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Food security in Sub-Saharan Africa: an explorative study

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FOOD SECURITY IN SUB-SAHARAN AFRICA: AN EXPLORATIVE STUDY

BACKGROUND STUDIES

Food security in sub-Saharan Africa: An explorative study

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Food security in sub-Saharan Africa:
An explorative study

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FINDINGS

Food security in sub-Saharan Africa: An explorative study

Summary

Expected demographic, economic and environmental changes in sub-Saharan Africa require concerted policies to improve food security. This study analyses food security issues along the lines of availability, access, and utilisation of food, in relation to policy areas, such as natural resource management and agricultural policies, as well as policies that facilitate and stimulate inclusive growth and food aid for the most vulnerable populations.

Food insecurity is a priority for international development policies

In 2010, 925 million people could not afford enough food (FAO/WFP, 2010). Since the 1970s, the global number of undernourished people generally has remained at this high level. However, over the last decades in sub-Saharan Africa the number of undernourished has increased with 41%, from 169 million around 1990 to 239 million in 2010. This increase is particularly remarkable since the first of the Millennium Development Goals (MDG) is to halve the 1990 level of hungry people by 2015. Also the Dutch Government has set food security as one of the priorities for international development cooperation. In development cooperation, improvement of food security and the development of the agricultural sector are closely related. Next to improvement and conservation of agricultural production, other facets such as population and economic growth, food market dynamics, poverty, climate change and water availability are of importance.

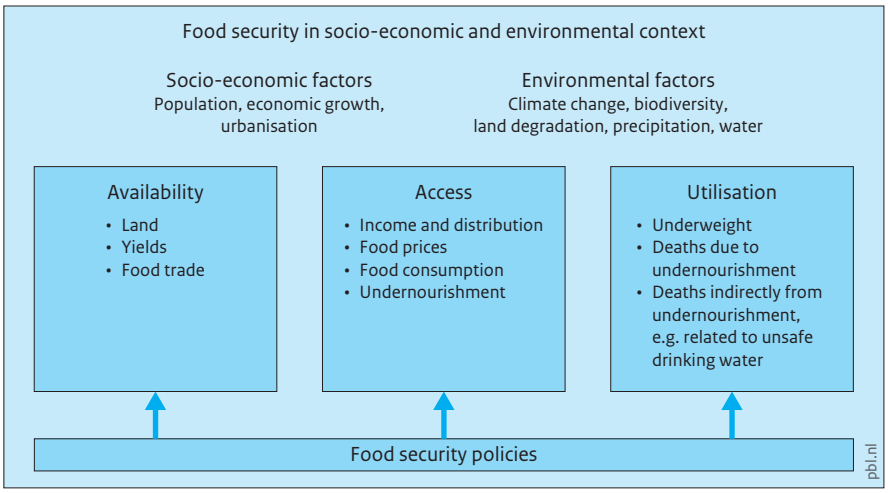
Food insecurity in an integrated framework of availability, access and utilisation

The food security framework used in this study distinguishes three dimensions availability, access and utilisation within the socio-economic and environmental context (see Figure S.1). The framework is helpful to identify and analyse important issues and dynamics of food insecurity. The focus for availability is on agricultural production as a combination of land and agricultural productivity. The access dimension includes food prices, and income and food distribution. The utilisation dimension concerns impacts from inadequate use of food, in particular the prevalence of child malnutrition, and its interaction with other risks such as limited access to safe drinking water. The indicators of the framework are used to analyse food security in sub-Saharan Africa at the regional level to explore the most important long-term dynamics, and at a geographic sub regional level to identify the most food insecure population groups.

