea, intestinal worms, and trachoma. The lack of access to safe drinking water and sanitation overwhelmingly affects the health and feeding practices of women and children. Living in an unsafe environment contributes to food and nutrition insecurity, and climate change is likely going to further increase these negative consequences (Boko et al., 2007).

Water is a critical component of properly functioning ecosystems, particularly freshwater ecosystems including inland capture fisheries, aquaculture, and terrestrial ecosystems. Africa has a number of freshwater ecosystems that are used for harvesting local fish and shellfish. The future supply of water and increasingly, the future health of these ecosystems are going to be strongly influenced by climate...
change. Higher temperatures increase the rate of evaporation and transpiration of water from land and plants, leading to dryer soils that have a higher saline content, increased erosion and water run-off, and decreased water quality (Godfray, 2010). Poor soil quality is particularly damaging to crop yields and crop health.

To compound decreasing precipitation, water stress is occurring with the rapid use and depletion of aquifers—groundwater reserves. Shallow aquifers are a particular concern for agro-ecological zones as they are directly connected to surface hydrology and are often used for irrigation when surface water is low. To combat water stress, enhancing water efficiency in food production is a priority. Just 6 percent of Africa’s cultivated area is under irrigation, and in sub-Saharan Africa the figure is 4 percent. This compares to the global average of 18 percent (Svendsen et al., 2009).

Climate change will aggravate the water stress currently faced by some countries, while some countries that currently do not experience water stress will become at risk of water stress (very high confidence). Climate change and variability are likely to impose additional pressures on water availability, water accessibility and water demand in Africa. Even without climate change, several countries in Africa, particularly in northern Africa, will exceed the limits of their economically usable land-based water resources before 2025. About 25% of Africa’s population (about 200 million people) currently experience high water stress. The population at risk of increased water stress in Africa is projected to be between 75-250 million and 350-600 million people by the 2020s and 2050s, respectively (Boko et al., 2007).

Climate exerts significant effects on agricultural and water-resources sectors of Africa, and heavily influences food availability (Boko et al., 2007). Food production depends on water availability, utilization, infrastructure, and soil and land management. Water availability and infrastructure are strongly influenced by climate change. There is evidence all over Africa of inter-annual lake-level fluctuations and volatility since the 1960s. Even during floods or heavy rains, changes in runoff and hydrology as a result of climate have been observed in southern Africa, south-central Ethiopia, Kenya, Tanzania, and the wider continent, and are contributing to a decreased or stagnating food production (Boko et al., 2007).

Access to clean, safe drinking water affects sanitation and is affected by climate and precipitation change. Thus, climate and precipitation change is a key driver in the incidence of diarrheal disease, the spatiality of disease vectors, and the change in malaria and other infectious disease prevalence in East Africa (Boko et al., 2007).
3.1.3. Agro-ecological zones and threats to biodiversity

Like water, land and agro-ecological zones are under threat. For many centuries, humans could respond to an increasing demand for food by increasing the amount of land that was used for agriculture. This turnover of land is less of an option today as populations grow and continue to urbanize. Additionally, it is estimated that by 2100, parts of the Sahara are likely to emerge as the most vulnerable agro-ecological zones as desertification spreads. Mixed rain-fed semi-arid systems will be affected in the Sahel by climate change. Similarly, mixed rain-fed and highland perennial systems will be affected the Great Lakes region and in other parts of East Africa (Boko et al., 2007).

The FAO/IIASA Agro-Ecological Zones model shows further agricultural impacts such as changes in agricultural potential by the 2080s (Fischer et al., 2005). It is predicted that by the 2080s, there will be a significant decrease in suitable rain-fed land for cereals. The same projections also indicate that the arid and semi-arid land in Africa could increase by 5-8 percent, impacting wheat production and maize production enormously (Stige et al., 2006). South African agricultural impacts based on climate models indicate that crop net revenues will likely fall by as much as 90 percent by 2100 with small-scale farmers being most severely affected, and while adaptation may reduce some of these negative effects, other factors will likely continue to increase threats to agro-ecological zones as well as to biodiversity (Boko et al., 2007).

3.1.4. Climate change impacts on ecosystems

Changes in a variety of ecosystems are already being detected, particularly in southern African ecosystems, at a faster rate than anticipated. Climate change, interacting with human drivers such as deforestation and forest fires, are a threat to Africa’s forest ecosystems. Changes in grasslands and marine ecosystems are also noticeable. It is estimated that, by the 2080s, the proportion of arid and semi-arid lands in Africa is likely to increase by 5-8%. Climate variability and change could result in low-lying lands being inundated, with resultant impacts on coastal settlements. Climate variability and change, coupled with human-induced changes, may also affect ecosystems e.g., mangroves and coral reefs, with additional consequences for fisheries and tourism. The projection that sea-level rise could increase flooding, particularly on the coasts of eastern Africa, will have implications for health. Sea-level rise will probably increase the high socio-economic and physical vulnerability of coastal cities (Boko et al., 2007). Changes in ecosystems and environments will induce changes in livelihoods, food production, water resources, health-related risks, and ultimately on nutrition.
Today, as urban populations grow; more land is required for cities as well as for competing demands for non-food products such as wood and fibre. Land use changes including the encroachment of agriculture into natural habits threaten biodiversity. Mountain ecosystems appear to be undergoing significant changes, aspects of which are likely to be linked to complex climate-land interactions and which may continue under climate change (Boko et al., 2007). It is suggested that by 2020, the ice cap on Mount Kilimanjaro could disappear for the first time in 11,000 years.

Changes induced by climate change are likely to result in species range shifts and changes in tree productivity increasing stress on forest ecosystems. Grasslands, mangroves, and coral reefs are also all likely to also experience changes as a result of climate change. Based on these estimates, 10-15 percent of African mammals are expected to fall into the IUCN Critically Endangered or Extinct categories by 2050 and increase to 25-40 percent of species by 2080 (Boko et al., 2007). Agriculture can also negatively impact natural ecosystems by adding to pollution and agricultural wastes, decreasing soil integrity and fertility, thereby contributing to biodiversity loss (Godfray, 2010). Soil degradation is perhaps one of the biggest threats to biodiversity and food and nutrition security by threatening capability to grow food.

Conversely however, reforestation along with other agro-ecological protections have been noted as ways to help reduce the rise in greenhouse gas concentrations and climate change while improving natural ecosystems. Natural ecosystems increase biodiversity, protect vulnerable animals and their habitats, reduce soil erosion, increase carbon sequestration, and improve the nutrient content of soils. Natural ecosystems also regulate hydrological flows, help retain water, and help maintain healthy populations of pollinators and the natural enemies of weeds and pests—increasing yields in adjacent farmland which can help protect food and nutrition security.

3.1.5. Climate change acts in conjunction with others stresses and trends in Africa

The impacts of climate change are already having an effect on the lives and livelihoods of millions of individuals and households in Africa, particularly sub-Saharan Africa, home to some of the poorest and most food and nutrition insecure individuals in the world. To understand the impacts of climate change, it is important to have knowledge and trends on future population characteristics, demand, and vulnerabilities.

Population characteristics (background): Between now and 2050 it is expected that the population of Africa will more than double to approximately 2.2 billion people.
Climate change and nutrition in sub-Saharan Africa (UN Population Division, 2011). An increase in extreme climate conditions will affect agro-ecological zones, biodiversity, soil stability, and water availability throughout Africa and will ultimately threaten food and nutrition security in the world’s poorest nations including the countries in sub-Saharan Africa (Godfray, 2010; Trocaire, 2011).

It is expected that climate change will negatively impact on the livelihoods, assets, and coping strategies of the poorest African urban dwellers to an extent that has not been experienced yet. In fact, sub-Saharan Africa is the only region of the world that has become poorer in this generation.

3.1.6. Migration, environmental refugees and social conflict in Africa

Migration, climate change, and the environment are interrelated. Migration as a result of climate change may increase the likelihood of war as groups compete for limited resources in a changing environment. Such conflicts do not necessarily lead to violence; whether they do depends very much on the specific social and political context, and the policy responses undertaken (Cohen et al., 2011).

At the same time, war that leads to migration of refugees may damage the environment and their surrounding ecosystems (International Organization for Migration, IOM, 2011). Migration can be a coping mechanism and survival strategy for those who move. At the same time, migration, no matter the cause, can also have significant environmental repercussions for areas of origin, areas of destination, and the migratory routes in between and contribute to further environmental degradation.

Slow-onset disasters and gradual environmental degradation, including phenomena such as desertification, reduction of soil fertility, coastal erosion and sea-level rise, which may be associated with climate change, impact existing livelihood patterns and systems of production and may trigger different types of migration, conflict, and environmental degradation (IOM, 2011). Climate change has been estimated to have displaced over 20 million people, conflict has been estimated to have displaced over 4.6 million people. Each of these risk factors poses increased risk to subsequent climate and conflict interactions. Thus, climate change may contribute to increased wars, increased numbers of refugees, and increased competition for limited resources.

The UN projects that there will be up to 50 million people escaping the effect of environmental deterioration by 2010. The spectrum of associated health risks includes food and water emergencies, infectious, nutritional diseases, as well as mental health problems.
Environmental degradation is often associated with war and other forms of conflict. By increasing the scarcity of basic food and water resources, environmental degradation increases the likelihood of violent conflict (LEAD 2006). The Southern African Millennium Ecosystem Assessment suggests a bidirectional causal between ecological stress and social conflict: conflict may cause environmental degradation but the latter may also trigger conflict (Biggs et al. 2004).

In sub-Saharan Africa, where cropping and grazing are often practiced by different ethnic groups, the advance of crops into pasture land often results in conflict, as shown by major disturbances in the Senegal river basin between Mauritania and Senegal, and in North Eastern Kenya, between the Boran and the Somalis (Nori et al. 2005). According to UNEP, the conflict in Darfur has been driven in part by climate change and environmental degradation, which threaten to trigger a succession of new wars across Africa (UNEP, 2007).

The link to violent conflict has until very recently been largely unexplored. It is entirely plausible—though not predetermined—that violent conflict will emerge as the result of climatic shifts. One of the more likely and most discussed scenarios, is that conflict could emerge as a result of environmentally induced migration. Political refugees from violent regions are more likely to become involved in militant activities, although even this is not a foregone conclusion. Furthermore, conflicts in Chad were in part associated with environmental changes and to growing tensions in southern Africa fuelled by droughts and flooding.

### 3.2. Climate Change Impacts on Food and Nutrition Security

#### 3.2.1. Climate change and food security in Africa

Agricultural production and food security (including access to food) in many African countries and regions are likely to be severely compromised by climate change and climate variability. A number of countries in Africa already face semi-arid conditions that make agriculture challenging, and climate change will be likely to reduce the length of the growing season as well as force large regions of marginal agriculture out of production. Projected reductions in yield in some countries could be as much as 50% by 2020, and crop net revenues could fall by as much as 90% by 2100, with small-scale farmers being the most affected. This would adversely affect food security in the continent (Boko et al., 2007).

Small-holder agriculturalists are especially vulnerable to a range of social and environmental stressors. These may include: population increase driving fragmentation of landholding; environmental degradation stemming from population poverty, ill-defined property rights; regionalized and globalize markets
Climate change and regulatory regimes concerned with food quality issues; market failures interrupt input supply following withdrawal of government intervention; protectionist agricultural policies in developed countries, and continued declines and unpredictability in the world prices of many major agricultural commodities of developing countries. Health stressors such as the acquired immunodeficiency syndrome (AIDS) pandemic, particularly in Southern Africa, attacking agriculture through mass deaths of prime-age adults, which diverts labor resources to caring, erodes household assets, disrupts intergenerational transmission of agricultural knowledge, and reduces the capacity of agricultural service providers. State fragility, social and armed conflict in some regions (e.g. Ethiopia, Darfur) are further increasing reducing resilience of small holder agriculture to climate change.

Africa is vulnerable to a decline and instability in food production, both seasonally and long-term. As climate change progresses, many African countries experience increased drought and unstable climate conditions adversely affecting food production. Changing hydrology, decreased land productivity, a lack of economic inputs, and water stress account for the majority of the decrease in local production and supply channels in the local and international markets (as a result of global climate changes), and results in the reduced stability of the food supply (UNICEF, 2000).

Decreased precipitation and shortened growing seasons in the semi-arid regions of Africa are straining agriculture, making it more challenging, while at the same time decreasing the overall yield of food produced. Boko et al. (2007) project that reductions in crop yield in some sub-Saharan countries could be as much as 50 percent by 2020. Moreover, small-scale farmers who rely on subsistence farming are likely to be the most affected by these climate changes losing as much as 90 percent of their net revenues, their ability to provide food for their own consumption or purchase food on the market, and ultimately their food and nutrition security (Boko et al, 2007).

### 3.2.2. Climate change, undernutrition and nutrition

According to the IPCC AR4, if current trends continue, it is estimated that 200–600 million more people will suffer from hunger by 2080 (Yohe et al, 2007). Calorie availability in 2050 is likely to decline throughout the developing world resulting in an additional 24 million undernourished children, 21% more relative to a world with no climate change, almost half of which would be living in sub-Saharan Africa (Nelson et al, 2009; Parry et al, 2009). Figure 3.
3.2.3. **Climate change and impacts on household food access**

Price increases limit a household’s purchasing power, particularly for the many households in Africa who are subsistence farmers, have incomes equivalent to less than one dollar per day, and have very few other resources to access for food.

Agriculture is the main source of livelihood for the majority of people globally affected by HIV/AIDS. And agriculture as a sector is particularly threatened by the pandemic, given the implications of reduced labor power for the ability of affected households, particularly the poor, to feed themselves, and the rapid rate of attrition of agricultural extension capacity (RENEWAL 2006). Likewise, the consequent loss of livelihoods from drought is a major trigger of rural-to-urban migration, which may increase communicable disease and poor nutritional status from overcrowding, a lack of safe water, food, and shelter, and ability to access food (Confalonieri et al., 2007).

Climate change could add to water insecurity, and increase these women’s work levels, particularly in Africa and Asia (Parikh and Denton 2002). In areas threatened with drought and desertification in Africa, women’s increased domestic care responsibilities could significantly reduce their opportunities to engage in income-generating activities (Masika 2002) with negative implications for household food security (FAO, 2006).

3.2.4. **Climate change, Maternal and child care and feeding practices in Africa**

While climate change is expected to have major impacts on maternal and child care, mostly related to forced displacement, there are no data in the literature on the influence of climate change on maternal and child care and feeding practices.
Many of the world’s poorest people are women living in rural areas in developing countries who are currently dependent on subsistence agriculture to feed their families, and who are disproportionately affected by a lack of modern fuels and power sources for farming, household maintenance, and productive enterprises (Lambrou and Piana 2006).

Climate change could add to water insecurity, and increase women’s work levels, particularly in Africa (Parikh and Denton 2002). In areas threatened with drought and desertification in Africa, women’s increased domestic care responsibilities could significantly reduce their opportunities to engage in income-generating activities (Masika 2002) with negative implications for household food security (FAO, 2006).

Limited livelihoods opportunities and increased work levels will adversely affect health and nutrition security through a number of pathways: lack of access to clean drinking water and safe sanitation; lack of time for necessary caring practices, such as breastfeeding; and reduced access to and availability of food, due to inadequate agricultural water.

Climate change will increase the frequency and intensity of extreme weather events, with negative impacts on food security, especially in Africa. Among women, an expectation that they fulfill their roles and responsibilities as carers of their families often places extra burdens on them during extreme climate events. Natural disasters have been shown to result in increased mortality, domestic violence and post-traumatic stress disorders in women from poor countries.

3.2.5. Climate change and health in Africa

Human health, already compromised by a range of factors, could be further negatively impacted by climate change and climate variability, e.g., malaria in southern Africa and the East African highlands (high confidence). It is likely that climate change will alter the ecology of some disease vectors in Africa, and consequently the spatial and temporal transmission of such diseases. Most assessments of health have concentrated on malaria and there are still debates on the attribution of malaria resurgence in some African areas. The need exists to examine the vulnerabilities and impacts of future climate change on other infectious diseases such as dengue fever, meningitis and cholera, among others (Boko et al., 2007).

Drought affects health by diminishing dietary diversity and overall food consumption. This may lead to micronutrient deficiencies, and has been demonstrated to have a serious effect on anthropometric indices of the affected populations. Similarly, HIV/AIDS is amplified during drought as malnutrition
increases the risk of acquiring and of dying from an infectious disease. Within the context of people’s livelihoods, food insecurity and malnutrition stand out as key drivers of the spread of HIV and key mediators of the impacts of AIDS.

In the semi-arid sub-Saharan countries of Africa, the spatial distribution, intensity, seasonality, and transmission of infectious diseases from meningococcal meningitis to mosquito-borne diseases is affected by climate changes such as drought (Confalonieri et al., 2007). Climate plays an important part in the transmission and the timing of disease. During prolonged droughts, mosquito activity is reduced and the population of non-immune persons increases. When the rains return, there is a large proportion of susceptible individuals thus potentially increasing transmission. Drought events are also associated with dust storms, respiratory health problems, water scarcity, and water-washed diseases (Confalonieri et al., 2007).

High temperatures are demonstrated to increase the risk and prevalence of diarrhoeal diseases. Overall, studies have found a nearly linear increase in reported cases of foodborne diseases such as Salmonellosis with each degree increase in weekly or monthly temperature (ibid., 2007). Contact between food and pest species such as flies, rodents, and cockroaches is temperature sensitive. Warmer seas may increase harmful algal blooms, which produce toxins that can cause human disease such as human shellfish poisoning.

The climate-related changes in rainfall, surface water availability, and water quality could affect the prevalence of water-related disease. Water-related disease can be water-borne (ingested) or water-washed (caused by poor hygiene). Diarrheal diseases are one of the primary consequences of decreased water availability and quality. Furthermore, the effect of water scarcity on food availability and supply has major effects on malnutrition and health status as reductions in rainfall lead to low river flows, reducing effluent dilution and thus increasing pathogen load. Conversely, extreme rainfall/runoff events in conjunction with warmer temperatures may also serve to increase the total microbial load in watercourses and drinking-water reservoirs (ibid., 2007). Thus, climate change is likely to contribute to increased disease morbidity, increased malnutrition, and increased mortality.

Health stressors such as the acquired immunodeficiency syndrome (AIDS) pandemic, particularly in Southern Africa, attacking agriculture through mass deaths of prime-age adults, which diverts labor resources are caring, erodes household assets, disrupts intergenerational transmission of agricultural knowledge, and reduces the capacity of agricultural service providers. State fragility social and armed conflict in some regions (e.g. Ethiopia, Darfur) are further increasing reducing resilience of small holder agriculture to climate change.
4. Analysis of past, current, planned research conducted in Africa on adaptation and mitigation.

This section reviews the existing research and projects addressing at the impacts of climate change and variability on nutrition security and adaptation and mitigation interventions in Africa according to the elements described in the framework described in Figure 1. This framework combines livelihoods and food and nutrition security factors as affected by climate change.

4.1. Climate change adaptation and nutrition security

Human or societal adaptive capacity, identified as being low for Africa by the IPCC Third Assessment Report, is now better understood and this understanding is supported by several case studies of both current and future adaptation options. However, such advances in the science of adaptation to climate change and variability, including both contextual and outcome vulnerabilities to climate variability and climate change, show that these adaptations may be insufficient to cope with future changes of climate.

In terms of economic development, adaptation to climate variability is a requirement for future sustainability of agriculture and food security, and of health in sub-Saharan Africa. Adaptation to current climate variability can increase the resilience of countries to long-term climate change (Adger et al., 2007). Within adaptation, a number of strategies are used that fall within agriculture, food security and household access, nutrition security and agriculture, maternal and child feeding practices/health care access, and health, environmental, and water/sanitation services. Each of these sub-headings represents an adjustment or projects that individuals, groups, and countries are making to moderate harm from climate change.

4.1.1. Agriculture and food and nutrition security

Agriculture projects tend to involve major structural changes to agricultural practices to maximize yield under new conditions. This can involve the application of new technologies, new land management techniques, and water-use efficiency related techniques. Examples of these types of projects include:

- Seasonal changes and sowing dates.
- Planting of different varieties or species that are heartier against climate changes.
- Water and irrigation system changes.
- Fertilizer, tillage, grain drying, and other input alterations.
- Promotion of agroforestry, and adaptive management with suitable species and silvicultural practices (FAO, 2005).