Socio-economic changes in sub-Saharan Africa lead to an increase food demand more than fourfold

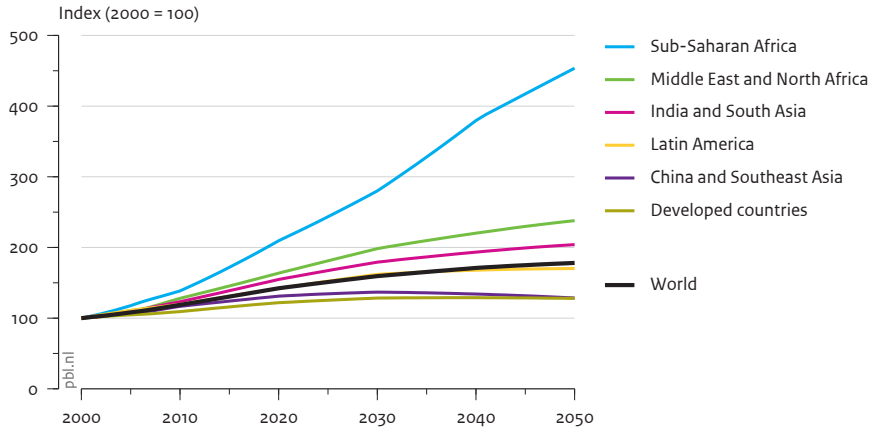
Population and income growth result in a more than fourfold increase in total food demand by 2050, compared to 2000, which is a much stronger increase than in other regions in the world (see Figure S.2). In 2050, the sub-Saharan Africa population is projected to more than double to 1.7 billion people by 2050 compared to 814 million in 2010. The resulting increase in food demand will be further enforced by the projected annual

Figure S.1
Conceptual model to analyse food security



Source: PBL

Figure S.2
Food demand



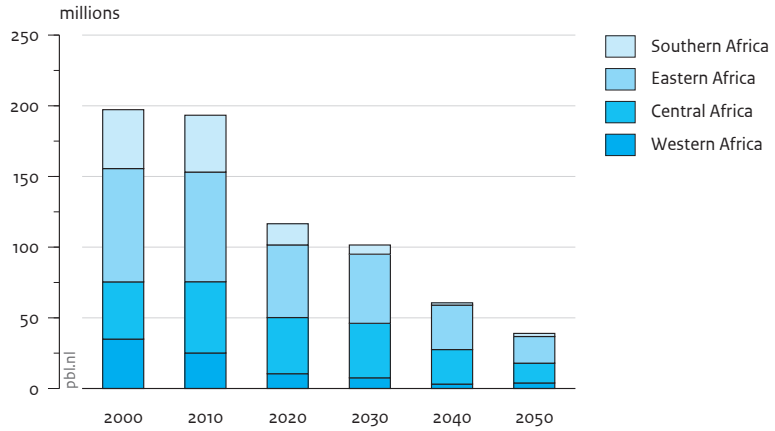
Source: PBL

economic growth of more than 5% over the 2010–2050 period. Higher incomes enable people to have higher food intake levels, and also to switch to different diets (e.g. more meat).

Sub-Saharan Africa has the potential to greatly improve food security

The increase in food demand is projected to be fulfilled by increased agricultural production through expansion of agricultural land and improved agricultural productivity. Especially in west Africa, the potential for expansion is high while in east Africa, where the potential for agricultural expansion is smaller, increase of production relies on improved agricultural productivity. Consequently malnutrition is expected to be eradicated almost entirely by 2050 (see Figure S.3). However, the projected progress will not be enough to achieve the MDG target to reduce the malnutrition level, by 2015, to 50% of the 1990 level.

Figure S.3
Undernourished population in sub-Saharan Africa



Source: PBL

Increased agricultural production will be at the price of the environment

The increase in agricultural production is expected to result in a reduction in forest cover of 29% and, consequently, an accelerated biodiversity loss up to 2030, despite global policy goals of reducing biodiversity loss. Sub-Saharan Africa is expected to show an acceleration in species loss in the coming decades. Half of the additional loss in the period up to 2030, compared to 2000, may be attributed to agriculture and grazing. Between 2030 and 2050, especially infrastructure and climate change will become drivers of biodiversity loss.