**Agroforestry, agriculture diversification and nutrition/food security Example:**
The Benin Agricultural Productivity and Diversification Project (PADA). This project is designed to restore and improve the productivity of value chains. There are 4 components to this project: 1) Adopt improved technologies and restore productivity to enhance food security and export-oriented value chains (aquaculture, maize, rice, cashew, and pineapple). 2) Develop/rehabilitate irrigation and market infrastructure to improve productivity and reduce variability. 3) Coordinate value chain and agricultural financing to improve access to financial services. 4) Coordinate sector program and project management to strengthen capacity of the Ministry of Agriculture, Livestock and Fishery (MAEP) to coordinate the sector program (PADA) and to manage and monitor the project.

**Microinsurance in Ethiopia Example**
The Horn of Africa Risk Transfer for Adaptation (HARITA). This project brings together Oxfam America, Ethiopian farmers, the global reinsurance company Swiss Re, the Relief Society of Tigray (REST), the International Research Institute for Climate and Society at Columbia University, Nyala Insurance, the Ethiopian Federal Ministry of Agriculture and Rural Development, and several other organizations. It contributes to resiliency for smallholder farmers based on a combination of agroecological farming technologies, drought insurance, and credit. The scheme reaches the poorest farming families in Adi Ha, Tigray Region, through a premium-for-assets program supported by the United Nations World Food Program (WFP) and the Ministry’s Productive Safety Net Program. This scheme monetizes the risk-reducing labor of poor farmers into their premiums. Farmers participated in a community-wide vulnerability and capacity assessment and identified lack of rainfall and droughts as the primary hazards to their well-being. They now apply resilience-building and agricultural risk-reducing solutions such as composting, water harvesting, seed washing, and tree and grass planting. Less-poor farmers who do not qualify for the premium-for-work program can pay cash premiums. Payouts are based on indexed meteorological indicators. In December 2010, Oxfam and WFP announced a five-year, $28 million partnership to scale this model up in other developing countries.

Agrobiodiversity increases the resilience of crops to changing environmental conditions and stresses. Genetically-diverse populations and species-rich ecosystems
have greater potential to adapt to climate change (FAO, 2007). The selection of crops, cultivars, and wildlife with tolerance to abiotic stresses such as high temperature, drought, blooding, high soil salinity, pest and disease resistance, increases nutrition security by maximizing growth yields of crops and animal products that are suited to their specific environment while maintaining biodiversity. By increasing the types of resilient crops, the nutrition and livelihoods of millions of people are better maintained. Examples of these types of projects include:

- Resource (forest/land) management.
- Seed systems support/management.
- Agriculture/rehabilitation projects.
- Wildlife/oceanic rehabilitation and biodiversity projects.

**Nutrition Security and Agriculture example:**

Moringa Trees in Senegal are designed to increase biodiversity and the resilience of crops throughout Senegal. Moringa trees are drought-resistant and tolerate a variety of soil types. The use of moringa trees increases nutrition security because they can be cut and regrow, they can be produced within small backyard or rooftop gardens. They also provide a rich source of vitamins A, C, B-complex, and E in addition to iron, Calcium, potassium, magnesium, and selenium. Finally, the leaves contain an essential amino acid, making them a rare commodity among the legume family. Finally Moringa trees help to fertilize the soils around them, helping with land management, and increasing crop output.

### 4.1.2. Food household access

Food household access projects tend to involve structural changes to increase a household’s access to income, to foodstuffs via market price regulations, subsidies, or cash-transfers, and increase a household’s access to food distribution. Food distribution often occurs in schools, via cash-vouchers, or in camp-situations for refugees or migrants. Similarly, increasing agriculture productivity as described above increases household food access and household security through an increased supply of food and better food prices. Examples of these types of projects include:

- Recovery and relief programs.
- Food-support projects.
- Livelihood support programs.
- Projects that focus on social services.
**Household food security example:**

Burkina Faso’s Food Security and Nutrition Project is designed to 1) reduce the government’s response time to react to national food crisis, 2) improve the targeting of food security programs for low income groups in drought-prone provinces 3) provide a database for rational decision-making on food security and nutritional issues 4) provide an institutional focal point within the Ministry of Agriculture and Livestock (MOAL) for food security management with an integrated early warning system, income earning opportunities during the dry season, and by targeting nutrition information, education, and communication campaigns for behavioral changes in child weaning and feeding.

### 4.1.3. Maternal and child care access and feeding practices

Maternal and child feeding practices care access are important adaptation practices as they increase resilience of individuals to climate-induced agricultural changes. Maternal and child feeding practices include increased access to food, often through some of the strategies mentioned above for household access. Health care access is increasingly important during child malnutrition related to climate-induced migration. Projects that focus on enhancing feeding practices and health care access alongside household access include:

- Programs related to maternal education, child education, and health and social services. This includes safety-net programs.
- Programs related to school feeding and take-home rations.
- Health sector support for AIDS, Malaria, measles, and other nutritionally-associated diseases.

**Maternal and Child care, nutrition and food security and child health Example:**

Senegal’s Rapid response child-focused social cash transfer and nutrition security project: The goal of this project is to reduce the risk of nutrition insecurity in vulnerable populations—children under 5—in poor rural and urban areas of Senegal. The project has four components. The first three focus on protection and promotion of nutrition security of mothers and young children by scaling up and intensifying the existing package of community-based nutrition, health services, and activities. The fourth component, the child-focused social cash transfer, is a rapid response mechanism to mitigate the adverse effects of high food prices on young children in vulnerable families.
4.1.4. **Health, environmental, water/sanitation services**

When managed carefully, climate adaptation strategies may have environmental benefits for some countries. Health, environmental, water/sanitation services include changing land topography, using artificial systems to improve water use/availability, protection against soil erosion, changing farming systems, the timing of farm operations, governmental and institutional policies and programs, and research into new technologies all of which involve some form of resource management. The FAO, for example gives priority to ecosystem approaches to fisheries which address environmental impacts to manage fishery resources and their ecosystems. Other types of projects include:

- Water sanitation and rural infrastructure projects.
- Flooding, environmental, and resources management.
- Sustainable agro-pastoral and land management programs.

### Health, environmental, water/sanitation services Example:
Morocco’s Irrigation Based Community Development project: The goal of this project is to improve the incomes and the quality of life of rural communities that are centered on small and medium irrigation. This project rehabilitates, improves, and complements community infrastructure, water supplies and sanitation, and health and education facilities to benefit the community. This is a project most geared towards water sanitation and rural infrastructure.

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4.2. **Climate change mitigation and nutrition security**

To achieve climate change mitigation, “technological change and substitutions that reduce resource inputs and emissions per unit of output [in addition to] implementing policies to reduce GHG emissions and enhance [carbon] sinks” are critical (UNFCCC, 2010). Mitigation tackles the causes of climate change, and aims to reduce or minimize the negative impacts and maximize any benefits from future climate change. Climate change policies are critical to sustainable development which can reduce GHG emissions and reduce vulnerability to climate change (Rogner et al., 2007).

Mitigation is ultimately designed to stabilize GHG concentrations to prevent anthropogenic interference with the climate system. Rogner et al. (2007) propose that global warming of more than one degree centigrade, relative to 2000, would constitute dangerous climate change and would likely have negative effects on sea level and would exterminate some species. The IPCC references the Stern Review’s
findings that to minimize the most harmful consequences of climate change, concentrations would need to be stabilized below 550ppm and that any delay in reducing these emissions is costly and dangerous. In order to prevent the deleterious effects of high GHG concentrations in the atmosphere, a number of mitigation strategies have been proposed.

### 4.2.1. Mitigation strategies

Most mitigation strategies involve links between sustainable development and actions/policies to reduce CO2 emissions or absorb CO2 already in the atmosphere. Mitigation that limits climate change can conserve or enhance natural capital (ecosystems and the environment) as sources and sinks for economic activities that prevent or avoid damage to humans systems (Rogner et al., 2007). Similarly, sustainable development paths can reduce vulnerability to climate change and reduce GHG emissions through enhanced technology. Additional strategies are outlined below.

- Reducing CO2 emissions with improved agriculture technologies.
- Increasing the number of carbon sinks.
- Planting of trees and other green-house gas absorbers.
- Development of renewable and alternative energy supplies.

**Mitigation Example:**

Democratic Republic of Congo’s carbon sequestration and rural alternative energy in the Tshilenge Swannah, Kasal Oriental project: The goal of this project is to create carbon skinks to revalue the marginal soils, provide renewable energy sources, and to create economic activities for the local population. This is an example of sustainable development. This project also supports food production by using residuals from oil extraction as organic fertilizer to be added to soil and applied to maize and other vegetables. These actions not only provide foodstuffs, but also provides alternative domestic energy sources while contributing to CO2 mitigation.

### 5. Conclusion and recommendations

#### 5.1. Research Gaps

Whereas there is an understanding of some causal pathways leading to undernutrition, but no single study analyzes the impacts, threats and vulnerability of climate change in Africa in cross-sectoral manner.
Some sectoral issues that shape nutrition security are overlooked, so is their interplay with undernutrition in the context of climate change.

Consistent prediction models are missing regarding undernutrition in a changing climate context in Africa.

Very few nutrition surveillance systems monitor climate-related factors in Africa e.g.; climate-related seasonality and increased cases of undernutrition as a consequence of climate-related shocks.

There is a need to identify and analyze coping strategies for the most vulnerable in sub-Saharan Africa to mitigate the effects of climate change shocks and their effects on nutritional status.

5.2. Research Needs on Climate Change and Food and Nutrition Impacts, Vulnerability, Adaptation and Mitigation in Africa

Several areas of basic and applied research are suggested to better understand and address the impacts and threats of climate change on food and nutrition security in Africa:

**Analyse food and nutrition security in a multi-sectoral, comprehensive manner**

Although the links between climate change and undernutrition have been increasingly examined recently, most analyses consider isolated pathways such as those of food insecurity, health or water. Comprehensive analyses of observed and predicted climate change-related vulnerabilities and food and nutrition security are non-existent in Africa. There is an understanding of some causal pathways leading to undernutrition, but no single study offers a comprehensive analysis of the climate change-nutrition security linkages. It is essential to develop such analyses and the required tools in African rural, peri-urban and urban areas, and in different representative ecosystems and socio-economic contexts. It is particularly important to analyse which regions and populations are particularly vulnerable to climate-related hazards (climate-related shocks; seasonality; trends and gradual changes) and why, and which local coping and adaptation strategies are successful. It will also be necessary to consider how the effects of climate change interact with and exacerbate other phenomena that have major implications for food and nutrition security, such as population growth, HIV/AIDS, food and fuel price volatility, poor governance, conflict, gender discrimination, and adverse global economic arrangements.
Study specific overlooked sectoral issues and their interplay with undernutrition/nutrition in the context of climate change

Whereas the analysis of nutrition security requires a multi-sectoral analysis, specific causal pathways leading to undernutrition in a changing climate are overlooked, i.e. the impacts of climate change on food quality and the crop micro-nutrients contents, on dietary diversity and on maternal and child care and feeding practices; the interlinks between child health status, diseases (particularly water-related diseases) and undernutrition; or the impacts of climate change on the body's nutrient requirements.

Provide consistent prediction model and data of undernutrition (wasting, stunting, underweight) in a changing climate continent

It is urgent to develop consistent and realistic models to predict the future impacts of climate change on undernutrition (wasting, stunting, and underweight) under different scenarios. Studies should provide data and information for the attribution of current and future climate change and variability to undernutrition under different scenarios.

Monitor the interplay between climate-related hazards (i.e. climate-related shocks, seasonality and trends) and food and nutrition security, and develop tailored early warning systems

Climate scientists and researchers should support the food and nutrition security stakeholders in setting up and/or strengthening nutrition early warning and surveillance systems, integrating (further) the climate dimension. Climate monitoring systems (at various time scales, e.g. seasonal, inter-annual, longer-term) can be better linked to existing food and nutrition security monitoring systems and early warning systems. Enhancing comprehensive early warning systems linked with early food and nutrition security responses mechanisms – particularly in face of climate-related shocks and seasonal hardships – deserve particular attention. It is also important to enhance the capacity of African decision makers to respond to information generated by early warning systems.

Identify effective adaptation actions for food and nutrition security under a changing climate

A knowledge base capitalizing on lessons learnt through experience is necessary to inform future programming on climate change and nutrition, along with the identification, validation and costing (i.e. using cost-benefit analyses) of the set of interventions required to protect nutrition from climate-related hazards and climate change. The development of a response framework for use at multiple levels and
different scales for ensuring resilience to climate change and other shocks and food and nutrition security at community and household level is also needed. This response framework should be multi-sectoral and nutrition-sensitive, i.e. identified risk management and adaptation actions have a greater impact in terms of preventing / reducing undernutrition. Ideally this response framework should be adjusted to areas affected by conflict and protracted crises. This response framework should particularly consider the needs of young children and women, since they are the most vulnerable to both hunger and undernutrition and climate change impacts and threats, without neglecting the needs of other groups (adolescents, elderly people).

**Analyse and monitor the synergy opportunities and the threats of climate change mitigation measures on food and nutrition security**

The analysis and monitoring of synergy opportunities and the threats of climate change mitigation measures on food and nutrition security deserve the attention of scientists and researchers. Suggestions to minimise or avoid such harmful effects of climate change mitigation measures on food and nutrition security are required.

**Identify how to strengthen institutional capacity and the policy framework in Africa**

It is essential to identify and analyse how climate change work can be better aligned with current agendas, initiatives and policies which aim to reduce hunger and undernutrition at the various level; how to strengthen institutional capacity and the policy framework (e.g. preparedness, horizontal and vertical integration, bottom-up processes, strengthening policies, etc.) and how to ensure policy coherence between food and nutrition security, adaptation and mitigation objectives.

Regional and research institutions in Africa should incorporate climate change analysis in their programs. The Africa Union Commission and Regional Academies of Science should lead in this effort by coordinating the development of policies for the mitigation of the effects of climate change for adoption by countries. Academies of Sciences can be “think tanks” that provide advice and support to governments on the management of the effects of climate change. Conferences on climate change and nutrition organized under the auspices of professional scientific associations and regional academies of sciences will keep the focus on the problem.

Regional Centers for the study of Climate change impact and analysis must be created within the Sub Saharan Africa region for building the capacity of Africans and for sustaining research on climate change issues. Universities should develop programs and courses to introduce and sensitize students on climate change issues.
Climate change analysis should factor into the design, implementation, and evaluation of all food and nutrition security projects and research programs.

The participation of African experts and researchers on the work of the Intergovernmental Panel of Climate Change (IPCC) should be encouraged and facilitated.

6. References


Annex 1 - Key terms used

HUNGER AND UNDERNUTRITION

Malnutrition is a broad term that refers to all forms of poor nutrition. Malnutrition is caused by a complex array of factors including dietary inadequacy (deficiencies, excesses or imbalances in macronutrients –carbohydrates, protein, fats– and micronutrients), infections and socio-cultural factors. Malnutrition includes undernutrition as well as overweight and obesity (Shekar M, 2009; UNSCN, 2010; SUN, 2010).

Hunger is a term which literally describes a feeling of discomfort from not eating, and which has also been used to describe undernutrition, especially in reference to food insecurity (Black et al, 2008).

Undernutrition exists when insufficient food intake, repeated infections and poor care practices result in one or more of the following: underweight for age, short for age (stunted), thin for height (wasted), and functionally deficient in vitamins and/or minerals (micronutrient malnutrition) (based on UNSCN, 2010).

Stunting reflects shortness-for-age; an indicator of growth retardation and calculated by comparing the height-for-age of a child with a reference population of well-nourished and healthy children (SUN, 2010).

Wasting reflects a recent and severe process that has led to substantial weight loss, usually associated with food shortages, disease, inappropriate child-caring or feeding practices or a combination of such factors. Wasting is calculated by comparing weight-for-height of a child with a reference population of well-nourished and healthy children. Wasted children are very susceptible to infections and death. It is often used to assess the severity of emergencies because it is strongly related to mortality.

Food security 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; household food security is the application of this concept to the family level, with individuals within households as the focus of concern (FAO, 2002; FAO, 2009; UNSCN, 2010).
Nutrition security exists when food security is coupled with a sanitary environment, adequate health services, and proper care and feeding practices to ensure a healthy life for all household members (Shekar M, 2009; UNSCN, 2010; SUN, 2010).

Figure 4 | The overlapping concepts of hunger, food insecurity and undernutrition

‘Shocks’ are defined here as ‘sudden events such as floods, epidemics, droughts, but also wars, persecution and civil violence’, and ‘stresses’ are defined as ‘pressures which are cumulative and continuous, such as seasonal shortages and climate variability, soil degradation, population pressure’ (Chambers and Conway, 1991).

CLIMATE CHANGE

Climate change refers to any change in climate over time (decades or longer), whether due to natural processes or as a result of human activity. This definition is in line with the IPCC (the UNFCCC only considers the changes in climate only as a result of human activity).

Climate variability denotes deviations of climate statistics (mean state, standard deviations, the occurrence of extremes, etc.) over a given period of time, such as a specific month, season or year, compared to the long-term climate statistics relating to the corresponding calendar period. Examples of climate variability include the fluctuations that occur from year to year, the statistics of extreme conditions such as severe storms or unusually hot seasons, and conditions that result from periodic El Niño and La Niña events. As a result of climate change, climate variability is expected to increase in most locations.

Vulnerability is the degree to which people, communities and the systems on which they depend are susceptible to, and unable to cope and adapt when exposed to climate change. Resilience can be seen as the opposite of vulnerability.
Resilience is the degree to which people, communities and the systems on which they depend are persistent to, and able to adapt when exposed to climate change. Adaptive capacity is the capacity of people and communities – using available knowledge, skills, resources, information, technology, services and institutions – to cope with climate-related hazards and adapt to climate change, i.e. to anticipate and prepare for the hazard(s); to prevent or moderate the adverse effects of the hazard(s); to respond to and quickly recover from any adverse effect of the hazard(s); to adapt to stress and change and to take advantage of eventual opportunities, while maintaining or improving their situations and ways of functioning as compared to before the hazard(s) occurred.

Climate change adaptation refers to actions, measures and processes taken by people, communities and institutions which might ultimately reduce vulnerabilities, build resilience and enhance adaptive capacities to actual or expected changes in climate and their effects, within the broad context of sustainable development.

Climate change mitigation it refers to actions, measures and processes taken to reduce the sources of or enhance the sinks of greenhouse gases.
1. Nutrition, trade and agriculture: ‘quick fixes’ vs. underlying factors

Any expert on nutrition knows the secrets against, say, the epidemic of child stunting: well-nourished and empowered mothers; health support for mother and child during delivery and beyond; breastfeeding; nutritious complementary foods in adequate quantities and frequency; and access to safe water and sanitation.

Yet millions of Africans are denied these basic ingredients, partly because their fulfillment falls beyond even the most far-reaching nutrition policies: maternal and child nutrition depends on the education and income of their families; on the availability of adequate health facilities; or the food self-sufficiency of the communities and countries they live in. Health services have to be built and nurtured through the tariffs and taxes that sustain public spending. Farmers deserve enabling market environments to produce their food and sell it in national or international markets. High-quality institutions must reflect the will and interests of individuals and communities through proper participation schemes.

In a sense, this is a dilemma between the ‘quick fixes’ of direct nutrition policies and the need to address the underlying factors of hunger through more comprehensive policies. If the former includes vitamins supplementation, food fortification or specially formulated products for vulnerable groups (Hawkes and Ruel 2011), the latter will try to reduce the risks that threaten vulnerable communities and reinforce their resilience against them. (Figure 1 below describes in an oversimplified way the different links that exist between nutrition and the underlying factors such as trade and agricultural policies). As the FAO puts it, “Poor diets and disease are often the result of insufficient household food security, inappropriate care and feeding practices, and inadequate health care” (FAO 1997). Any sustainable strategy against hunger has to guarantee adequate levels of all three factors.
Unfortunately, a combination of aggressive global warming, unfair international trade rules and inadequate policies at the national level is magnifying the food and nutrition vulnerability of African poor communities, particularly in the rural sector. After the food prices’ spikes of the last decade, the continent faces the challenge of multiplying its agricultural yields while being the battlefield of a new global scramble for productive natural resources such as land and water. The risk of status quo can be grasped through a couple of recent research papers that look at food security in Africa in 2030: staple food crops such as wheat, rice or maize doubling or even tripling its current prices; families in Eastern Africa spending as much as half of their total income on food; maize producers obtaining a 20% less in their yields due to climate change and poor investment; an extra 9 million children affected by malnutrition. (Willenbockel 2011) (IFPRI 2010) The responses to each of these challenges will require a multidisciplinary approach that includes the community of nutritionists.