Important conditions to take into account to achieve food security

Sub-Saharan Africa will have to take into account factors which, historically, were seen as blocking progress, but also to ensure that factors necessary for success will be stimulated. The most important factors are: 1) a healthy and educated population, essential to be able to capitalise to demographic dividend through higher labour productivity; 2) inclusive growth to let progress at macro level trickle down to poorer population segments; 3) modernisation of agriculture including adequate infrastructure and production conditions; 4) address competing claims, for energy with biofuels as well as for water and irrigation; 5) institutional settings that provide stable incomes and incentives to invest in agriculture; 6) environmental sustainability and ways to mitigate and cope with biodiversity loss and climate variability; and 7) political stability and conflict resolution. These seven conditions are necessary, although maybe not sufficient, for achieving food security.

Food security policies need geographic and location specific information

Policies will be more effectively targeted and better able to attune various development cooperation initiatives if they are based on geographic location specific information on production systems and local economies. An example of regional policies is a development strategy for the Sahel region that combines the challenges of conservation and restoration of the natural resource base with effective improvement of food utilisation. A second example would be policies that warrant the inclusiveness of economic growth that is based on the development of international commodity chains. A third example is the need for policies that target specific spots of poverty that can be found in Mozambique, Uganda or Kenya.

In the arid regions limited food availability causes high vulnerability for relatively few people

Improvement of the lives of population in arid regions requires combined efforts of conservation and restoration of the natural environment and structural alleviation of hunger. The vulnerable groups that live in the arid areas in sub-Saharan Africa represent a relatively small share of the population (less than 10 million people and about 1.5% of the total population). The situation in which these people live is relatively bad from an environmental perspective (land degradation, water scarcity, climate change sensitivity) and from a socio-economic perspective (high poverty, high population growth, limited investment capacities). Recent promising initiatives to re-green the Sahel need to be systematically integrated in national policies such that the entire Sahel region will benefit.

In more productive regions access to rather than availability of food is a constraint for many people

In the more productive areas higher economic growth is observed and population density is an important factor that determines the opportunities to improve access to food. A larger proportion of the population in these regions is more food secure, yet due to high population densities still many people face malnutrition. In the densely populated regions live almost 200 million people (40% of the population) and economic growth should potentially warrant access to food such that food insecurity is prevented. Food security policies in more productive regions should focus on inclusive growth; for example, through making agricultural commodity chains more sustainable.

Recommendations for food security research and policy

The following priorities for policy and research are identified. First, different scenarios should be developed to better account for key uncertainties such as urbanisation, economic growth, climate change and agricultural production. Second, more in-depth analyses are needed on land degradation and water scarcity. On the one hand food insecurity in sub-Saharan Africa is widely present, while on the other hand agricultural land is abundantly available and several countries have the potential to greatly increase food production. Inefficient use of agricultural land and limited availability of inputs may lead to further land degradation and water scarcity. Third, better understanding of production systems including the role of markets, infrastructure and livestock is needed. Important issues are the scale of production, location of production (e.g. agro-hubs) and policies that concern international production chains. Fourth, there is an evident urgency in alleviating hunger and extreme poverty, yet to formulate and implement food security policies, there is a need for unambiguous and useful indicators on the number of undernourished people. Fifth, research is needed for governance issues, in national and regional perspective. Within countries, governance structures should allow for stakeholders involvement to meaningfully participate in policy processes and to generate adequate information. International organisations could play a more pivotal role between donor and recipient countries.

FULL RESULTS

Food security: from challenge to policy

As is reflected in the Millennium Development Goals (MDGs), one of the global challenges is to substantially reduce poverty and hunger in the world by 2015. Another major challenge is to improve food security in sub-Saharan Africa. In addition, the Dutch Development Cooperation (a division of the Ministry of Foreign Affairs) has refocused its priorities, identifying food security as one of the most important ones. This report explores the future challenges for sub-Saharan Africa concerning the possibilities and constraints of achieving food security, making use of global assessments currently undertaken that also include future developments for sub-Saharan Africa, complemented by a geographically explicit vulnerability analysis. This chapter introduces the various facets of food security and its further analysis.