This paper will briefly address some the main factors linking trade and agricultural policies with the levels of food security and nutrition in Africa, suggesting potential areas of interest for nutritionists’ research in this regard. Section 2 after this introduction outlines the three main drivers that link trade and agriculture with nutrition. A final box at the end of this section contains an illustration of these problems in the West Africa region. Finally, section 3 contains 5 specific proposals to the nutritionists’ community for further research in these areas.

Figure 1 | The links between trade and nutrition (based on Ruel and Hodinott 2008)
2. The links between trade & agricultural policies and the nutritional status of African populations

Trade and agricultural policies play a key role in determining the underlying environment of households and states, therefore influencing food security and nutrition levels. This happens in three main ways:

- they affect the income and spending capacity of households and states;
- they are largely responsible for availability of food, both in terms of quantity and quality;
- and they are a determinant driver of the volatility of food markets and agricultural production

Each of these factors is explained below. In each case we will briefly address the links with nutrition, the nature of the problem and how the future looks like. The final section will explain what could nutrition researchers do about it.

2.1. The role of trade in determining the income of households and states and promoting the redistribution of its benefits:

2.1.1. What is the link?

Trade can be a powerful engine for gross income generation as well as an effective tool for income redistribution to the poorest sectors of society. The nutritional intake and status of individuals and households is both an effect and a cause of income-earning and employment opportunities. They determine the quantity and the quality of the food that is consumed, as well as the relative importance of food in the overall household budget. This is a critical factor in poor households where food is by far the main spending item and is likely to remain so in the two coming decades (see Willenbockel 2011). Nutrition levels, in turn, have a direct influence on the income capacity of individuals, since they influence the productivity of workers and students (Islam 1997). Finally, developing countries’ States highly depend on trade flows to guarantee the public income that will finance the support programs and social protection that can sustain nutritional policies.
2.1.2. **What is the problem?**

a) **The potential of trade for Africa’s development is still to be unleashed:** Due to their high dependence of trade as a source of revenue, African economies have joined a number of global, regional and bilateral trade agreements (most notably, the WTO’s Agreement on Agriculture). However, it has been argued that the architecture of the agreements at the WTO is more demanding for the poorest economies, since they limit their possibilities to protect their vulnerable sectors through tariffs or subsidies but allow considerable margins for rich countries’ protectionist policies (IFPRI 2003). This happens in three distinct ways:

- Subsidies in OECD countries (particularly in the EU and the USA) have lowered world prices of temperate agricultural commodities and provoked price instability globally. According to the latest OECD statistics, overall support from rich countries to their producers was 227 billion.1

- Increasingly selective tariff and non-tariff barriers (such as arbitrarily tight sanitary requirements) have restricted opportunities in Northern and third markets. (Laborde 2008)

- Dumping and restricted opportunities have had negative effects on domestic markets, pushing down prices and forcing local farmers to find something else to sell or simply go out of business. Tied food aid (from the US, mainly) has been one of drivers of dumping. (Barret and Maxwell 2008)

b) **Poor countries lack the necessary policy space to optimize the development benefits of increased trade:** There is no ‘one-size-fits-all’ approach to trade liberalization. The most successful experiences used a paced insertion strategy in world markets that combined increased exports and a slow liberalization of sensitive economic sectors with investment in labour-intensive sectors and social measures to tackle income inequality. In other words, a controlled process where public intervention could protect the most vulnerable sectors and establish the basis for long-term growth. (Chang 2002). East Asia has been particularly successful in this strategy, but a few African countries such as Mauritius have also followed this path.

But this was the exception to the rule. In Africa, regional and multilateral trade agreements have tied the hands of Governments whose countries had already gone through long-term, IMF-led adjustment programs that

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unilaterally disarmed their economies. This has considerably reduced their legal capacity to intervene in the interest of recent research after 2008 food crisis shows that while various economic sectors were expeditiously rescued by the EU and US, African governments were not only out of economic resources to sustain the affected population, but also had their hands tied to intervene through the use of tariffs and other trade tools. (FAO 2008)

c) National policies not always play their role in the distribution of benefits and opportunities: Even within their narrow financial and policy margins, public authorities in developing countries can establish the difference in the development impact of trade and agriculture. In Vietnam, for instance, the link between small-farming and markets was a key component of a twofold success: reducing poverty and enhancing food security. After the economic reforms known as doi moi (1986), investment in family farming and rural social services increased Vietnam’s agricultural productivity by an average 5 per cent during the 1990s. In less than 15 years, Vietnam transited from being small importer of rice to being the second largest world exporter, including a dramatic drop in malnutrition levels (Oxfam 2002).

But, in the midst of the difficult international environment we have just described, African governments are often an aggravation of the problem, rather than the contrary. Governments concentrate their trade infrastructure and agricultural investment in large farms and corporate conglomerates at the expense of small farmers and poor consumers, as the West Africa case below shows. The few trading opportunities are concentrated in national elites spoiling the public benefits of trade.

Moreover, they have also neglected the introduction of policies to promote basic social protection and the inclusion of the rural poor. These have been critical in the success of countries such as Brazil against hunger and malnutrition: The so called Bolsa Familia (a conditional cash transfer program that combined education, primary health and investment in family farming) was instrumental to reduce hunger prevalence by a half in only five years.

2.1.3. What does the future look like?

We can expect few opportunities from the trade negotiating arena in the coming years. The multilateral negotiating process at the WTO that is currently in a stalemate and no immediate improvements are in sight. The one exception will be the EU’s discussion on the future of the Common Agricultural Policy, which will take place in
the coming months; a reform in the right direction could help to reduce distortions in world markets and ease the chances for new agreements at the WTO.

So the real opportunities are at the national and regional level, where governments can fight to determine the orientation of their trade and agricultural policies and intervene to guarantee the protection of vulnerable producers and consumers. The potential role of national public authorities was apparent during the recent food prices’ crisis, when an array of different responses was taken in order to reduce the food and nutrition impact of prices’ shock: establishing social protection mechanisms, protecting family farmers through certain exceptional trade measures, establishing food reserves or refining food aid mechanisms. Some of these elements have an important nutritional perspective and we will come back to them in the research proposals of final section of the report.

2.2. Trade and agriculture can determine the availability and the quality of food

2.2.1. What is the link?

The future of global food production will be determined by a complex combination of demographics, climate and scarcity. In order to ensure that the future world population can count on sufficient and nutritious food to eat, governments and international institutions will be required to act and reduce the risks of this cocktail increasing the resilience of poor producers and consumers and guaranteeing fair shares for all. Trade and agricultural policies play a crucial role in this regard, since they determine what is produced, how and by whom. Since 80% of those who are now affected by undernutrition live in rural areas, the fate of vulnerable agricultural producers is critical in this regard.

2.2.2. What is the problem?

a) Increased demand of food and increasingly scarce productive resources:

According to the UN, global population will surpass the 9 billion by 2050 (FAO 2009), maybe even more at the end of the century. Part of these increases will take place in emerging economies where average diets are shifting from grain to meat, fish and vegetables, therefore increasing the ecological footprint of production. In the meantime, the proportion of land dedicated to agriculture has recently peaked and the average annual yields’ growth has

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halved in the last decade (due to a combination of global warming and insufficient investment).  

b) With prices breaking records month after month, Africa has become the battlefield of a global scramble for natural resources, with international investors disputing the best productive resources in order to guarantee their future provisions or a simple business opportunity. The International Land Coalition has calculated that over 80 million hectares of land have been sold since 2000 –most of them in Africa and in the last four years. (Oxfam 2011)

c) This massive land and water-grabbing is possible thanks to the absent or weak regulation of international investment and the open complicity of national governments, posing fundamental obstacles to the fight against hunger and malnutrition in Africa. Poor communities are expelled from the best lands or cheated in these agreements, threatening their vulnerable food-security. But, even as importantly, it is calculated that around 80% of the acquired land remains unproductive, their buyers waiting for the best business opportunity to produce or sell. (World Bank 2010).

d) The market power of different actors is unbalanced, exacerbating the food vulnerability of poor rural consumers and producers: Three large companies control 90% of all grain traded in the world (Giminez and Patel 2009) and four companies dominate over 50% of the global seeds market. Corporate concentration at the production, processing, trading and retailing phases determines who and how enters the market and can provoke an unfair distribution of risks and benefits. This has a direct effect on the access of poor rural populations to nutritious food, but also on other nutrition-related aspects such as the quality of water or the labor and health conditions. Governments can intervene to regulate the participation of companies in the common benefit. In an increasingly interrelated food market, poor producers and consumers are the weak link in global value chains.

2.2.3. What does the future look like?

The context we have described suggests that Africa is already facing the challenge of a true productive revolution that increases yields and production within the limits of ecological sustainability. There are around 33 million small agricultural producers in Africa, operating on farms with an average size of 1.6 has. (Oxfam 2011)

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While large-scale farming models have a role to play in the increasingly sophisticated global value chains and the creation of employment opportunities in Africa, there’s no possibility to transplant these models without a massive displacement of poor rural families to the slums of large cities. African family agriculture will then require massive investment in the coming years, as well as sound regulatory trade and investment frameworks that protect the common interest and the sustainability of food security.

From the nutritionists’ perspective, two of the key questions to be answered are: (a) how to guarantee the food and nutritional needs of the population through a proper balance between household and market-oriented productions; and (b) what is the impact of this new massive land-grabbing phenomenon in the nutritional levels of affected population. We will come back to these at the end of the paper.

2.3. Trade can moderate or exacerbate the volatility of food prices and the instability of agricultural markets

2.3.1. What is the link?

After more than three decades of depressed prices, global agriculture has entered a new phase of higher average prices and increased volatility. The extreme manifestation of this phenomenon took place in 2007-08 and 2010, when the spike in global food prices increased the food bill by a half in most developing countries and boosted the global number of poor people by more than 100 million, spreading food fragility across the globe:

- Across the world, food security in poor communities was severely damaged. Small farmers and traders were crowded out of the market, incapable of maintaining their businesses or their productive capital (a small piece of land or a handful of animals) in the light of increasing food prices.

- For regions like Eastern or Central Africa, where over half of the total household income is spent on food, the effects of price volatility are simply devastating. (Willenbockel 2011)

- Today, at least 35 of the so-called Net Food Importing Countries are in Africa (World Bank 2008). In an era of highly volatile markets, extreme agricultural import dependence has proved to be very dangerous for vulnerable African economies.
2.3.2. What is the problem?

The recent crises have unravelled a system that is out of control. While structural factors such as the ones mentioned above (climate and demographics) have played an important role in the long-term increase of prices, this crisis was artificially magnified by a number of factors in the trade and financial arena:

✓ The USA and the EU have insisted on their dangerous energy policies, which reduce the overall supply of staple foods (such as corn or palm oil) by diverting crops into the production of biofuels. According to the Financial Times, 40% of the total US corn production (the biggest in the world) was devoted to bio-ethanol production in 2010.5

✓ Key exporters such as Argentina, India or Russia contributed to reduce the global demand through a series of export restrictions that triggered panic and created a vicious circle of price increases and scarcity. Leading players at the WTO have made no meaningful effort to discipline the chaos of unilateral export restrictions, either at the multilateral or at the the regional trade forums.

✓ The free ride in food markets’ financial speculation (which has increased by 24-fold between 2003 and 2008) is believed to have increase prices’ volatility, although its role in the longer-term trend is not yet clear. (Kaufman 2010)

Rice is a powerful example of these market vagaries. The market fundamentals of this food staple crop were strong in 2007, ready to satisfy an increasing demand and apparently isolated from the speculative movements that were affecting the food markets. But a series of completely uncoordinated market interventions from governments, banning their rice export operations or eliminating any restriction to import it, created a snow ball that sent the prices to historical levels (Minot et al 2011). The scarcity of rice as a basic staple food has been identified as one of the drivers behind the massive increase of hunger levels after the 2007-08 prices’ spike.

2.3.3. What does the future look like?

The structural factors behind the increase in prices (demographics and climate) are likely to intensify in the coming decades. However, this is not necessarily true for the induced ones (energy policies, export restrictions and speculation). Should governments and international institutions act to avoid it, extreme volatile prices are

5 http://www.ft.com/cms/s/0/a2aa510a-1e89-11e0-87d2-00144feab49a.html#axzz1CFL7EY1
not necessarily here to stay. From the trade and agricultural perspective, solutions must consider innovative forms of old market instruments, such as physical or even virtual food reserves and renewed food aid mechanisms. Such instruments would help to reduce the risks associated to low buffer stocks (Wiggins and Keats 2010). The World Food Program’s Purchase for Progress (P4P) initiative—which has been successfully implemented in countries like Burkina Faso, Ethiopia or Mali—constitutes an interesting example in this regard.

Box 1. The case of West Africa

By 2010, over 10 million West Africans had been directly affected by the food crisis (Oxfam and Enda 2010), which was directly related with the spike in prices: Ghana and Niger experienced record increases in the prices of rice (25% and 35%, respectively), while in Ivory Coast, Senegal and Nigeria the price of wheat and maize increased between 50% and 100% in just the year 2008 (FAO 2009 and Boulif et al 2009). In a region where the great majority of the population lives in the rural sector and depends on agriculture for their livelihoods, this crisis has unraveled some critical truths:

The economic model that has been implemented for decades in this region has proved to be dangerous and mistaken. The focus on export-led monoculture at the expense of family farming has planted the seed of food dependence in West African populations. Today, West African agriculture is insufficiently diversified and heavily dependent on the international exports of a reduced number of products that will guarantee foreign exchange. A good share of that money is used to buy food products which prices are getting higher and more volatile due to global markets. The tone of milk powder, a critical product for the nutritional equilibrium of children that is mostly imported from the EU, increased from $2,125 to $4,550 in 2007.

The general and unilateral disarmament of tariff and non-tariff protection mechanisms has left the region completely exposed to the unfair competition of external products, most of them heavily subsidized by the EU and the USA. Ghana had to face an increase of 650% of tomato sauce imports between 1998 and 2006, watching its national production disappear because of heavily subsidized products from Italy. (Oxfam and Enda 2010)

The food diversity in West Africa is limited and tends to narrow as poorer populations turn to cheaper substitution products with a lower nutritional value. These persistent deficits have direct consequences on the nutritional status of vulnerable individuals such as pregnant and breast-feeding women, young children, elders or households led by single mothers (Cambrezy et al 2008). In

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6 This box has been written on the basis of information elaborated by Dr. Cheikh Tidiane Dieye, from Senegal.
Senegal, for example, two strategies were particularly noted. As the imported rice is the staple food, households are often forced to maintain the quantity of cooked rice, to reduce or waive the quantity of fish, meat, vegetables and oil. Other households opted for beans and millet couscous or pasta imported from Europe and consumed with little or no vegetables, meat or fish. Similar strategies have also been observed in other countries of West Africa such as Burkina Faso, Mali and Niger.

The limited policy space and the lack of willingness of national governments in the agricultural sector have only accentuated the vulnerability and their food security risks. Agriculture is not only threatened by climate change, but also by other factors, such as national and international investors that grab the best land to produce biofuels. In Ghana, more than 452,000 hectares were sold to private investors. In Mali, such areas are estimated at 150,000 hectares, of which 100,000 were sold to a Libyan sovereign fund (Oxfam, 2010). A similar trend was observed in Senegal. Development of rural services reported land allocation for agrofuel production. The government also confirmed its ambition to establish nearly 600,000 ha for ethanol production. Nearly 321,000 hectares have already been devoted to the production of Jatropha. This area accounts for more than 8% of arable land estimated at 3.8 million hectares. Organizations of civil society and farmers have expressed concern about competition that leads to growing biofuels crops. A region known for the quality of agricultural land and water availability is also affected by the government for the production of agrofuels. Some farmers reject this option: "I prefer to continue to increase my production of rice and maize. Imagine what would happen if world demand dropped and the price of agrofuels collapsed after we have concentrated all our efforts: our situation would be worse than now and there would be a famine. We cannot eat Jatropha, but we can eat rice" (Oxfam, 2010)

REGIONAL RESPONSES TO THESE CHALLENGES

Despite of these difficulties, the region remains as one of the most active in the continent. Different initiatives have been taken in the last years in order to guarantee the food security of West African populations, including those tackling the effects of climate change. Some countries, for instance, have tried to establish food reserves or early warning systems, either at the national or at the regional level. But these efforts often lacked a critical volume, were weakly articulated or excessively dependent on foreign assistance to have a real impact on the problem.

One of the most relevant ones was the Interstate Committee on the Fight Against Drought in the Sahel (CILSS, in its French acronym, comprising 9 countries), which was founded in 1973 after a long drought had devastating effects on the region. CILSS included a food security surveillance mechanism that monitored expected crops, regional stocks and prices in order to anticipate the riskier zones and suggest actions in
Trends in international, regional and domestic agricultural and food markets, and potential impact on nutrition in Africa

advance. (Cilss 2009) Unfortunately, this mechanism proved to be inefficient in the absence of proper national information, so local actors and NGOs had to rely on national early warning mechanisms that were better in calibrating the availability of food stocks than the actual accessibility of poor populations to them. (Oxfam 2010)

Hopes are now put on the regional integration process and the creation of a common agricultural policy within the ECOWAS (the regional trading block, which comprises 16 countries), so called ECOWAP. First adopted in 2005, this policy builds on the previous efforts to achieve food security, reducing external dependence and reinforcing the functioning of agricultural markets (Oxfam 2010):

**Agricultural investment:** One of the three main pillars of ECOWAP is focused on the food and nutritional security of vulnerable populations in the region. It is designed to be implemented through the national agricultural investment programs, with very similar objectives to the ones pursued by CILSS and other initiatives. In fact, the old CILSS might well be restructured into a new technical branch of ECOWAS for the management of food crises. They have the instruments and only a clear political will is now left, provided external partners will help.

**Creation of food reserves and national social protection mechanisms:** One of the main challenges that these new institutions will face is the availability and accessibility of food. The region cannot count on enough food reserves. Its national stocks are heavily reliant on the external support that comes from other regional partners or from the help of official donors and NGOs. These reserves are critical in order to stabilize food prices and guarantee an easier access for vulnerable populations, most of which have seen their resilience affected by the latest cuts in social protection programs. During the last crisis, Ghana has played a leading role in the massive distribution of food coupons, and some other countries implemented more modest national social safety nets. Some pilot programs have been launched at a small scale, but without considerable external help Sahel countries will lack the financial capacity to upscale them into national social protection programs.

It is possible to reduce this vulnerability and enhance food security in the region. But for that to happen it will be necessary to reconsider the fundamentals of West Africa’s trade and economics, so that they reflect the real interests of the people. Family agriculture is the main instrument to guarantee the right of people to food and underpin their nutritional security. It must be dealt with as a sector that is different from the rest, its interests protected from the vagaries of international markets.
3. **Recommendations for a research agenda**

Many of the issues mentioned above have been extensively researched and looked into, and it is simply a question of political will to put the good ideas in practice. But there are a number of policy areas that should be further explored and where nutritionist could bring a clear added value. This final section contains five specific proposals in this regard:

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<th>Issues</th>
<th>Importance of issue</th>
<th>Barriers to developing research in this area</th>
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<tr>
<td>1. How can we expand social protection mechanisms in Africa in order to increase the resilience of poor producers and consumers? What is the nutrition component that these programs should necessarily consider in order to succeed?</td>
<td>Safety net programs in developing countries, targeting food insecure people and women in particular, can play a critical role in extending the benefits of trade and increasing poor people’s resilience against price volatility. The better-known examples of these social protection mechanisms are now in Asia and Latin America, but incipient initiatives are also taking place in Africa. The purpose of this research would be to provide evidence-based and gendered-aware policy recommendations for advocacy to donors and governments developing/reforming these safety nets. In particular, the nutritionists’ community could help to identify those elements and/or tools that reinforce these programs from the nutritional perspective (for instance, targeting children and mothers through nutritional supplements or school feeding, as part of the whole package).</td>
<td>The role of social protection in the fight against food insecurity has raised considerable interest in few last years, so it is not likely that financing will be a fundamental problem. But there is a methodological and practical challenge in the transposition of the Latin American and Asian experiences to the African context. Institutional capacity and communities’ organization, in particular, might prove to be very different and therefore demand. Finally, while some work has been done in terms of mapping the experience of social protection in Africa (see, for instance, Ellis, Devereux and White (2009), which covers some food-related programs in Southern Africa), very few has been properly researched after the 2008-10 food prices’ crisis, which unraveled a complete new picture.</td>
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<td>2. How can investment in small farming be designed so that the impact on nutrition levels is optimized?</td>
<td>This research area is somehow linked to the previous one. If we accept that a massive investment in small farming is a necessary condition to tackle the current and future challenges of sustainable production, it is important that support programs are designed in a way that optimizes the impact on the nutritional levels of farming communities. It would be important to calibrate, for instance, what is the best combination of crops in order to obtain the nutritional needs of the family, as well as a market-oriented production. It could also consider the relative nutritional gains of women-oriented agricultural investment, as opposed to the traditional one. The research could be based on the identification and replication of best practices in these areas.</td>
<td>Again, this is a research area that has gained considerable policy importance in the very last years and the future looks promising. Financing should be available. The challenge, however, is to establish the importance of a nutritionist perspective in an area that will most likely be handled by economists and agronomists. But this narrow approach is part of the problem we’ve had in the past.</td>
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<td>3. What is the impact of food prices’ volatility in the nutritional status of poor consumers?</td>
<td>We take as a given that the sudden increase of food prices has a nutritional effect on poor households, but the details of these effects are not necessarily there. Most importantly, the intensity of the recent prices’ increase and variation has been higher than ever. The nutritionists’ community could make a considerable contribution to the policy and scientific debate on the impacts of the recent food crisis in terms of the volume and composition of household food consumption, as well the nutritional effects and the likely implications for their future opportunities. Using household surveys and qualitative research, this work could help to understand who has been affected, how and why, helping to anticipate the worst effects in the future.</td>
<td>The clear obstacle in this regard is the availability of recent data. The real added value of this research is to look at the most recent food prices’ spikes (2007-08 and 2010), so it is not likely that the main information is available. Creating new databases with quantitative and qualitative data is the alternative, but this would obviously make the product more expensive. Another alternative is to take some specific cases and deepen into them.</td>
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4. What is the impact of land-grabbing/biofuels on the nutritional status of affected communities?

This research area is very similar to the previous one, but looking now at the phenomenon of land-grabbing and/or biofuels and its implications for food security and nutrition in the affected communities.

The importance of this research is related to the massive relevance of these two interrelated phenomena and how they are displacing or affecting poor communities all over the continent. The approach, however, should be a more specific one, picking three or four concrete cases where these effects could be studied and then extrapolating policy lessons for the whole problem. Qualitative methodologies could be used.

If the case-study approach is taken, no major methodological or financial problems should appear. But there is a security problem to be taken into consideration here. Cases where violence has been used against local communities affected by land-grabs are not so uncommon. In the best case, local and national governments could legally obstruct the research.

5. The future of the food aid system: a nutritionist perspective

Donation of food, either in cash or in-kind, is a common tool in the humanitarian response against food crises, such as the long-lasting ones that have been affecting 14 countries (two thirds of them in Africa) for over a decade. (FAO 2010)

There is a heated policy debate regarding the opportunity of these programs and the best way to guarantee the access of populations to food. Part of it (that related to trade policies, dumping and WTO regulation) has been extensively researched, but there is still an important gap around the new models of food aid and how these would help to create virtuous circles between farmers’ income and the nutritional needs of poor consumers.

A research from the nutritional perspective could help to orient the new food aid instruments, indicating how much would be needed and what crops and products it could come from. This would then help to design food aid provision mechanisms adapted to the needs of local and regional producers and traders.

The policy appeal for this research area is considerably lower than the previous ones. It would also be necessary to prove the added value of this research in terms of what we already know about nutritional needs in emergency or chronic food crisis (although the baseline of this proposal is the implementation of a new model of food aid that is not necessarily based on the same geographical and agricultural parameters).

For these reasons, it is likely that financing might be a problem.
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Socio-demographic changes and potential impact on nutrition in Africa

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1. Introduction

Social and demographic data are essential for planning and monitoring socio-economic development programmes. Population composition by age and sex including geographical distribution are among the most basic data necessary to describe a population or/and a sub-group of a population. These basic characteristics provide the context within which other important information on social phenomena, such as education, disability, labor, health, nutrition, crime, fertility, mortality and migration can be studied. This paper seeks to highlight socio demographic changes in sub-Saharan Africa (SSA) with an exploratory focus on the potential impact on nutrition in the region at the different stages of the demographic changes. The paper ends with a framework of research priorities over the next 30 years (short, medium and long term) to understand the impact of socio-demographic changes on nutrition in sub-Saharan Africa.

2. Nutrition situation in sub-Saharan Africa

Nutrition security remains a serious challenge for human welfare and economic growth in sub-Saharan Africa. The inabilities of majority of the population to effectively acquire and utilize the food they need in addition to inaccessibility of health and care are major constraints to nutrition security in SSA. Insufficient food at the national level to meet the needs of all the citizens; and inaccessibility at the household level is visible in many SSA countries.

Micronutrient deficiencies plague large numbers of Sub-Saharan Africans particularly vitamin A, iron, iodine, zinc, and folate which all pose a public health problem affecting over 2 billion people. Over a third of the people in sub-Saharan Africa suffer from hidden hunger or deficiencies in key vitamin and minerals essential for growth.
and bodily function [2]. This happens despite the fact that more than half of them consume enough food to satisfy daily calorie and protein needs.

Despite the fact that undernutrition poses challenges to economic growth and human development, its high prevalence in SSA is not seen as anomalous or indicative of the inability of the government to fulfill its duties to its citizens. It also tends to be treated in national policy processes as an issue which will take care of itself once food production is adequate. The lack of drama, poor perception of its critical situation translates to low political demand for action against malnutrition and nutrition issues generally. There is limited understanding among political leaders and policymakers of both the costs of aggregate malnutrition in their countries for national development and the determinants of nutritional status. This disconnect is evident in the inadequate linking of any policy descriptions on nutrition to master development plans in the countries.

This disconnect brings in to focus the need to use a different approach to engage policy makers to take action on nutrition issues based on evidence from research by African researchers committed to bringing about change to the current dismal situation. Availability of socio demographic data and how it impacts on nutrition will be very good advocacy for policy makers to take action. Exponential population growth and increased per capita food consumption, rapid urbanization, migration and social policy affect food and nutrition security of households throughout sub Saharan Africa (SSA). These macro changes induce competition for resources i.e., availability and accessibility to health services and food thereby affecting the livelihoods of the current and next generations of Sub Saharan Africans.

3. Current Socio-demographic changes in sub-Saharan Africa

3.1. Demography

The demographic transition (DT) is the transition from high birth and death rates to low birth and death rates as a country develops from a pre-industrial to an industrialized system. The theory is based on an interpretation of demographic history developed in 1929 by the American demographer Warren Thompson (1887–1973) which observed changes, or transitions, in birth and death rates in industrialized societies over the previous 200 years [3]. The 4 main classic phases of demographic transition, has Sub-Saharan African countries mainly falling into phases I and II of the model, with majority of the stable countries in the 2nd phase of the model [4]. Characteristics of the first phase include high birth rate and fluctuating
death rate; examples in SSA include Uganda and Zambia. Declining birth and death rate signifies the second phase with Ghana as an example; while Gabon is an example of an SSA country in the third phase that is characterized by birth rate approaching replacement of 2.1 [4]. The major exceptions are some poor countries, mainly in sub-Saharan Africa, which are poor or affected by government policy or civil strife.

3.2. Demographic trends and responsible factors

Three major demographic trends - mortality, fertility, and immigration shapes and will continue to shape the size, age, structure, and distribution of tomorrow’s population. The average number of children per woman fell from 5 in 1950 to 2.7 in 2005 [5]. While all regions are recording fertility decline, high rates still persist in 35 of the world’s poorest countries including Nigeria and Uganda who are on course to triple their population by 2050 [6]. Fertility decline is the most important change in demographic movement. One important factor in this regard is the fact that many sub-Saharan African countries have no population policy and where they are available they are poorly implemented making it difficult to control population growth.

Mortality rates, determined chiefly by child mortality and longevity, showed an improvement worldwide. The rate of child mortality decline has slowed since around 1980 although it may now be picking up again. More recently, DHS data indicate that rates of child mortality decline appear to have been reversed and now accelerating compared to even two or three years ago. The current increase in child mortality can be attributed to poor nutrition during pregnancy, infancy and childhood [7]. The effect of nutrition in adolescence, pregnancy and infancy represents the three critical nutrition timings which are associated with the life course risks of morbidity and mortality as well as health and disease.

The movement of people within and across borders is the third force shaping population size, age structure, and distribution. Migration in SSA features a variety of movements, mostly intraregional: migrant workers, undocumented migrants, nomads, frontier workers, refugees, and highly skilled professionals. Changing patterns and especially the increase in irregular migration, diversification of migratory routes and trafficking in migrants result from worsening socio-economic and political conditions in the region. Sponsored, selective male migration and increasing female autonomous migration are manifesting migration as survival strategies. Each of these migrants carry with them their food culture which are eventually lost if they have no means of access to familiar foods. Consequently there would be adaptation to available foods which may not be healthy choices. An
understanding of these migration patterns will allow for a better ability to promote the healthy food choices and nutrition of the migrants. Continually, there is migration of whole families or particular age groupings from rural to urban or immigration of professionals and their families from developing countries to developed countries shaping changes in the demography of those countries.

3.3. **Age structure transitions**

When fertility declines due to increased survival of children the adolescent period, and the rapid growth of elderly populations relative to the working age population are two key age structure transitions that are shaping demography of each country of SSA. These two age transitions have been increasing on a continuous basis in the first decades of the 21st century.

3.3.1. **Adolescence**

Adolescence is a key period of demographic transition in the life cycle. During their adolescent years educational trainings may be terminated, they may leave home; begin conjugal life child bearing and adult work. At this life stage girls encounter strong social pressures for child bearing before they have had adequate preparation for adult responsibilities.

To optimize nutrition in adolescents, three critical issues has to be addressed

(i) development of risk factors during this period;
(ii) prevention of risk factors throughout life course
(iii) Healthy/unhealthy habits developed throughout life

It seems increasingly likely that there are widespread consequences of early diet on later body composition, physiology and cognition. This provides strong support for the recent shift from defining nutritional needs for prevention of acute deficiency symptoms to long term prevention of morbidity and mortality. The ‘obesogenic’ environment affects adolescence by making healthy food choices that much more difficult. With better part of days spent in school, at a factory, in front of a TV screen or computer, games played and handheld devices, exercise pattern is changed. Thus, the onus of avoiding developing risk factors and managing it when they develop for the large numbers of adolescents is enormous, with the primary aim being to impact healthy habits on the growing number of adolescents in the region. The adolescents especially the females are bearers of tomorrows’ future, it is then important that their nutritional status is assured to enable them execute their duties maximally in due time. The age at first marriage is related to fertility trends. Among some ethnic
groupings marriage of girls aged between 12 and 13 years is common which transit the child to adulthood with child bearing responsibilities immediately. The consequence is the physical and physiological immaturity of the child to carry through pregnancy and her nutrition becomes compromised. The potential impact is intrauterine growth retardation, low birthweight complications affecting the reproductive tract and the laying of the foundation for adult non communicable diseases in the newborn baby. These factors make the adolescent period a critical nutrition timing for child survival. Since in-utero nutritional status is an important determinant of children’s developmental potential, maternal undernutrition is of equal concern. Evidence for maternal malnutrition is provided by the fact that between 5 and 20 percent of African women have low BMI as a result of chronic hunger; thus paving way for maternal morbidity and mortality. Pregnancy and lactation are among the most vulnerable stages of the life cycle. The consequences of poor maternal nutritional status are reflected in low pregnancy weight gain and high infant and maternal morbidity and mortality. Suboptimal infant feeding practices, poor quality of complementary foods, frequent infections and micronutrient deficiencies have largely contributed to the high mortality among infants and young children in the region [8]. The nutrition transition is more easily seen amongst the adolescents based on peer pressure, advertising and increase in fast food establishments. The exact changes in dietary habits of adolescents from the traditional food system to emerging malnutrition types, trends and prevalence are unknown. Given that adolescent food habits are prone to peer influences there is a need to understand the dietary pattern of urban versus rural adolescents with emphasis on the influence of education, employment peer influence and lifestyle.

3.3.2. Aging in sub-Saharan Africa

Most sub-Saharan Africans enter old age after a lifetime of poverty and deprivation, poor access to health care and a diet that is usually inadequate in quantity and quality. Two key areas need focus to identify priorities for future research and policy development which are: the nutritional status of old and the elderly in sub Saharan Africa as well as the determinants of undernutrition. Information on micronutrient status is sparse, yet it appears that anemia related to suboptimal folate status is a particular problem. Important determinants of poor nutritional status in the elderly in the African context include inadequate household food security, war and famine, and the indirect impact of HIV infection and AIDS. The rapidly increasing size of the older population, combined with their increased burden of care-giving responsibilities and severe socioeconomic hardship, indicates an urgent need for increased attention to this group, including applied research on nutrition problems and the development and evaluation of nutrition interventions.
Three critical issues affect nutrition and health of elderly, they include:

(iv) Manifestation of most chronic diseases  
(v) Benefits arising from adoption of health-promotion nutrition behaviors  
(vi) Maximizing health and quality of life by avoiding or delaying preventable disability [9]

The most important nutritional need for the aged is managing them with the chronic diseases that manifest at this stage, particularly for those at risk. Of importance also are the needed interventions for change into optimum nutrition promoting behaviors. With the gradual increase in numbers, the dynamics of the above issues becomes complicated.

4. Urbanization

Urban cities and towns are vital agents of socio demographic changes that greatly affect nutrition and health. With increase in urban cities, lifestyles, foods, agriculture and the general way of living are affected. Age at marriage, education and all nutritional indices are also affected by residence – Urban versus rural. The DHS data for Ghana, Senegal and Zimbabwe show that urban and rural differences for age at first marriage (rural lower than urban), for stunting, wasting and underweight (rural higher than urban) and exclusive breastfeeding (Rural lower than urban) [10, 11, 12]. Predominately, older people are found in the rural areas than urban areas. This is also aided by the retiring to the rural area of older people in sub-Saharan Africa, this trend will change in the coming years as today’s adolescents become tomorrow’s older generation. There is a need to evaluate the impact of urban life-style on nutritional status, body mass index (BMI) of mothers and indices of malnutrition of preschool children. Currently in SSA, the food base is shrinking due to migration from rural to urban areas with the loss of biodiversity in the African food system. Traditional foods are underutilized, neglected and are becoming extinct making it difficult to attain sustainable diets.

Health and nutrition status variations exist in urban environments because of urban slums. Arising from unplanned structures and slowed pace of infrastructural and social services, much of the new urban population live in slums and are thought to be in poverty. As people migrate to the cities they tend to settle in squatter communities or with relatives already living in overcrowded areas. In this view, the dynamics of nutrition security and difference in urban settlers becomes important with respect to food consumption pattern, living environment, food safety, nutrition transition amongst others.
5. Governance

Currently, most SSA countries rank high in the Failed State Index (FSI) from fund for peace and foreign policy, with Somalia, Chad and Sudan topping the list [13]. The effect of governance or political climate of a country is a factor that cannot be undermined especially in SSA where unstable governments are common precipitating wars, violence and conflict. Without good governance and stability, development cannot take place. The role of government in power is most visible in policies made and implemented that affect people’s lives economically and socially amongst others. At the foundation of survival is the need for adequate policy for nutrition, this can only be possible in the event of stable government and atmosphere that mainstreams nutrition into its agenda. A government that has an understanding of the importance of nutrition for development and thus prioritizes nutrition when executing developmental programmes is more likely to produce the best possible human resources needed for productivity than when the opposite no such recognition exists evidence from research must be collated and used to produce advocacy tools for a paradigm shift.

6. Wars, conflict and natural disasters

The nature of SSA is such that “domino effect” is felt in every conflict situation which leads to increases in the neighboring country’s population through the refugee population. Apart from the internal factors, external factors also play a major role in producing conflicts of opposing interest leading to ethnic, religious or political crisis causing instability. The livelihood disruption includes agriculture, food processing, storage and preservations. The effect of conflict is also visible in its effect on food prices, for instance, though there is continued increase in food prices in east Africa, prices are rising less sharply in relatively more stable northern Somalia, which indicates that the effect of civil insecurity and ensuing internal displacement and market disruptions is stronger than the combined effects of poor successive rains and high international food prices [14]. Thus, people in refugees are most likely to be food insecure more than others. By making food purchase impossible and farming difficult, the food chain is destroyed in crisis and wars. All situations that cause malnutrition among people – inadequate food security, poor diet, insufficient health services, unsanitary environment and inadequate maternal and child care practices – are all exacerbated during conflicts and wars. The implications of the crisis especially protracted ones lead to long term malnutrition with their adverse effects on cognition, the economy, education and health on individuals and the country at large [15].
Baker’s hypothesis in relation with thrifty expedition of nutrients draws special attention to children born under wars and conflicts and specifically in SSA situation is yet to be explored. The magnitude must be known to plan adequately. It is important to ensure that nutrition of the pregnant and lactating women especially adolescent girls during wars and conflicts are improved to avoid a future of NCDS in SSA. The need to assure child survival of children born during these emergency situations call for research in the African context to understand the pathway to infant and child survival.

Though sub-Saharan Africa has not seen the height of natural disasters, it has to large extent witnessed erosions, floods and droughts that have led to outflow/out flux of people. The current famine in the horn of Africa and those of Ethiopia from 1970s to date at different times are clear cases. The increase of these vulnerable populations (refugees or internally displaced persons) has impact on malnutrition, because they are displaced from their lands, thus cut off from food access and income sources. This vulnerability begins with loss of familiar food and their food system, and then it is compounded with the health facilities at their disposal. Their hosts on the receiving side, are left to deal with rush for already scarce resources.

7. Cultural changes

Culture is critical for the establishment of social order and stability of societies. The cultures in sub-Saharan Africa are diverse and varied from country to country and also within countries. Culture defines issues of religion, marital relationships and economic empowerment. Advent of communication and travel is bridging the gap of culture, easing transfer of ideas and thus gradually eroding people’s beliefs and way of life. The highest impact of cultural changes is felt in food choices and the subsequent increase in overweight and obesity in Sub-Saharan African [16]. The influence on nutrition is seen in the loss of agricultural biodiversity as traditional foods are neglected by the new class in favour of western diets which lead to non-communicable diseases, related to overweight and obesity. With the changes that accompany migration and urbanization, family systems are likely to be eroded, especially the extended family support system. The loss of family support affects all age group with higher impact on the aged. SSA value on children is one of the most propelling factors for higher fertility rates. The gold value of male children, shame attached to barrenness and smaller number of children pushes for higher reproduction. When women irrespective of nutrient storage continually begets, it propels mortality rate.
Culture’s role in food distribution within the household is very important, with import on gender segregation and the liberties accorded a man/male child when it comes to sharing.

8. Gender

SSA countries rank low on the Gender Inequality Index, an index that takes into consideration maternal mortality ratio (MMR), adolescent fertility rate, population with at least secondary school education (25 years and older), labor force participation, contraceptive use prevalence rate, antenatal coverage of at least one visit and finally birth attended by skilled health personnel [17]. Cultural practices embedded in SSA are the limitations of a girl-child and females generally. Changing construction and understanding of gender, most especially influenced by education, has played a long-term role in the fight against malnutrition. By not limiting the life of a girl-child to the house and kitchen, doors of education and nutrition are opened by firstly extension of age at first marriage, increasing economic possibility and strengthening against life of malnutrition and poverty. The most proponent of population growth – fertility is fuelled by early marriages and childbearing, based on uninformed choices, discrimination against the girl-child, and gender-based violence among others [18]. Social/Societal attributes of gender roles integrate with biologic features to make the female gender susceptible to malnutrition. The gender susceptibility to malnutrition begin with the monthly cycle and then childbirth, accompanied by societal demands and pressures that reduce her access to land, education, technology etc. Her limited role in decision making impedes her voice were reproduction is concerned. All inequality against women that include restraints from education, economic/capital exclusion etc. affects their nutrition and gears towards high population growth [19].

9. Research Priorities

A four pillar research priority framework is proposed as follows

- Current knowledge, practices and policies on population and nutrition in SSA

- Demographic changes and its interaction with nutrition in SSA

- Linkages, opportunities and threats of cross-cutting issues on socio demographic changes and nutrition

- Research Capacity development of the human resources and institutions in SSA
The central pillar is the relationship of socio-demographics and nutrition in SSA as shown in figure 1. The interactions of the pillars are such that without a given one, the others cannot fully optimize nutrition in SSA alone. The interactions between nutrition and socio-demographic changes cannot be explored without a foreknowledge of current practices and policies, without due consideration for cross-cutting issues that affect the relationship and finally adequate capacity to carry the research.