1.1 Many people are food insecure and global demand will increase

The global number of those undernourished is still at a high level

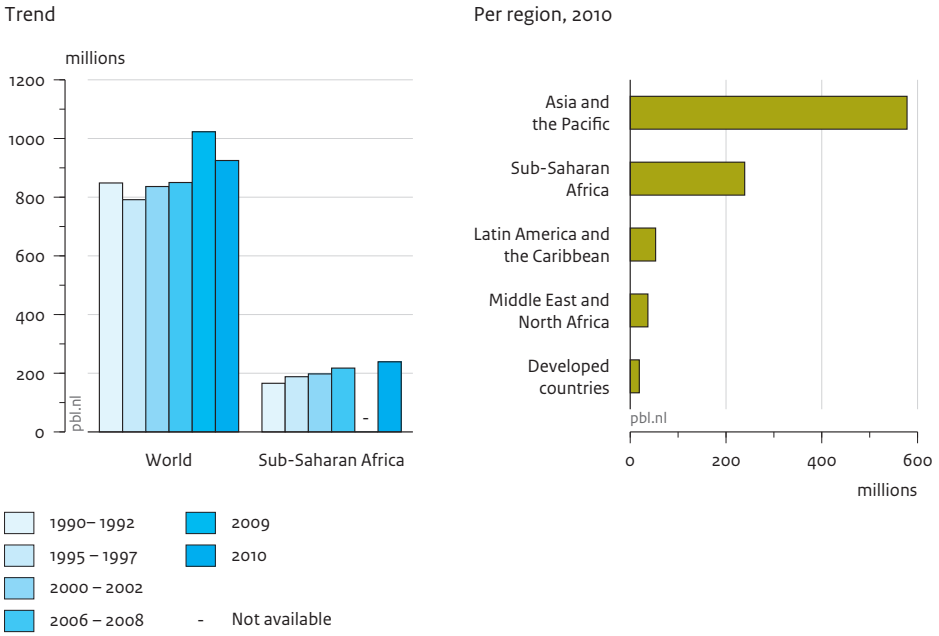
In 2010, 925 million people could not afford enough food for a sufficient diet and, thus, were undernourished (FAO/WFP, 2010). Since the 1970s, the number of undernourished people[1] generally has remained at this high level (Figure 1.1). More than 60% of the almost 1 billion undernourished live in Asia, most of them in India and China, but trends over the last decades have shown that most of the increase in undernourishment has taken place in sub-Saharan Africa. In this region, the absolute number of hungry people over the last two decades increased by 70 million, from 169 million to 239 million, an increase of 41%. In sub-Saharan Africa, the increase is particularly remarkable since the first of the Millennium Development Goals (MDG) is to halve the 1990 level of hungry people by 2015. Expectations of achieving this MDG are rather gloomy (AUC/ECA/AfDB/UNDP, 2011). Given the interrelations between the various Millennium Development Goals (e.g. hunger is associated with child mortality), other goals will also be difficult to achieve even by 2030 or 2050 (PBL, 2009).

The world food crisis has pushed many people into hunger

In the recent years, world food crises pushed many people into hunger (Figure 1.2), putting food security once again at the top of the development agenda (FAO, 2008). The factors behind increases in food prices vary from crop failures to speculation and have their roots in physical, economic and political processes, all with their own underlying dynamics. These dynamics can be structural, such as increases in prices driven by an increasing demand for food and raw material due to population and economic growth, or they can represent a conjuncture of multiple effects, such as those caused by droughts or political instability, causing sharp price peaks. This study focuses on the structural, longer term aspects of food security.