**Figure 1 | Proposed pillars of research priority on nutrition and socio-demography**

In setting a research agenda, the issues to be handled can be addressed based on – What, and how it will be handled/carried out, where it is mostly needed. The timing of which will make the most impact – When, is also vital to get the end result of optimum nutrition in SSA. Based on the four pillars, a matrix (figure 2) of the “what”, the “how”, the “when”, the “where” and possible impact is proposed.
9.1. Current knowledge, practices and policies on population and nutrition in SSA

**WHAT** - Currently socio demographic data in SSA is not readily available and without accurate data, projections cannot be made. Collecting such data is a priority need and also factors affecting the collation of such data and bottlenecks should be cleared, paving way for the much needed research and solutions/interventions. All data generated in the above exercise should be organized into a database and information system for users in different countries with avenue to update with monitoring and evaluation data from interventions.
HOW - The research priority will be a systematic review and meta-analysis of the current SSA regional strategy to combat socio demographic changes in relation to the quality of life as indicated by health and nutrition status of the citizens. The result of such documentation will feed into a multi-disciplinary scenario building exercise to understand better the linkages between demographic factors and socio-economic progress. Such understanding will allow the creation of alternative pathways for adoption by different countries based on their system of governance. Some of these studies will be cross cultural, cross-sectional and longitudinal in nature. The multi-disciplinary scenario building, exercise should explore environmental, economic, agricultural options and nutrition responses to predictable demographic changes over a 20-30 year horizon in specific countries which will include consideration of strategies to mitigate the adverse effects of rapid population growth.

WHERE - This should be carried out in selected countries in each of the sub-regions of SSA as a means of developing advocacy tools for next action.

WHEN - Being the most immediate need of research, it is short-term because it is the most urgent and the foundation on which other pillars stand.

9.2. Demographic changes and its interaction with nutrition

9.2.1. Practices/Action

Demographic changes occur throughout life and as such any research agenda on socio demographic changes and potential impact on nutrition must follow a life cycle approach in which these changes are correlated with nutritional events at each stage of the lifecycle. The changes occurring during the critical nutrition periods of adolescence, pregnancy and lactation as well as in infancy will receive priority attention.

WHAT - In view of the interaction between socio-demographic changes and nutrition, taking cognizance of the problem tree analysis of malnutrition, continued evidence of what is obtainable when fertility declines is imperative i.e. the decreased pressure on marginal lands, food and water security enhancement, under/unemployment reduction, risk of civil/political unrest decrease. A cohesive approach to reducing poverty and nutrition inequality requires understanding linkages to demographic change at each level of wealth index. Age and sex are the most important factors that affect mortality and health, both of which influence nutrition. The critical nutrition timings in the life cycle of infancy, adolescence and pregnancy confirms this assertion. Similarly the evidence of critical nutrition timings has led to the documentation of interventions needed to prevent intergenerational malnutrition.
by ensuring good nutrition during the first 1000 days [20] leading to the conclusion that in different age groups health and mortality are influenced by nutrition and that poor nutrition will increase mortality through poor health status [20].

Longitudinal data relating the process of aging to lifestyle factors, including dietary intake patterns, are nonexistent. The notable lack of systematic studies on nutrient and food intakes in this group limits the development of appropriate community-based strategies to improve nutritional status. Furthermore, the likely heterogeneity of elderly people in different settings both within and between countries requires cross-country comparisons of the impact of nutritional status on health outcomes, using standardized methodology. The micronutrient status of older Africans is largely unknown and this area of research should be considered high priority for the older generation considering the rapid urbanization trends and demographic transition taking place.

The poverty-fertility decline nexus needs to be studied as a priority. It needs to be studied in relation to location specific causes, urbanization trends, gender empowerment, education, and age at first marriage to bring out how to generate income sufficient to changing behavioral pattern for adequate food consumption.

There is a need to study methods of rejuvenating the African food system within the cultural context in both rural and urban areas. There is no food composition database upon which food based dietary recommendations can be made while ways of conserving biodiversity must be developed. Promotion of food-based strategies to change the consumption habits of people will ensure long-term impact.

**HOW** - Investigating the relationships between different socio demographic factors and nutrition and health is becoming of greater importance as people age since dietary patterns and lifestyles changes significantly. To effectively address this problem socio-demographic variables have to be substantiated with adequate longitudinal studies in SSA that would yield data for the different stages of the life cycle. Investigating the relationships between different socio demographic factors and nutrition and health is becoming of greater importance as people age since dietary patterns and lifestyles changes significantly with a focus on aging. Surveys describing the nutritional status of older adults on the continent are mostly small and slanted toward individuals expected to be at highest risk, such as refugees and displaced persons. Longitudinal data relating the process of aging to lifestyle factors, including dietary intake patterns, are non-existent. The notable lack of systematic studies on nutrient and food intakes in this group limits the development of appropriate community-based strategies to improve nutritional status.
WHERE – This is needed at all levels – district, community, household and national

WHEN – Short-term, nutrition is such that the wait for the current knowledge cannot be afforded. Medium-term is necessary for outcomes/practice and actions based on the first research priority and long-term investigations (cohort studies) are important for proving trends etc.

9.2.2. Food and nutrition policies in SSA

WHAT - In each country, four interrelated elements of the policy processes for addressing nutrition and socio-demography must be examined. The first three elements are firstly the interdependence—policymaking structures, including both formal institutions and less formal political interests;

Secondly Political actors who engage strategically with particular policy processes;

Thirdly, the narrative or persuasive understanding of undernutrition that is the basis on which choices are made to derive policy in this area is important.

However, by themselves these three elements do not explain policy change. A fourth element, timing, is also critical. It is important to ascertain when a policy or intervention can be called “late” and why Demographic factors affect poverty levels and inequality within and among countries in fundamental ways. At the micro level, fertility levels affect household economic well-being; at the macro level, the demographic opportunity associated with the transition from a majority adolescent population to a large productive-age population influences unemployment and economic growth rates; and urban-rural and continent wide migration are all a cause and results from differing levels of economic development which prompts people to move from one level to another seeking a better way of life. Strong evidence is needed when fertility declines maternal mortality is reduced, child mortality is reduced, enrolment in primary education is increased and gender equality improves.

Just like the case of undernutrition policy (impact analysis of healthcare systems and factors that affect them), the emerging case of overnutrition and obesity, including its accomplice Non-Communicable Diseases (NCDS) has to be approached in a similar manner to undernutrition.

The socio demographic changes and potential impact on nutrition research priorities must begin using the conceptual framework of the determinants of nutritional status from the perspective of policymaking and the institutional organization of government to assess the various opportunities for and constraints on prioritizing
actions to address undernutrition in the public sector in SSA countries. The effect of regional groups/agencies/governments and their partnership/cooperation in the fight against malnutrition in relation to socio-demographic changes need to be studied and analyzed to determine what has worked and what did not work to propose a new course of action based on the outcomes of the scenario building exercise in sub-Saharan Africa. The roles of different institutions/parastatals and agencies of governments should also be studied to identify opportunities to promote implementation of policies and plans of actions that would allow greater collaboration and coordination.

**HOW** - The research with policy can only be executed by “action/doing”, visible in policies made and implemented at the different level in SSA.

**WHERE** - This can only be through “execution” at all levels where policies are made. Most important is the role of household and community policy in aid or reducing nutrition in SSA.

**WHEN** - Research and policies needed to promote nutrition will also like practices begin now and continued to long-term. A longitudinal approach is necessary considering the time and process needed for policy making.

9.3. **Linkages, opportunities and threats of cross-cutting issues on socio-demographic issues and nutrition**

In synthesis of research priority for the interaction of cross-cutting issues on nutrition-demographics dynamics, the relationship and cyclic interaction of all cross-cutting is most imperative.

**WHAT** - A synthesis of research of gender mainstreaming into sustainable diets based on culture, biodiversity and child friendly sensitive programs, to combat malnutrition and promote traditional food system is one of the priorities in this area. Awareness is needed to ascertain the influence of gender/cultural gender orientation on population growth and nutritional status of a given population. Male orientation, involvement and role in Household food security are fertile grounds to explore. The gender dynamics to nutritional issues is also important to ascertain the vulnerability or otherwise of a given gender. SSA shares the universal need for good training, management, communications, and information systems in gender equality programs, but new, country-specific and innovative institutional mechanisms are needed to address SSA's nutrition problems using gender perspective. Each country must look for its own institutional strengths and weaknesses in developing nutrition programs.
While a population might increase some cultural practices, it acts exactly opposite on other ones. The continuous practice of cultural beliefs or otherwise has implications for malnutrition that needs to be made visible. This will aid the promotion of some traditional practices, based on evidence of their ensued benefit. Food and behavioral taboos and beliefs that can aid or prevent good nutritional status exist; an excellent understanding will aid the nutrition community in making culture-sensitive programming, thus resulting in beneficial outcomes and impacts.

Nutrition trend and the dynamics through which they operate in the presence or absence of good governance, conflict and wars (aggregated by types of conflicts, regions etc.) is necessary. The nature of influence of socio-demographic and nutrition interaction on governance, conflicts, wars, natural disaster etc. is an explorable terrain.

These issues are embedded in the basic causes of malnutrition where the foundations of most socio demographic changes occur and should attract the first priority attention in the effort to address those changes and potential impact on nutrition.

**HOW** - Studies on governance, conflict and wars will use the multi-disciplinary scenario building exercise in which assumptions are made on the type and nature of governance, conflict, level of corruption and the various socio-demographic changes occurring under such situations, the type of malnutrition trends and pattern will be documented and possible solutions proffered

**WHERE** - At all levels, but specially segregated along tribal and cultural alignment because of the differences that occur at those level. Conflict comparisons are necessary in afflicted zones in comparison with suitable similar control. Governance at all level is also essential with particular attention to local governance, because their effect is felt most on the population and little known about them. The impact of international governance, policies and aids are often given backseat, but nonetheless important. This priority is important at different levels for institutional reforms to support the redressing the possible impact of socio demographic changes and improved nutrition. Research can then be carried out to identify sub-national differences, sector specific actions, conflict and demographic security as well as micro-level factors.

**WHEN** - Interaction of cross-cutting issues is given to be of medium- and long-term priority.
9.4. Research capacity development of the human resources and institutions in SSA

The nutrition research priorities on socio demographic changes require that the capacity of African researchers and their institutions be built to undertake the research in a multi sectoral and multidisciplinary manner since the issues involved are multifactorial. Similarly adequate resources are required and must be available to ensure that the researches are well conducted using standardized and globally recognized approaches. Thus there is a need for advocacy to African Union and member governments to set up a special research and capacity development fund for African researchers to engage in priority nutrition researches in partnership with other development agencies including relevant UN agencies, bilateral and multilaterals particularly the European union.

WHAT – To achieve optimum nutritional status in Sub-Saharan Africa inspite of growing population and changing demographic pattern the issue of capacity development is necessary; at the institutional, individual and national level in different sectors and workplaces/disciplines to provide the human resources that will carry out these researches in collaboration with the experts and also serve to implement outcomes. Policy makers, program implementers also need the capacity to be able to enact sustainable policies and execute programmes.

HOW – It will begin with individual and institutional building and development. Other vital forms include partnership and trainings between SSA and other regions (South-North) knowledge transfer in addition to within-SSA (South-South) knowledge transfer. Making new converts to nutrition and the development of advocacy materials generated from research results is also a valid option; this is an angle to be explored because of the multi-disciplinary nature of nutrition. The nutrition agenda must be high on the political agenda such that it has high input into development in practice. To spearhead the fight and quest for adequate nutritional status in SSA should be experts of other fields, who have been made to understand the implication of the different course of life on nutrition.

WHERE – At all levels, in-school, out-school, nutritionist and non-nutritionists alike.

WHEN – This is needed at short term and long term, being that the trained and developed capacity is vital to the completion of other research priority.
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Social dynamics and potential impact on nutrition in Africa

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1. Abstract

Social dynamics play an important role both as a determinant and solution to Africa’s nutrition challenge. Through a desk review, this paper seeks to better understand (a) what social dynamics are (b) their link with nutrition (c) their potential impact on nutrition in sub-Saharan Africa in the next decade, and (d) their implication on nutrition research in the years to come.

The review shows that in order to understand better the role of social dynamics in the causal chain of malnutrition and develop evidence-based social change strategies that complement current high impact interventions for nutrition, there is an urgent need to invest more in multi-disciplinary research. Such research would need to embrace social change concepts and tools developed by disciplines beyond nutrition and should include the development of a guiding conceptual model, perceptions of key stakeholders, lessons from successful programmes that include social dynamic interventions, how globalization is influencing nutrition relevant social dynamics including practices related to agriculture, health and care. A review of sub-Saharan’s nutrition governance structure and the uses of mobile technology for scaled up nutrition advocacy are areas also worthy of study.

2. Introduction

Recent reviews of high impact interventions designed to improve nutrition and prevent related diseases in children and women reveal that the maximum impact they could achieve was a 36 per cent reduction in stunting at 36 months and a 25 per cent reduction in mortality between birth and 36 months. ¹ To achieve higher impact in the long term, the authors recommended supplementing these interventions with measures that address the underlying and basic determinants of undernutrition such as poverty, poor education, disease burden, and lack of women’s empowerment; all of which require changes in social dynamics. These findings suggest the critical
importance of incorporating social dynamic interventions in programmes designed
to achieve high and sustained nutrition impact.

The main reason for neglecting inclusion of social dynamics in nutrition
interventions is because of a poor understanding by the nutrition community of how
these dynamics impact on nutrition and how social change strategies can be used to
achieve nutrition goals. The social dynamic determinants of health and nutrition
are the conditions in which people are born, grow, live, work and age, including the
formal and informal institutions and systems that impact on health and nutritional
status. These circumstances are shaped by the individual and societal dynamics-
political, social, cultural, economic and technological - that determine the
formulation of policies and strategies and the allocation and use of material,
economic, human and organizational resources. There is a pressing need, therefore,
to invest in more research to generate new understanding of these social dynamics
and how they impact on nutrition. This paper attempts to identify such a research
agenda for the nutrition community for Sub-Saharan Africa.

3. **What are social dynamics?**

Social dynamics refers to the behavior of groups that results from the interactions of
individual group members as well as the relationship between individual
interactions and group level behaviors. Such interactions are conditioned by the
social context, the interplay between the social forces that affect individual behavior
and group dynamics that change society. A good understanding of the social context
is important in helping define societal changes, recognize what brought the changes
about, and search for any future patterns, and more importantly, offer solutions.
With regard to nutrition, our knowledge base appears to be skewed toward
individual versus contextualized accounts of human societal behavior.
Transformative group and societal behaviors and dynamics are more complex to
understand and predict than individual behaviors and are, therefore, less researched.

From a research perspective, social dynamics is an emergent discipline in the field of
complex adaptive systems or complexity science. Complexity sciences do not have
single theories, but encompass more than one theoretical framework and are highly
interdisciplinary. Other examples of complex adaptive systems include any human
social group-based endeavor in a cultural and social system such as political parties,
communities, corporate organizations or financial markets. Complex systems present
difficulties in mathematical modeling and, therefore, enormous challenges in making
future predictions. Thus, any study on social dynamics and its potential impact on
nutrition in Africa would present three key challenges. First, the complex nature of
social dynamics makes it difficult in developing a consensus analytical framework.
Second, the tension that exists when conceptualizing the complex nature and consequences of interactions between the complex areas of social dynamics, nutrition and Africa; and third, the multiple levels and units of analysis (individual, family, community and population) raises theoretical and methodological issues. Much clear this new introduction!

4. Social dynamics and the link to nutrition

Social dynamics are linked to nutrition directly and indirectly in at least three main ways. First social dynamics determine whether or not a nutrition situation is perceived and accepted as a societal problem, and, therefore, the need for it to be addressed at scale. An agreement on the existence of a problem is perquisite for addressing it. Nutrition relevant behavior at all levels of society, from the individual, community to the population level, reflects the dominant perceptions about nutrition existing at those levels. Secondly, social dynamics provides the language used in assessing, analyzing, acting, monitoring, advocating and researching on the nutrition problem. Language reflects concepts, understanding, values, attitudes, perceptions and decision making patterns related to human experience and the prevailing paradigm in a particular area. The “movement” language being used by the global “Scaling Up Nutrition (SUN)” Initiative is a case in point. True movements use the power of social dynamics to achieve transformational societal changes of issues like nutrition, which seem intractable. The dismantling of apartheid in South Africa and the recent Arab spring revolutions are examples of the transformative nature of social dynamics. Thirdly, although there is always a point that initiates, catalyzes, and facilitates transformative change; often a momentum builds up and takes a life of its own with the roles played by different actors becoming not so much apparent. To achieve transformative nutrition change in sub-Saharan Africa the nutrition movement should evolve in a way that generates a better understanding of the social dynamics involved for effective catalysis and facilitation.

Conceptually, the linkage between social dynamics and nutrition is reflected in the causal chain of the social determinants of nutritional status. Such a conceptual framework acknowledges that fundamentally nutritional status and mortality are the manifestations or outcomes of complex social and biological processes in human societies determined by three levels of causality: immediate, underlying and basic and operating at three levels of society: individual, community and population. In this framework, social dynamics play an important role both at the levels of causality and especially society. It also determines demand and supply aspects of the nutrition challenge.
The basic causes (sometimes referred to as structural or root causes or the causes of the causes) relate to the economic, political and cultural conditions which are influenced by the availability and utilization of resources (human, financial and organizational). The availability and control of these resources is dependent on the potential of that society and the social organizations and relations. Population dynamics, gender, technology and environmental factors like climate change also operate at the level of basic causes. The link between poverty, nutrition and social dynamics is also most explicit at the level of basic causes, as the causes of poverty are the same causes of malnutrition. It is also at this level that the ethical aspects of nutrition as a right are best addressed.

Although social dynamics largely impact on nutrition at the level of basic causes, they also play a role at the levels of underlying and immediate causes. The underlying causes comprise of three interrelated clusters, namely (i) household food security (includes water and energy); (ii) care for children and women and (iii) basic social services (health, education and sanitation). All three conditions must be fulfilled for good nutrition. The immediate causes are the most proximal factors that precipitate malnutrition and are generically identified as inadequate food intake which interact with diseases in a mutually reinforcing manner. The social dynamics at the underlying and immediate causes relate mainly to household practices that allocate financial and human resources for food security, care, health, education, energy, water and sanitation, all of which impact on nutrition.

Also to note that there is a time dimension to the link between social dynamics and nutrition, since the causative factors occur within the context of historical processes. Families, communities and nations are results of historical processes; so are social, economic, cultural and technological developments. Diseases have incubation periods. Climate change is the result of long historical processes; and above all social change requires time to occur.

5. Social dynamics trends in Africa and their future impacts on nutrition

Africa and in particular sub-Saharan Africa is hugely diverse in its geography, people, cultures and levels of economic, social, political, ideological, cultural and technological developments. The potential impact of social dynamics on nutrition is universal, so what makes them special when it comes sub-Saharan Africa?

It is acknowledged that over the last two decades human societies in sub-Saharan Africa have undergone rapid and fundamental social changes in both rural and urban areas. These changes, driven by (i) demography and the natural, physical,
social and financial environment (including globalization, modernization and urbanization), (ii) economic, political and ideological choices, (iii) formal and informal institutions, including markets and service providers are likely to impact on nutrition status in African households and communities. In addition, a digital and social “revolution” challenges the traditional social norms and structures and offers innovative ways to stimulate social cohesion and equity. Household dynamics (values, beliefs, culture, traditions, decision making mechanisms and trade-offs) potentially change the way households produce, access and utilize food, livelihood strategies and assets (including pre- and post-shock strategies), their social resilience, access to health services (including beliefs and traditions on management and treatment of disorders) and maternal and child care and feeding practices to name just a few. In addition, changes in community dynamics (i.e. gender, stigma, benefits and opportunities for women leadership) have important repercussions on household nutrition and food security. Research is urgently needed to understand these dynamics of change and tailor nutrition interventions to sub-Saharan Africa’s specific social context.

6. The nutrition, demographic and epidemiological transitions

There are three closely related nutrition and social dynamic relevant historic processes of social change occurring simultaneously in sub-Saharan Africa at great speed and earlier stages of the economic and social development than happened in industrialized countries. The first is the demographic transition (discussed in paper 3) - the shift from a pattern of high fertility and mortality to one of low fertility and mortality (typical of high income economies). Second is an epidemiological transition- a shift from a pattern of high prevalence of infectious disease, associated with malnutrition, periodic famine and poor environmental sanitation - to one of high prevalence of chronic and degenerative disease—associated with urban–industrial lifestyles characterized by low levels of physical activity and a dietary pattern of high saturated fats, sugar, and refined foods but low in fiber. Embedded in the epidemiological transition is the “nutrition transition”, a shift in the nutrition pattern from one of undernutrition and communicable diseases to one where undernutrition and communicable diseases exists alongside overweight/obesity and non-communicable diseases. Such a double burden of malnutrition presents countries with difficulties in the formulation of nutrition policies, strategies and programmes because choices in allocation of scarce resources have to be made.

These transitions caused by changes in social dynamics at the population level are reflected in nutritional outcomes, such as changes in average stature, body
composition, and morbidity and have implications for food and nutrition security and public health. Coupled with the variety of programmes that have successfully eliminated the severe forms of undernutrition in most sub-Saharan African countries, individual and societal perceptions of malnutrition are also changing affecting the prioritization of nutrition actions. Research on how these transitions have impacted on nutrition would add to a better understanding of the impact of social dynamics on nutrition.

In some parts of sub-Saharan Africa social dynamics have put a break on these transitions. The most recent example is the Horn of Africa where over 12 million people have been affected by a severe humanitarian crisis prompting the UN to declare a famine in some parts of Somalia in July 2011. Prolonged drought, the worst in the past six decades, affecting several countries including parts of Ethiopia, Eritrea, Djibouti, Kenya, Somalia and Uganda has been exacerbated by chronic poverty, protracted conflict and breakdown in social cohesion in some of the areas affected. Relevant to social dynamics are the disruption of patterns of migration of pastoralists to access reserve pastures and water; lack of investments to support resilience of pastoralist communities; prevention by governments of trading of livestock fearing loss of revenue; conflict and insecurity, and an attitude of waiting until severely malnourished children are seen before intervening. A study of the social dynamics of hunger in the horn of Africa would greatly support future famine prevention measures. The social dynamics of Africa’s economic trends

There is increasing recognition that Africa is “arriving” as a serious location for investment because to a large extent, the region weathered the global financial and economic crisis; debt levels and fiscal positions have improved; there has been a substantial improvement in political and civil rights of its citizens; traditional trappings are rapidly being given up and human resources in many areas including for analytical nutrition, health, agricultural, socioeconomic research has increased and become more rigorous. Moreover, the average years of education of the population aged over 15 years has roughly doubled from 2.5 to 5 years during the last 25 years; and above all the policy frameworks have greatly improved. There is also a broad agreement that poverty rates in Africa are at last falling: substantially by the macro-development GDP approach which showed 10% points reduction to 33 per cent by 2007 from a peak of 43% in 1990s and by 3% points reduction from 50% in 2001 to 47% in 2009 using survey-based data. These trends also coincided with a turnaround of Africa’s economy which grew at about 3% during 2005-2008 declining to 2.5% in 2010 due to the 2008 financial and economic crises and estimated to double to 5% in 2011. The question then is why have the economic improvements not yet been translated into general human improvements, including for nutrition? Factors such as high levels of inequity, lack of public accountability, poor communication...
infrastructures, a very low initial socioeconomic base, weak planned responses to
global events, little public and private strategic investments, failure to modernize
agriculture, failure to use evidence in making policy and in many instances failure to
develop a sense of national identity from the diverse ethnicities are but some of the
reasons.

However, a major reason of falter in the economic nutrition front, is the global
downturn of soaring food prices, reduced remittances, contractions in trade,
reductions in foreign direct investments and official development assistance, and the
inability of poor economies to effectively absorb the challenges of globalization.\textsuperscript{13, 14}

Although the lag in price transmission from global to domestic markets provides
temporary relief, multiple shocks worsens situations where households were
already using a large amount of their income on food, often as high as 80%.\textsuperscript{13}
Coupled with decreased demand for agricultural products due to cheaper synthetic
alternatives, labor deficit in rural areas caused by migration of able bodied youth to
urban areas, the multiplier effect on purchasing power impacts negatively on food
and nutrition security in both rural and urban areas. To cope with these shocks,
households resort to coping mechanisms that negatively impact on nutrition like
reducing the number of meals per day, change in cheaper and nutritionally inferior
consumption patterns, reduced expenditures on food, education and health and in
some instances individuals have been forced to take extreme measures such as street
begging, child labor and prostitution to maintain access to food and other basic social
services.\textsuperscript{13} These coping mechanisms increase the risk to malnutrition both for energy
and micronutrients, shifting diets from a varied pattern to one dominated by starchy
staples, especially the poor nutrient cassava, sub-Saharan Africa’s, main staple of the
poor. They also increase the risk of bad health outcomes as undernutrition makes
people, particularly children more susceptible to the killer diseases (e.g. diarrhea,
malaria, pneumonia, AIDS) and those affected forego treatment. Chronically food
insecure households suffer from chronic nutrition deficiencies, making them more
susceptible to infectious diseases which in turn results in undernutrition generating a
vicious cycle of undernutrition, disease and poverty.

7. Mobile technology for social change

The impact of advancements in science and technology on nutrition in sub-Saharan
Africa has been huge. Many of the high impact interventions (e.g. immunization,
micronutrient supplementation and fortification, treatment of diseases, hand
washing with soap, use of long lasting insecticide treated nets for prevention of
malaria) are the result of culturally acceptable science and technology. A relatively
recent technological development that can greatly impact on social dynamics and
which nutrition actors have not taken advantage of is Africa’s unparalleled growth in the area of mobile technology. The penetration rates of wireless technologies in Sub-Saharan Africa have leapfrogged the wired computer infrastructure across socioeconomic and demographic groups including those populations most in need of health and nutrition interventions producing considerable potential to reach and follow individuals and communities who were previously unreachable via traditional communication channels.

In 2011 nearly 400 million people (half of Africa’s population) have a mobile phone compared to only 11 million in 2000. Already the technology is being used by various businesses to reach customers and by farmers looking for fair agricultural prices. For example, M-Pesa, designed as a tool for repaying microfinance loans in Kenya, was also key to the recent Kenyans for Kenya drought aid funding drive; EpiCollect (http://www.epicollect.net/) developed by the Imperial College, London, allows the geospatial collation of data collected by mobile phone and has played an important role in drought affected areas of East Africa. Kenyan vets are using it for disease surveillance, monitoring outbreaks, treatments, vaccinations and animal deaths. There is also “Frontline SMS” which by connecting a standard mobile phone to a laptop, data can be received or transmitted wherever a basic phone signal is available, without any need for 3G or an internet connection. It has been used to track drug availability in clinics across East Africa, and it is used by a company distributing agricultural pumps in Kenya and Tanzania to keep in touch with farmers.

Mobiles, also offers the possibility for accessing the internet and, therefore, the social networks (Facebook, twitter etc.) and professional networks like HealthNET dedicated to helping healthcare clients improve quality and efficiency through effective use of mobile technology. How can nutrition actors use the mobile technology boom in Africa to scale up evidence based nutrition actions? What model should be used by mobile technology for interactive and adaptive health and nutrition behavioral interventions? These are some of the questions that if answered could significantly change the social dynamics of technology for improved nutrition.

8. Social dynamics, equity, gender and nutrition

The main drivers of inequality in sub-Saharan Africa that impact on nutrition and have social dynamic components are income, rural-urban differentiation, geographical location and gender. With regard to income, there are substantial differences in the disparities recorded. For example in Nigeria where disparities are high, the prevalence of stunting in the richest 20% is 21%, and in the poorest 20% is 54% (a disparity factor of 2.5); while in Ethiopia where disparities are relatively
low, the stunting prevalence in the richest 20% is 53% and the poorest 20% is 40% (disparity factor of 1.5). Consistently the prevalence of underweight in children in the rural areas is higher than in the urban areas often by a factor of two. However, there are some studies which show that urban-slums have higher rates of undernutrition than the planned urban areas and in some cases even higher than in rural areas.\(^8\) Addressing disparities is important to ensure that marginalized communities, normally the ones with the highest levels of multiple and multi-dimensional deprivations including nutrition, are pro-actively prioritized because as recently shown by UNICEF, the evidence suggest that not only is it right in principle and in practice, but also holds much promise in addressing the social dynamics of disparities impacting on nutrition.\(^17\)

The revitalization of efforts to address maternal nutrition remains one of the biggest challenges in Sub-Saharan Africa; not only as a woman’s right, but also as a way to address the vicious cycle of intergenerational growth failure. Manifested by a high prevalence of low body mass index (BMI) and low birth weight (birth weight of less than 2.5 kg) in the newborn, maternal undernutrition is the pathway through which intergenerational transmission of undernutrition occurs.\(^13\) Although Africa’s prevalence of low birth weight of 14% is better than that of Asia, it masks the fact that despite high ante-natal attendance rates, over 60% of newborns are born at home and, therefore, not weighed at birth.\(^18\) This shows that traditional birth attendants still play a major role and lack of skilled attendance at birth is responsible for the high rates of maternal mortality in sub-Saharan Africa. Why is there this discrepancy between antenatal attendance and delivery at health facilities?

The nutrition of adolescent girls is especially important. Improving the nutritional status of adolescents, delaying first pregnancy to above 18 years and generally improving the birth weight of babies are critical not only in transmitting a healthier generation of babies, but also in addressing the serious issue of girl child marriages and child births that result in poor health and nutrition outcomes of both the mother and the newborn. Addressing social factors that lead to child marriage and teenage pregnancies will improve birth weight and maternal and child undernutrition. A better understanding of these factors in sub-Saharan Africa would greatly support interventions measures.

Interestingly, there appears a consistent finding that the nutritional status between girls and boys is similar with boys having a slightly higher prevalence of stunting than girls; and that sex disaggregated programme coverage and practice data reveal no significant differences on the basis of gender.\(^17\) There is also some improvement in the gender parity index in education (Girls’ school enrolment ratio in relation to boys’ enrolment ratio) for primary education in sub-Saharan Africa. However,
evidence shows that gender disparity becomes significantly pronounced during and after puberty as girls and boys enter secondary schools, the labour market and the political arena.\textsuperscript{18} This is the period when the “socialized” gender stereotype roles manifest. Evidence shows a significant disparity in nutrition status related to the educational and income status of the mother. Overall the socioeconomic status of the mother is a critical determinant of nutritional status, not only of the mother and of the child but also of the household across the life cycle. Thus, policies and strategies that empower women would also lead to improvements in nutritional status at all levels of society. Too much data, I will suggest to reduce and go to the point

9. The social dynamics of food, health and care

Food security includes water and energy at the household level in terms of constancy of availability and social and economic accessibility. Since most food production in sub-Saharan Africa is subsistence, outdated traditional farming systems and migration of the youth from rural to urban areas looking for better living standards means that traditional methods, human capacity and mechanisms for food production, storage and marketing no longer suffice. Overall, the green revolution has not reached sub-Saharan Africa and large scale farming is the exception rather than the rule. Moreover, due to deforestation caused by overgrazing and felling trees for charcoal, the main source of energy for cooking in Africa, water sources have also diminished with the destruction of traditional protective systems. Efficient and alternative sources to charcoal would greatly enhance eco-friendly food security. In transiting from subsistence farming, it would be important for research to find out what would be the best agricultural model which in addition to addressing poverty, would also enhance food, water and energy security.

Health security is dependent on food security and availability and utilization of basic social services, particularly for health, education and sanitation which greatly influence nutrition outcomes. Access to quality basic services often determines survival and development and the human capacity to participate in social change initiatives.

In sub-Saharan Africa, the importance of health practices in determining survival outcomes is summarized in the sayings that “count your children after they have had measles”, a crucial reminder of the lethal combination of undernutrition, diarrhea and pneumonia in measles. Understanding household behaviors related to the prevention and treatment of these and other killer diseases like malaria and AIDS are critical in addressing nutrition, which is always compromised by these diseases.
With regard to diarrhea, some African traditions stop breastfeeding and giving fluids thinking that it will make the diarrhea worse. This is in fact not the case as children with diarrhea require more frequent feeding including breastfeeding. Some parents give ineffective diarrhea medicines instead of the effective Oral Rehydration Salts (ORS). Safe disposal of faeces, including that of infants in a latrine, toilet or burying it; and hand washing with soap after going to the toilet are important in the prevention of diarrhea. The tradition of open sanitation in rural Africa including that of open defecation made possible by the presence of large areas of bush and low population density is often not easily discarded for water-based institutional systems and is one of social dynamic explanations of the wide gap between progress in the achievement of the MDG targets for water and persistently low and slow progress in sanitation.

Practices related to malaria are also important as frequent episodes of malaria are responsible for a large portion of undernutrition in sub-Saharan Africa. Sleeping under long-lasting insecticide treated nets (ITN) and spraying of long lasting insecticides on walls of houses to protect against mosquito bites is gaining momentum in Africa as ways to prevent malaria transmission. This is because communities are increasingly becoming aware of the impact of these technologies in controlling malaria by observing that families using ITNs suffer less frequently from malaria than those not doing so. Because of the increased awareness, households and communities are cooperating more with health workers in malaria control programmes including ensuring that children with fever are sent to the health facility for early diagnosis and treatment.

With improved education levels and awareness, practices with regard to health and nutrition are also improving. However, the fact remains that in most African rural communities the first call for a health problem including malnutrition, is still the traditional doctor and when this does not work out, modern medicine is then consulted. What then should be done to convince families to take their sick children directly to health facilities? Can traditional doctors help in this aspect? These are some areas worthy of study.

Although practices related to care are also improving there is still a long way to go. Care for women includes practices related to family planning, pregnancy, delivery and post-natal care. These include ensuring adequately spaced births, increased dietary intake of pregnant women, doing ante-natal visits and ensuring skilled attendance at birth and post-natal care. Care for children includes exclusive breastfeeding for six months, complementary feeding and practices related to hygiene, sanitation and psychosocial care. A relatively recent “discovery in the nutrition literature” care practices started to be given prominence when it was
observed that in some contexts, rates of malnutrition remained high even in the presence of food and health security. Care translates household availability and access to food and health services into good growth and development of the child. A caregiver, normally the mother, must be available to ensure that the child is exclusively breastfed on demand for the first six months; that thereafter complementary food is given at least four times a day; the child is kept clean and hygienic; and timely decisions are made to access the health services for both prevention and treatment when the child is sick. Ensuring access to education is also an issue of care. Resources to improve care at the household level include income, time, attitudes, relationships, knowledge, affection, emotional support, and effective and stable allocation of these resources for good nutrition. All these are affected by social dynamics. Moreover, there are vulnerable groups that require special care for good nutrition outcomes: the sick, disabled children, orphans, and vulnerable children (OVC) and internally displaced people and refugees whose numbers have grown to over 20 million in Africa. In most societies in Sub-Saharan Africa, gender roles are reflected in discriminatory care practices making caring practices an important aspect in the expression of gender discrimination. For example, women are given the role of caring for sick family members, and often policy makers do not allocate adequate resources for maternal care like for delivery facilities or breastfeeding facilities at work places.

Breastfeeding, a practice that fulfills the three conditions of food, health, and care security, still remains the traditional method for infant feeding in rural Africa. Most children continue to breastfeed up to 18 months. The main reason for stopping breastfeeding in urban areas is going back to work. With most countries offering at most three months maternity leave in the formal sector, lack of breastfeeding spaces at work and difficulties of transport, few employed mothers are able to exclusively breastfeed for six months. Studies also show that the major reasons for stopping breastfeeding in the rural areas are: another pregnancy, the child is old enough, the child has refused, the milk is not sufficient or the milk has gone bad. Some traditions make it a taboo for breastfeeding women to have sex believing that it makes breast milk go bad. This may affect both exclusive and prolonged breastfeeding with negative nutrition impact on the child.

The challenging social impact of the HIV and AIDS pandemic in sub-Saharan Africa is a grim illustration of how one disease is so much influenced by social dynamics in the form of stigma and discrimination. Households with patients affected by AIDS have reduced capacities for food security because it is often the young productive members that are affected and they have to spend a lot of their resources for care and health. This makes them vulnerable to undernutrition. The probability of 14 percent spread of HIV through breast milk means that mothers have
to make difficult choices about infant feeding options. With traditional pressure to breastfeed, this may lead to mixed feeding in poor hygienic conditions which can increase the risk of HIV transmission and undernutrition. 20 Given the critical role mothers play in the provision of care, their prolonged illnesses and death due to AIDS robs off the family and in particular children the primary care giver making them orphans often at critical levels in their development. Although a study done by USAID in eight sub-Saharan African countries with relatively high HIV prevalence (Cameroon, Cote d’Ivoire, Kenya, Lesotho, Malawi, Tanzania, Uganda, and Zimbabwe) found little evidence that OVC are disadvantaged in health, nutritional status and health care, compared to non-OVC, the finding that they are disadvantaged in schooling and use of insecticide treated nets compared to non-OVC, has implications for increased nutrition vulnerability due to lower education and malaria risk.21 Although the study bodes well for Africa’s extended family system with grand-mothers playing a crucial role, their resilience and coping mechanisms are being overstretched and without external support the extended family system can no longer cope.

The care of a malnourished child is very much dependent on the perceptions of caregivers about the causes of undernutrition. A study on malnutrition and gender relations in Western Kenya found that people in the community attributed malnutrition mainly to broken rules of family relationships e.g. conflict between husband and wife, conflict between child’s mother and other adults, in addition to other factors like women’s lack of social and economic independence, labor migration and poverty were also mentioned. 22 Thus, a better understanding of the dynamics of care giving and their link to nutrition would greatly assist in the creation of positive care giving change dynamics for better nutrition.

### 10. Recommendations on nutrition research on social dynamics

<table>
<thead>
<tr>
<th>Key social dynamic issues for research in Sub-Saharan Africa</th>
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<tbody>
<tr>
<td><strong>Issue</strong></td>
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<tr>
<td>1. What are the key social dynamics factors that determine nutrition status in sub-Saharan Africa? What should be the guiding conceptual model for such research?</td>
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</table>
7. Is subsistence farming still the way forward towards food and nutrition security in sub-Saharan Africa?
   - About 70% of Africans live off the land which is still Africa’s main resource; research and government support still focuses on small-holder subsistence farming as a way of reducing poverty: but is this tomorrow’s model for agriculture in Africa? What humane model should Africa adapt to transit to a more efficient agricultural system?
   - One model may not fit all countries given their different levels of development.

8. How can nutrition actors and in particular the nutrition movement use the mobile technology boom in Africa to scale up evidence based nutrition actions? What key nutrition messages should be spread?
   - The power of ICT and in particular the social networks is a globalization phenomenon that is rapidly catching up in sub-Saharan Africa. It should be harnessed more effectively in Africa’s nutrition movement. This is key to facilitating knowledge, information exchange and social interactions for social dynamics that will also impact on nutrition.
   - Enlisting support from ICT companies without being caught up in their product marketing.

   - Factors like teenage pregnancies and early marriage are responsible for intergenerational transmission of undernutrition. What are the social dynamic factors involved?

10. What are critical household factors influencing health seeking behavior? What is the role of care?
    - Health and care practices are important determinants of malnutrition and understanding their social dynamics would help in the design of nutrition interventions

The table below summarizes some of the key social dynamic research issues in Sub-Saharan Africa emanating from the above review.

### 11. Conclusion

There are three key messages emanating from this review. First, in sub-Saharan Africa, social dynamics are important considerations in complementing the high-impact nutrition interventions given the rapid and fundamental changes in the social context that have occurred during the last decade. Secondly, these rapid changes in social context are likely to continue in the next decade and research is urgently
needed to better understand the changes and their impact on nutrition in order to achieve higher impact and scale up nutrition actions. Third, to be more than a mere academic exercise and generate accessible new understanding on the social dynamics and their impact on nutrition there is need for research to recognize utilization of different types of evidence through multi-disciplinary inquiry. But nutritionists are not trained to cause social change and seldom inquire into the nature and processes of social changes required to achieve nutrition goals. Nutrition research, therefore, needs to incorporate knowledge and tools and methods of the social sciences including anthropology, sociology, psychology, economics, political science, management. The need to understand better the social dynamics of change in nutrition is urgent not only for sub-Saharan Africa, but also for the global nutrition movement.

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Trends in water availability and accessibility and potential impact on nutrition in Africa

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1. Abstract

Water is the bloodstream of the biosphere and the base for all socio-economic development and thus the key to almost every aspect of nutrition. In this paper water availability and water accessibility in relation to nutrition are analyzed for sub-Saharan Africa (SSA) considering domestic and agricultural uses, blue and green water sources, and changes of demand and supply over time.

Domestic water is necessary as drinking water, for food preparation, and for personal hygiene, all three of which are prerequisites to secure a person’s nutritional status. In 2050, the urban population in SSA will have tripled and the rural population will have increased by one-third. To supply domestic water to all will be a major challenge. In the urban areas the domestic water demand might increase by as much as 650-1,300%.

To provide food for 900 million newborn and the present 220 million undernourished by 2050 will be another huge undertaking. Translated to agricultural water demands, more water will be required than appear to be available. Improved agricultural water productivity and irrigation expansion will assure food self-sufficiency in some SSA countries. Other water-scarce countries which have economic capacity can rely on food import. However, the majority will face major difficulties to both produce and import necessary food quantities. Lowered per capita food supply levels might be necessary to assure food security.

The linkages between water availability, accessibility and nutrition are manifold and a number of research questions need to be formulated to address future challenges. The most important and overarching objective must be to assure that water resources are sustainably used. The overall complexity to secure nutrition in SSA in the coming decades calls for interdisciplinary approaches. Nutritional researchers of SSA, with unique local knowledge, play a key role when developing the necessary research agenda to find successful development avenues for the future.
2. **Water and nutrition – a three-dimensional issue**

Water availability and water accessibility in relation to nutrition is a three-faceted issue:

I. Two main water uses – domestic and agricultural
II. Different water sources used – blue and green water
III. Changes over time - demand and supply, and availability

The optimal daily water supply for domestic use, including a couple of liters of drinking water, is in the range of hundreds of liters per person per day, which is less than one-tenth of per capita human food water requirements, estimated at several thousand liters per day.

There is a fundamental difference between domestic and agricultural water uses. Most of the domestic water use is related to washing, cleaning or other uses that allow a reuse “after use”. Although the quality of water in most cases is deteriorated, only a fraction of the water is evaporated, and most of the quantity of water remains and can potentially, after proper treatment, be reused downstream. In contrast, agricultural water use is, in principle, entirely related to evapotranspiration (ET) during crop cultivation or fodder growth, and cannot be reused. The water use in agriculture is thus a “consumptive water use” resulting in a vapor flow back to the atmosphere, and the domestic water use a “through flow” based use, generating return flows (**Figure 1**).

The terms **green water** and **blue water** were introduced in the beginning of the 1990s\(^1\). Blue water stands for the liquid water in streams, rivers, wetlands, lakes and aquifers that can be abstracted and used for irrigation and other human uses. Green water stands for the rain-fed soil moisture, i.e. the water source naturally available to plants. Globally, the consumptive water use in agriculture amounts to 7,130 km\(^3\), with 78% being green water and only 22% being blue. On the other hand, municipal and industrial consumptive water uses, all blue, only amount to 53 and 88 km\(^3\), respectively.\(^2\)
Figure 1: Global water use by sectors, showing consumptive water use of water-infiltrated rainfall, green water, and of water from surface water bodies and aquifers, blue water.²

The third important aspect to consider for both domestic and household water use is the change in demand and supply of green and blue water over time. With continued population increase and urbanization, the demand for blue water for domestic use will grow in many parts of the world, and with more people and changed food preferences green and blue water for food requirements might in many countries, and at the global level, multiply to unsustainable levels. With limited water resources to be shared, the idea of “water crowding” is a relevant standpoint when thinking about the future (Figure 2).

Figure 2: With increased population more people have to share the same water resource, thus increasing the risk of water scarcity. The figure visualizes a twentyfold increased population pressure for the same water quantity, i.e. “water crowding”.³

Water resources accessible to human use also change over time. More blue water can be supplied with new technologies and water infrastructural investments enabling earlier discarded blue water of inferior quality to be treated and used, and previously spatially unreachable water resources to be appropriated. The availability of both green and blue water is due to climate change expected to be reduced in many areas.
in sub-Saharan Africa (SSA), with altered rainfall patterns and temperature-driven evaporation demand. Upstream activities can also reduce the availability of blue water and usability for downstream use, with changed land use reducing run-off formation, water diversions to other basins, or different activities irretrievably degrading the water quality. Due to human alterations of vegetation cover and land management both green and blue water sources change.

3. Water resources in SSA - preconditions and water scarcity

The precipitation pattern in Africa is characterized by extreme variability at inter-annual, decadal and longer-time perspectives. Unreliability of rainfall translates to a general unreliability in green and blue water resources at all scales impacting domestic, industrial and agricultural uses, and water scarcity and water stress limit livelihoods and economic development in large parts of the sub-Saharan African region. Large parts of the arid or semiarid water-constrained areas in SSA coincide with the savannah climatic zone, that stretches as a band from Senegal in the west across the Sahel region to the Horn of Africa in the east, and down along the eastern coast to South Africa. Seasonal wet and dry periods are particularly manifest in these drought-prone areas.

Surface water and groundwater are blue water sources that can be developed for domestic, industrial and irrigation uses. However, unpredictable rainfall, high evaporation losses and low run-off generation call for increased blue water storage as an adaption to compensate for both erratic accessibility of blue water and unreliable availability of green water. In Africa, sufficient water storage is still lacking in many areas. Small-scale water harvesting reservoirs for supplemental irrigation of presently rain-fed croplands will be a crucial undertaking to lift sub-Saharan agriculture in the future.

Aquifers constitute natural sub-surface blue water storages of high strategic value that can be easily developed, and they offer access to water resources during periods without rainfall or river flow. Although groundwater only stands for 15% of the renewable blue water resources in Africa, it is of vital importance in many dry areas in sub-Saharan Africa receiving inadequate precipitation. Across Africa, 75% of the population depend on groundwater as the major source for drinking water, and in a country like Botswana 80% of domestic and livestock demands is met by groundwater. Increasing demands and improved technology lead to abstractions often exceeding the recharge rate from rainfall, with rapidly falling groundwater tables in some areas.
Semiarid and sub-tropical sub-Saharan Africa is predicted to belong to the areas where climate change in particular, through higher temperatures, more rainfall variability and greater frequency of extreme events, will affect availability of water resources and agricultural production. However the pattern will not be the same everywhere. Less rainfall is expected to increase the soil moisture stress, i.e. green water stress, in southern Africa, with falling crop yields and decline in food security. In contrast, in eastern Africa higher rainfall might potentially open up irrigation expansion and more water for domestic and industrial uses.7

4. Domestic water use

The domestic water use is the prime societal water use in both urban and rural areas. Safe drinking water is crucial for human nutrition. In some countries, water is by itself is regarded as a nutrient and thus treated by the same standards of, and regulations for, as food. Safe domestic water supply meets two basic water uses:

A. To meet basic human physiological water requirements, i.e. adequate hydration.
B. To ensure human hygienic conditions, both crucial for humans to stay healthy and thus highly linked to nutritional aspects.

4.1. Adequacy of supply – quantity and quality

A number of basic service parameters are used to assess the adequacy of domestic water supply: quality, quantity (service level), accessibility, affordability and continuity.8

Good quality, characterizing safe drinking water, includes microbial, chemical, radiological and acceptability aspects. The most important aspects in relation to immediate health concerns are microbial agents as pathogenic bacteria, viruses, protozoa and helminths. To prevent drinking water from such contamination is essential and best achieved using multiple barriers along the distribution chain from the abstraction point to the consumer.

Water supply, i.e. the service level, should fulfill three needs:
I. Drinking water.
II. Water for food preparation.
III. Water for personal hygiene.
The water demand per capita per day ranges from a minimum level of a few liters to an optimal of 200 liters. From the perspective of a developing country, and thus highly relevant for sub-Saharan Africa, an important aspect to take into account is the time required to retrieve the daily water quantities. In Africa about 70% of the duties of water collection are performed by women, thus losing valuable hours carrying water over long distances. Four service levels are shown in Table 1.

Table 1 | Service level and quantity of water collected.

<table>
<thead>
<tr>
<th>Service level</th>
<th>Distance/time</th>
<th>Likely volumes of water collected</th>
<th>Public health risk from poor hygiene</th>
<th>Intervention priority and actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>No access</td>
<td>More than 1 km/ more than 30 minute round-trip.</td>
<td>Only 5 litres per capita per day.</td>
<td>Very high Hygienic practice compromised. Basic consumption may be compromised.</td>
<td>Very high Provision of basic level of service. Hygienic education. Household water treatment and safe storage as interim measure.</td>
</tr>
<tr>
<td>Basic access</td>
<td>Within 1 km/ within 30 minute round-trip.</td>
<td>On average, 20 litres per capita per day.</td>
<td>High Hygiene may be compromised. Laundering may occur off-plot.</td>
<td>High Provision of improved level of service. Hygienic education. Household water treatment and safe storage as interim measures.</td>
</tr>
<tr>
<td>Intermediate access</td>
<td>Water provided on-plot through at least one tap (yard level).</td>
<td>On average, 50 litres per capita per day.</td>
<td>Low Hygiene should not be compromised. Laundering likely to occur on-plot.</td>
<td>Low Promotion hygiene still yields health gains. Encourage optimal access.</td>
</tr>
<tr>
<td>Optimal access</td>
<td>Supply of water through multiple taps within the house.</td>
<td>On average, 100–200 litres per capita per day.</td>
<td>Very low Hygiene should not be compromised. Laundering will occur on-plot.</td>
<td>Very low Promotion of hygiene still yields health gains.</td>
</tr>
</tbody>
</table>
Accessibility is defined as the proportion of the population with reliable improved drinking water supply. Improved sources include: piped water into dwelling or yard; public tap or standpipe; bore well; protected spring or dug well; and rainwater collection. Unimproved water sources are: unprotected spring and dug well; vendor supplying water via small tanks or tanker trucks; surface sources like rivers, dams, streams, irrigation canals; and bottled water from unimproved sources.

On average about 35% of the urban population and only 5% of the rural population in SSA have access to domestic water supply from piped water into dwelling, yard or plot. More than half of the population in the rural areas, and but less than one fifth of the urban population only, have access to unimproved water sources (Figure 3).

![Drinking water coverage sub-Saharan Africa 2008](image)

**Figure 3** | Drinking water coverage for rural and urban areas in sub-Saharan Africa in 2008.

In 2008, about 40% of the SSA population, 350 million, lacked access to improved drinking water. Although the proportion has fallen from 44% since 1990 the total number of people lacking improved water supply have, due to the rapid population growth, increased by more than 100 million. While three-quarters of the urban water supply in many sub-Saharan African countries comes from improved sources, the coverage in rural areas is still often critically low (Figure 4). South Africa, Namibia and Botswana are positive exceptions, both regarding urban and rural water supply.
Affordability is a key issue to ensure that the least privileged population stratum can gain access to safe water supply. However, in informal settlements lacking piped infrastructure water is often provided by private water vendors. Then the poorest people usually have not only to pay more per water quantity but get water of poor quality, compared to the more fortunate in formally recognized neighborhoods with piped supply.

Continuity in water supply is particularly important to ensure good quality. All water networks have leakages, and with interruptions in water supply there is an immediate risk for in-pipe contamination. Polluted water carrying waterborne diseases can enter the pipe through cracks during low pressure, and eventually reach the consumer when water pressure is restored. Unreliable water supply also forces households to build up water storage, with stagnant water becoming a health risk. Lack of supply can also drive people to acquire water from inferior sources.

4.2. Challenges ahead – more and urban needs

Between 1970 and 2010 the population in sub-Saharan Africa increased by about 90% and communities faced enormous challenges to orchestrate improved water supply.
In fact, as mentioned, more people today lack this service compared to 20 years ago. The projected population increase in the coming 40 years is estimated to be more than 100%, to 1.8 billion by 2050. The global trend in all other world regions is a stagnant or decreasing rural population, with the entire population increase limited to urban areas. With a projected increase of the rural population of 30%, to 710 million, sub-Saharan Africa differs from the rest of the world. However, the 300% growth of the urban population will result in more than 1 billion urban dwellers by 2050 (Figure 5).

![Sub-Saharan Population 1950-2050](image)

Figure 5 | Sub-Saharan urban and rural population projections, medium projection.

Dramatically, more people will consequently need water in both urban and rural areas. In the cities and peri-urban areas the challenge will be daunting. With the assumption that the average per capita water supply in urban and peri-urban areas in SSA today is about 50 liters per person per day (l pers\(^{-1}\) day\(^{-1}\)), the present water supply to these areas amounts to almost 6,000 million cubic meters per year (Mm\(^3\) yr\(^{-1}\)). With a future optimal water supply of 200 l pers\(^{-1}\) day\(^{-1}\) (see Table 1) and a tripling of the urban population, the water supply challenge amounts to 77,000 Mm\(^3\) yr\(^{-1}\), an alarming increase of 1,300%. With the assumption that a daily per capita supply of 100 liters will be sufficient, the increase would consequently halt at “only” 650% in 40 years. It is also important to realize that many cities today, on average, supply less than 50 l pers\(^{-1}\) day\(^{-1}\), and in these cities the amplification factor will be even higher.

Already SSA suffers from poor or no city planning in many of the rapidly growing peri-urban slum neighborhoods. Consequently, to build up a water supply infrastructure, including, for example, drinking water treatment plants, is per se a considerable enterprise. To find enough water is another mammoth endeavor. This will be more complicated compared to the preceding decades, in particular when considering that easily accessible water sources have already been appropriated, and
dramatically increasing competition from industry and agriculture. However, urban rainwater harvesting for domestic use or groundwater recharge might, in some areas, represent an alternative untapped potential for supplemental supply. Another possibility is to recycle wastewater for domestic water use. Through wastewater treatment techniques like osmosis the highest drinking water quality standards can be met. Although quite energy-demanding, this path is already practiced in a water-scarce city like Windhoek.\textsuperscript{13}

Groundwater is an important source for domestic water supply, generally cheaper to develop compared to other sources, and usually naturally protected from pollution. However, with increased population densities and a lack of sanitation, the risk for contamination is increasing. In sub-Saharan Africa about 70% of the population, a distressing 600 million, lack improved sanitation. Coverage is generally higher in cities compared to less well-served rural areas. Many million even lack the most basic sanitation alternatives as pit latrines, and between 1990 and 2008 the population practicing open defecation increased from 190 to 220 million.\textsuperscript{10} An amplified risk of human waterborne diseases contaminating vital groundwater and surface water resources, spread through faeces or untreated wastewater, underlines the quality dimension. Improved sanitation is thus an important parallel track when aiming to provide safe water supply to all in sub-Saharan Africa.

5. \textbf{Agricultural water use}

Water use for cultivation of food crops, feed crops and fodder is directly linked to nutrition. Availability and accessibility of water for agricultural use are thus also directly linked to food security, which according to the 1996 World Food Summit 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.” The concept builds on the three dimensions: \textit{availability}, \textit{access}, and \textit{utilization}. While food \textit{availability} refers to the national or international level of “supply”, including food production, stock levels and net trade, \textit{access} refers to meeting “demands”, i.e. inter- and intra-household food distribution. Effective \textit{utilization} defines the nutritional status of individuals and relates to whether individuals and households make good use of the food they have accessed, e.g. if food can be prepared under sanitary conditions and if the health status is such that essential macro and micro nutrients can be metabolized and absorbed.\textsuperscript{13} While \textit{domestic water use} is a prerequisite for optimal utilization, \textit{water for agricultural water use} is a requirement for availability. In SSA many smallholders are subsistence farmers living at the mercy of erratic rainfall and seasonal river flow. The volatile and unpredictable availability of green and blue water directly impacts the
fourth component related to food security, i.e. stability over time. With low dependability of water for agriculture many people are faced with chronic food insecurity and locked into a nutritional poverty trap. It is more often persistent conditions, like long-term or recurrent water scarcity, that determine the food security situation. Worldwide, in 2004 as much as 92% of hunger deaths were associated with chronic conditions, and only 8% related to humanitarian emergencies. 

5.1. Nutrition transition - more food for some, others still undernourished

The global shift from prevalent under-nourishment to richer and more varied diets, often leading towards over-nutrition, has been termed “nutrition transition”. Indigenous staple grains, starchy roots or locally grown vegetables and fruits, are replaced by more varied diets that include more pre-processed food, more added sugar and fat, often more alcohol, and more foods of animal origin. Livestock production generally increases the pressure on natural resources, as only a fraction of the vegetal energy consumed by animals is transformed into meat, milk or eggs.

Economic development and urbanization are key drivers as people move up the food chain and become consumers on the urban and, thus often, on the international market. In SSA, both access to affordable food and persisting under-nourishment and food insecurity are present at the same time, and chronic under-nutrition exists parallel to increasing childhood obesity and adult-onset of diabetes even in poor communities. The shift from subsistence economy to a modern industrialized society, with changed diet patterns, has in some sub-Saharan cities taken place in a span of only 10-20 years. Considering the projected urbanization shown in Figure 5 and current and projected positive economic development in parts of the region the diet changes are likely to gather speed.

In Figure 6 per capita calorie food supply from vegetal and animal products for four African sub-Saharan FAO regions (Appendix 1) are visualized next to some key developed and rapidly developing regions. The average total food supply level in North America is a staggering 3,700 kcal pers\(^{-1}\) day\(^{-1}\), and both North America and Europe have a supply of animal foods of around 1,000 kcal pers\(^{-1}\) day\(^{-1}\), or about 27%. Brazil and China are two examples of how economic development and urbanization have driven national average food supply levels to 3,000 kcal pers\(^{-1}\) day\(^{-1}\) and an animal foods fraction of more than 20%. These estimates include a staggering 130 million under-nourished in China and 12 million in Brazil. It is interesting to notice that the current situation in India is equal to that in Brazil in the beginning of the
1960s and in China around 1980. Out of the sub-Saharan examples, southern Africa, including Botswana, Namibia and South Africa, have the highest regional average per capita food supply, with about 400 kcal pers\(^{-1}\) day\(^{-1}\) from animal products. While both western and southern Africa since the 1960s have displayed an increasing trend, eastern Africa is stagnant and levels are distressingly falling in middle Africa.

Figure 6 | Per capita calorie food supply per day 1961-2007 separated into vegetal and animal calories for nine regions and countries, and three standard food supply levels for comparison.\(^\text{18}\)

In the analysis of future challenges for 2050 (given below) the three standard supply levels to the right in Figure 7 are used, and as can be seen southern Africa is approaching the highest level, western Africa the second highest level, and eastern Africa is close to the minimum level. If the regions in sub-Saharan Africa are to follow the same pattern as in many other developing countries, as China or Brazil, it can expect a pattern with higher levels and more animal products.

The very low food supply levels in middle and eastern Africa coincide with the widespread under-nourishment in many countries as visualized in yellow to red in Figure 7. This highlights the role of agricultural water use, not only to meet future higher demands, but to secure fundamental nutrition and basic food security. In 2006-2008, the total number of under-nourished in SSA was almost 210 million, or 27% of the population.\(^\text{19}\) Accordingly, the low average food supply values for sub-Saharan Africa regions shown in Figure 6 can be partly explained by large numbers of under-nourished. Overall, the picture has changed dramatically over the last 40 years, since most of SSA at the time of independence was food self-sufficient.\(^\text{20}\)
5.2. Food water requirements – for vegetables, animal foods and losses

The consumptive water use for different food compositions varies with regard to total calorie level, proportion and combination of different vegetal components, and share and mix of animal food items. The consumptive water use for different diets is basically derived from the water productivity in plant growth for vegetarian foods, of feeds and fodder used for livestock, and the conversion efficiency from vegetal feeds to animal foods.

5.2.1. Vegetal products

ET is an inevitable part of all plant growth. For a given crop and climate there is, in principal, a linear relationship between transpiration (T) and the yield of total crop biomass, i.e. the dry matter in the roots, stems, leaves and fruits/grains. The main variable part of the total ET is the E.22 While transpiration thus contributes to productive crop growth, evaporation represents “collateral” unproductive water losses.23

Two main categories of crops are grown for food production. Plants like wheat, barley, rice, potato, lucerne, soybean and pea belong to the least-water-efficient category and are consequently often grown in the temperate climate zone. Plants like

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Figure 7 | Undernourishment on country level in percentage of the population.21
maize, sugar cane, sorghum, and several other grasses are adapted to hotter climates and are more water-efficient. As an example, global data show a crop water requirement, i.e. ET per kilo, of 0.6 to 1.7 m$^3$ kg$^{-1}$ for wheat (mean 0.9) and 0.4-0.9 m$^3$ kg$^{-1}$ for maize (mean 0.6).$^{24}$

5.2.2. Animal products

Livestock water productivity depends on how efficient an animal can convert the feed to animal meat, dairy, egg or other produce, all depending on how and where production is taking place, e.g. the livestock system, breeds, management and different environmental conditions. The feed conversion efficiency rate denotes the amount of feed necessary to produce one unit of meat or other animal product.

Monogastric animals, like poultry and pigs, have a better conversion ratio than ruminants and consume as a rule only 2-4 kilos of grain per kilo of meat compared to 7 kilos of feed per kilo of meat for cattle, sheep and goats.$^{25}$ The actual feed conversion rate for each animal in combination with the ET to produce the feed thus decides the water productivity of livestock. The advantage of ruminant’s ability to digest grass makes it possible to base large parts of the feed demand for this category on grazing on pasturelands unsuitable for cultivation and on crop residues like straw. Ruminants can thus partly be produced without competing for green and blue water resources for vegetal crops. In contrast, industrial production of chicken and pigs depends on feed crops. Although these monogastric animals are more efficient and use less feed per kilo livestock product, the feed use directly competes for the same land and water resources as food crops.

5.2.3. Food losses

In a world with limited and decreasing water resources for food production food, considerable benefits could be reaped if food losses could be minimized. As shown in Figures 8a and 8b, developing and developed countries clearly differ. In developing countries more than 40% of the losses and spoilage takes place on the field, during transport or processing, i.e. before the produce reaches the market. In contrast, in North America and Europe, losses and waste are marginal in the first steps of the food supply chain, but very large in the latter half. In total, the food waste at consumer level in industrialized countries is almost as high as the total net food production in sub-Saharan Africa (222 vs. 230 million tons).$^{26}$
5.3. Challenges ahead – mammoth food water demands in water-scarce SSA

To assure food security for all in SSA will be an ambitious task. **Figure 9** spatially illustrates the close relationship between the population increase and the water constrained savannah climatic zone, which also overlap with the occurrence of under-nourishment as shown in **Figure 7**. Projections for 2050 show that, in the coming decades, the average per capita food supply levels in developing countries will increase considerably (**Figure 10**). In SSA, the average is expected to increase from 2,200 kcal pers\(^{-1}\) day\(^{-1}\) in 2003/05 to 2,700 kcal pers\(^{-1}\) day\(^{-1}\) in 2050. However, this forecast still includes a large number of under-nourished in SSA. From the present level of almost 220 million (2006/08) a projected decrease of 40% would mean that still 130 million would be under-nourished by 2050.\(^{27}\)
5.3.1. Food water requirements – increased availability, decreased demand

Several factors have to be considered when analyzing water for food production. Basically, the future challenge for sub-Saharan Africa can be divided into two different options when meeting future food demands. On the one hand, more water for food production can be mobilized and, on the other hand, food water requirements can be reduced.
Water use in agriculture is a continuum that stretches from purely rain-fed, as in most cultivated lands in sub-Saharan Africa, to fully irrigated fields as in large areas in Egypt. The potential for collecting surface run-off in large-scale reservoirs in SSA is still not fully utilized, and initiatives are now taken to secure more storage to balance natural rainfall variability, to meet demands from growing populations, and to build buffers to balance climate-change-driven precipitation alterations. However, in largely rain-fed SSA small-scale rainwater harvesting offers a high potential to secure crop growth for smallholders. One option is to build small run-off collecting storage structures such as dams, ponds and tanks in the landscape, for supplemental irrigation of field crops during dry spells, or for continuous garden crops. The other option is to use the soil as storage for infiltrated rainfall, and the capacity can be amplified by soil management techniques, increasing the infiltration and improving the water-holding capacity.6

If enough blue or green water cannot be mobilized for crop cultivation to secure national self-sufficiency, one option is to turn to food import. This is thus a way to externalize the water use for food production to meet food demands. The amount of consumptive water use behind food traded from the exporting country is conceptualized as “virtual water.” With increasing dependability of food imports, many countries have to rely on virtual water trade, and globally about 10% of the total consumptive water use for food is traded “virtually”.28

There are also different measures to decrease food water requirements. The first and most obvious option is to increase the water productivity (WP), i.e. “more crop per drop”. The WP potential is particularly high at low yield levels and thus an option for many smallholder farmers in SSA.6 Animal water productivity can also be improved, basically through a combination of three components: the direct water use, i.e. ET from crops for feed, fodder or from grazing lands; conversion efficiency of feed and fodder to animal products; and the “coupled” feed-livestock water productivity which includes, e.g. choice of production system; strategic choice of less-water-intensive feeds, etc.

Reducing losses is a second option. With modern harvest, transport and storage techniques, a large part of the losses in SSA can be overcome, as seen for Europe and North America in Figures 8a and b. However, regions rapidly becoming middle-class societies risk replacing one wasteful food system with another. As can be seen in Figures 8a and b food losses have started to shift from the first to the second half of the food supply chain in most regions. Only SSA and South and South-East Asia still have the same pattern. But, for meat losses, SSA alone have more than 50% of the losses in the first production step, indicating the importance of animal health and
animal management, etc. A global average per capita food supply level of 2,200 kcal pers\(^{-1}\) day\(^{-1}\) can be considered to be the loss-free level.\(^{29}\) This level is also often used as the break-off level by FAO, and is just above the poverty line for food energy intake of 2,100 kcal pers\(^{-1}\) day\(^{-1}\) used by the World Bank.

A third option is to reduce the amount of animal products in the food supply. As a global average it has been assumed that 0.5 m\(^3\) of ET are required to produce 1,000 kcal of vegetal products and 4 m\(^3\) 1,000 kcal\(^{-1}\) of animal products. In other words, in this simplified global-level comparison, replacing a calorie from vegetal products with a calorie from animal products requires eight times more water.\(^{15}\) For a standard per capita food supply of 3,000 kcal pers\(^{-1}\) day\(^{-1}\) and 20% from animal foods the annual water demand mounts to 1,300 m\(^3\) pers\(^{-1}\) yr\(^{-1}\).

**Figure 11** visualizes food water requirements for different food supply levels, different animal products fractions, and with and without food-loss reductions under two alternative water productivity levels. The figure reveals the importance of animal foods and losses for the overall food water requirements. If the animal foods fraction is reduced from 20% (3,000 kcal and 20%) to only 5% (3,000 kcal and 5%) the gain is as large as 45%, and if instead food losses can be eliminated (2,200 kcal and 20%) the annual per capita water gain is more than 25%. With both a reduction of animal products to 5% and a loss-free food production chain (i.e. 2,200 kcal and 5%) the total gain at the initial water productivity level is almost 60%. In the example it is assumed that the WP gap is 600 m\(^3\) pers\(^{-1}\) yr\(^{-1}\). A WP gap closure of 50% (50% of 600) thus reduces the annual per capita demand by 300 m\(^3\) pers\(^{-1}\) yr\(^{-1}\) down from 1,300 to 1,000 m\(^3\) pers\(^{-1}\) yr\(^{-1}\) (the four columns to the right in the figure). The figure highlights that even if the WP gap is optimistically closed by 50% the water gain will not be more than 25%, and thus less than if all losses are eliminated. The last pillar summarizes how the annual food water requirements can be theoretically reduced by almost 70%, by combining improved WP, less animal products, and no losses, i.e. from 1,300 down to about 400 m\(^3\) pers\(^{-1}\) yr\(^{-1}\).
Figure 11 | Bringing down food water requirements – comparing a per capita food water requirement of 1,300 m$^3$ pers$^{-1}$ yr$^{-1}$ and a future level of 1,000 m$^3$ pers$^{-1}$ yr$^{-1}$. Considering full standard food supply, no losses, less animal products, and combined loss-free and less animal foods.

5.3.2. SSA food water requirements 2050 – water scarcity or trade

To feed the sub-Saharan population by 2050 two challenges have to be faced, as mentioned above. Food production must be amplified to cater to the expected population increase of 900 million, and the Millennium Development and World Food Summit goals must be reached with enhanced per capita food supply to assure an acceptable diet level for the present under-nourished 220 million.

In Figure 12 the extracted results for sub-Saharan Africa from a global food water requirement analysis are visualized. The research study explores how availability of water resources by 2050 correlates to global food demand, analyzed on country level for food self-sufficiency. The results show whether a country has surplus water that can be used for food export or whether it is water-deficit and needs to import, or to find other solutions.

For any country with too little water available for self-sufficient food production import is a solution to balance food deficits. However, this is only possible for countries with necessary purchasing power. In the analysis, the economic situation in 2050 is assumed to follow a recent World Bank income country group categorisation. Countries are grouped according to 2009 gross national income (GNI) per capita, calculated using the World Bank Atlas method, giving four groups: Low Income; Lower Middle Income; Upper Middle Income; and High Income. For
2050 it is assumed that the three upper groups will have purchasing power to import food to compensate for water deficits. However, the poorest country group, i.e. Low Income, is assumed to lack this option. In Figure 12 only SSA is included and most countries thus fall into the two lowest categories, Low Income and Lower Middle Income. In the left column of Figure 12 the water deficits and water surpluses for the different economic income groups are visualized. In the right column the summarized populations for the different surplus and deficit categories are shown.

Country-level water values are generated from the process-based vegetation and hydrology model LPJmL including both green and blue water resources. Modeling is done for different crops on current croplands and combined and correlated to FAO statistics for yields, etc. to produce estimates at the national level. The underlying approach builds on calories, both regarding water productivity and demand. The base year is 2000, and scenarios are developed for the year 2050. Country-level food production on current croplands is analyzed for different per capita food supply combinations at the national level, considering several parameters. Population numbers are given by the UN medium population forecast. In all cases, climate change impacts on crops are included in the LPJmL modeling.

Statistics show that prevalence of under-nourishment tends to decrease towards zero only when the national per capita food supply approaches 3,000 kcal cap\(^{-1}\) day\(^{-1}\).\(^{33}\) To reach full nourishment in the analysis 3,000 kcal cap\(^{-1}\) day\(^{-1}\) and 20% from animal products (as in China or Brazil today) are thus the first level of three compared food supply combinations. The second represents minimal animal foods with a 5% fraction, still at the 3,000 kcal pers\(^{-1}\) day\(^{-1}\) level. The third is the loss-free level of 2,200 kcal pers\(^{-1}\) day\(^{-1}\) and 5% from animal products. Baseline water productivity is compared to a 25% WP-gap closure. In Figure 11 above, a 50% gap closure is exemplified. However, a 25% closure is a more realistic achievement and thus used here. In the three latter examples irrigation expansion is assumed to have been achieved, i.e. potentially available blue water is used to meet crop water deficits.

Figures 12 a and b visualize the situation in 2050 with the medium population projection and an average per capita food supply of 3,000 kcal pers\(^{-1}\) day\(^{-1}\) and 20% from animal products, and with the baseline water productivity. In fact, when viewed in the global context the water deficits in SSA stand for 96% of the global deficits and are so large that export from surplus countries, like USA or Brazil, would simply not be large enough. After taking differences in water productivity between importing and exporting countries, the demand from water-deficit countries would be seven times larger than the possible export.\(^{28}\)
Figures 12c and d show how the situation changes if the water productivity gap is closed by 25% and modeled possible irrigation expansion increases the blue water availability on current croplands. Deficits dramatically decrease, from 6,800 to 1,600 km$^3$ yr$^{-1}$. Globally, deficits can, in principle, be met by food export from water-surplus countries. With improved agricultural output a few SSA countries shift from being deficit to surplus countries, like South Africa. This can be seen when comparing Figures 12b and d where 58 million in the Upper Middle income population move from import to export. More worrying is the fact that 1.1 billion people will still live in sub-Saharan countries where part of the food supply cannot be imported, due to lack of purchasing power.

In Figures 12e and f the fraction of the calories from animal products has been reduced to 5% and in Figures 12g and h the overall calorie level has been reduced to only 2,200 kcal pers$^{-1}$ day$^{-1}$, the loss-free level and the current level in eastern Africa. For every change in the food combination the deficits decreases, but there is still a deficit that needs to be met. The results highlight the critical situation for the countries that are harboring 1.1 billion by 2050 and lacking water for food production, even at the lowest average calorie level.

Availability of food and water will be a critical issue in the coming decades. As mentioned, the analysis above builds on potential water availability on current croplands and a horizontal expansion of croplands can thus be one solution. However, such an expansion of current croplands to appropriate more green water implies that current vegetation and ecosystems will be replaced, endangering the resilience of the important SSA wildlife ecosystems and pastures. Any potential horizontal expansion also requires that the rainfall is sufficient and the lands are suitable for crop cultivation. Each country thus has to be analyzed individually.

Any country lacking the potential of full expansion of croplands to meet food demands will be in the most precarious situation, and might have to rely on food aid. A more constructive option would be international support to these countries to enable an economic development that opens up for food import to ensure national food security.

In summary, from a food water requirement and agricultural water availability perspective, Figure 12 shows four different scenarios for the sub-Saharan region by 2050. To ensure food security and provide food for all will accordingly be a major endeavor.
Figures 12a-f | Food water surplus and deficit in SSA in 2050 for four income country groups, three food supply combinations, for current water productivity (WP), and for 25% WP-gap closure and irrigation expansion. Blue indicates a food water surplus and food export possibilities, green indicates deficit with an income level permitting import, red indicates deficit countries assumed too poor to afford import. All cases include climate change (CC) impacts. NB: the scale of the vertical axis in differ c, e and g.
6. **Research issues – water and nutrition**

The linkages between water availability and accessibility and nutrition are manifold and a number of research questions can be formulated to address future challenges.

6.1.1. **Water availability across sub-Saharan Africa**

Water resources availability in sub-Saharan Africa is characterized by a large variability across both temporal and spatial scales. With water being a prerequisite for nutrition, it is crucial to understand where, when and how much water will be available for different uses.

**RQ 1:** How can data about hydro-climatic conditions (as precipitation, ET demand, temperature) and hydrological conditions (as run-off formation, river flow and groundwater levels) be more efficiently collected and shared across SSA?

**RQ 2:** How can these data be used to generate reliable water availability analyses? How much water is, and will be, available - including water storage to build redundancy – for both domestic and agricultural uses?

**RQ 3:** How can these data be transformed into information about water availability and accessibility to managers across different water-related fields to increase the understanding of water challenges and to encourage required actions? How can it be assured that this crucial information is shared?

6.1.2. **Domestic water availability and accessibility, and nutrition**

By 2050, the urban population in SSA will have tripled and the rural population will have increased by one-third. In the urban areas, the domestic water demand might increase by 650-1,300%. Domestic water is necessary as drinking water, for food preparation, and for personal hygiene, all three of which are prerequisites to secure the nutritional status of any person.

**RQ 4:** How can adequacy and continuity of domestic water supply be assured in the decades to come? Where should the water come from? Which sources can, and should, be used?

**RQ 5:** It is unlikely that optimal access to water can be mobilized for all (Table 2). How can the standard of drinking water be improved and how can personal hygiene be maintained, also for those still living under water-scarce conditions? How can
research find pathways to educate and motivate people without a reliable improved water supply to improve hygiene?

**RQ 6:** Water quantities must be matched by water quality. How can a minimum standard of sanitation be implemented to assure that water resources and water supply are not contaminated by waterborne human diseases?

**RQ 7:** Poor and resource-weak people are particularly vulnerable. How can these groups be assured of affordability, continuity and quality of domestic water supply?

**RQ 8:** Technological development is moving fast, e.g. wastewater can viably be treated and reused as drinking water, and information technology can improve monitoring of water supply and water quality. How can new technical options be used to improve and optimize domestic water supply?

### 6.1.3. Agricultural water availability and accessibility, and nutrition

In four decades the sub-Saharan African population will increase by 900 million. Already 220 million are under-nourished. Food supply for all will be a huge undertaking, and translated to agricultural water demands more water will be required than appear to be available. Improved agricultural water productivity and irrigation expansion will assure food self-sufficiency in some SSA countries. Other water-scarce countries, which have economic capacity, rely on food import. However, the majority will face major difficulties in both producing and importing the necessary food quantities.

**RQ 9:** The static analysis presented in this paper shows national food production self-sufficiency in a water perspective. More research can reveal to what degree food production in each local site is water-constrained. How should water-scarce countries act to assure food self-sufficiency? A plethora of options and alternatives must be developed. What are they?

**RQ 10:** A static analysis presents a baseline. However, today’s world is characterized by dynamic cross-scale linkages, including biophysical and socio-economic dimensions. For example, climate change might alter fundamental agricultural preconditions as climate seasonality and storm frequency, and social or economic turmoil in another part of the world can suddenly propel food prices and agricultural input costs rupturing both national food production and the global food trade system, potentially blocking imports. How can SSA countries build redundancy in their food production system to increase the resilience to such rapid changes? How
can different buffers regarding water storage and food supply be increased to build coping capacity?

**RQ 11:** Any losses along the food production chain represent a wasted water quantity. How can food losses be minimized in SSA to save water for additional food production and thus improved nutrition?

**RQ 12:** More than 50% of the losses in the livestock sector in SSA take place in the animal production step (Figure 8b). Why is it so? How can these losses be reduced to both save water and increase the amount of animal proteins available for consumption?

**RQ 13:** Rain-fed smallholder farmers are the pillars of future SSA food production. With successful water-harvesting techniques, over 50% of lost water can be recovered at relatively little cost. How can farmers be inspired to utilize and manage precious green and blue water resources better?

**RQ 14:** Mixed livestock and crop cultivation systems offer a number of synergies, as to assure diets with high nutrition value and to minimize food water requirements, as biomass residues from crops can be used as fodder. How can these synergies be further promoted and optimized?

**RQ 15:** The ongoing nutrition transition towards higher consumption of more sugar, cereals like wheat and rice, and more animal foods often lead to more water-intensive agricultural production, like irrigated sugar cane or paddy and production of pigs and chickens. A diet based on traditional cereals, often better adjusted to water-scarce conditions and more nutritious, and animal foods from ruminants, feeding from pastures and crop residues, would decrease the water demand. How can nutrition researchers impact food consumption and food preferences to secure a sustainable and water-resource effective food production and a healthy diet for all?

### 6.1.4. The nexus of domestic and agricultural water use and nutrition

Peri-urban areas are characterized by informal settlements without property rights, lack of planning, and continued inflow of new settlers. The likelihood is high that the future SSA urban majority will live in these areas where human living conditions often imply poverty, under-nutrition and lack of both water supply and sanitation. Here the domestic and agricultural water use overlap and thus open up for both options and challenges.
RQ 16: Peri-urban agriculture links urban water use and food production as untreated waste water is often used for cultivation of perishables, e.g. fresh vegetables and salad, at a short distance from urban consumers. On the one hand, this food production generates income and nutritious foods and, on the other, the health risks are considerable. How can the health aspects be addressed to safeguard the nutritional value of the produce, and the health of the farmers using such water sources?

RQ 17: The peri-urban areas are the transition zone between the urban core and the surrounding rural landscape. Often, the uncontrolled settlements spread into catchment areas polluting the water resource for the cities. At the same time, untreated waste water from the urban core often spreads into the peri-urban areas. How can management of scarce water resources be improved to both ensure uncontaminated water sources for the cities and waste water treatment to protect downstream users?

RQ 18: It is virtually impossible to live anywhere without water. Planning of settlements in relation to water resource availability is crucial. How can urban planners gain momentum to manoeuvre the ongoing urbanization in relation to future demand of water resources, sanitation and protection of the environment?

RQ 19: With increased demand for food and increased demand for domestic water supply, the competition for scarce water resources rises. How can multiple uses of water, as for example, drinking water, irrigation, industry, the environment and hydropower, be recognized and optimized to balance competing demands? What trade-offs have to be made?

7. Conclusion

Water and nutrition constitute a multi-dimensional issue stretching from local issues, such as the supply and quality of water from a neighborhood tap shared among a few households, to global World Trade Organization food trade agreements, setting the rules for any water-scarce country reliant on food imports. The overall complexity to secure nutrition in sub-Saharan Africa in the coming decades calls for interdisciplinary approaches. Current, often sectoral ways of thinking must be combined to broaden the perspectives. This is also the case regarding water. Too often, water is separated into individual compartments as water supply, irrigation, or ecosystem considerations without considering the wider interlinkages.
Water is the bloodstream of the biosphere and the base for all socio-economic development, and it is thus the key to almost every aspect of nutrition. The most important and overarching future objective must be to assure that water resources are sustainably used. With over-exploitation of blue water resources, leading to depleted aquifers, rivers running dry and heavy pollution, and mis-management of rain-fed agriculture, with water and nutrient losses and erosion, there is a risk of the base for sustainable water resource use and agricultural development being degraded.

The sub-Saharan region is at the cross-roads of future global water and food dynamics and it is important to find the best solutions. Sub-Saharan nutritional researchers with unique local knowledge have a key role to play when developing a research agenda to find successful avenues for the future.

8. References


Appendix 1. FAOSTAT African country groups

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<td>Sao Tome and Principe #</td>
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<td>Democratic Republic of the Congo</td>
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</tbody>
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| Southern Africa         |                         |
| Botswana                |                         |
| Lesotho                 |                         |
| Namibia                 |                         |
| South Africa            |                         |
| Swaziland #             |                         |

Regional classification according to the M49 UN classification.
# Countries not included in the food water requirement analysis due to lack of data
*NB. Sudan here part of Northern Africa, and thus not part of sub-Saharan Africa.