Figure 1.1

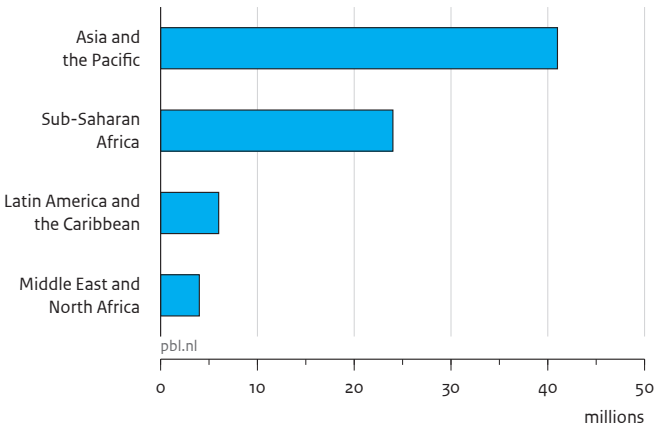
Global number of people undernourished



Source: FAO/WFP, 2010

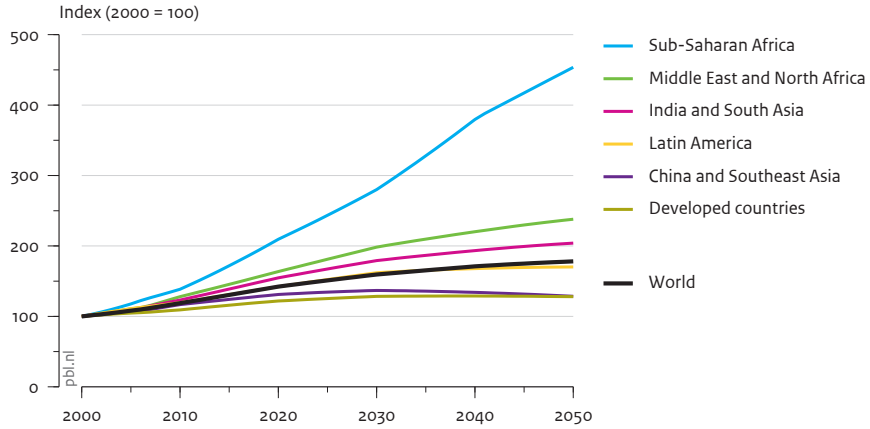
Figure 1.2

Additional number of people undernourished, due to high food prices, 2007



Source: FAO, 2008

Figure 1.3
Food demand



Source: PBL

Projections of food demand show a more than four-fold increase up to 2050

One of these structural changes is an expected increase in world population by 2 billion, in the period up to 2050. When combined with projected economic growth, this will increase the demand for food, tremendously, and will make the goal of halving hunger even more challenging. In sub-Saharan Africa, especially, these changes are expected to be rather dramatic, as the population size is expected to double and the high economic growth rates of the last decade may continue in the near future (see IMF, 2011; Ministry of Foreign Affairs, 2011c; World Bank, 2011a). Given these conditions, the resulting food demand in sub-Saharan Africa is expected to increase by a factor of four to five, by 2050 (OECD/PBL, 2012) (Figure 1.3). This report provides a further elaboration of this trend, including accompanying drivers, the role of agricultural production and impacts on health and the environment.

1.2 Food security in a broader socio-economic and environmental context

Food insecurity in the socio-economic context of poverty, water supply and education

The challenge in sub-Saharan Africa, undisputedly, goes beyond food security. The percentage of the population living on less than 1.25 dollars a day remains around 50%, and the numbers of connections to the water supply and sanitation are lagging behind. Despite the substantial increase in access to safe drinking water, from 56% in 1990 to 65% in 2008, this is not sufficient for the continent to reach the MDG target by 2015 (AUC/ECA/AfDB/UNDP, 2011). Another factor relevant to food security is educational status, especially secondary enrolment of women (Smith and Haddad, 2000b). Despite the progress that has been made over the last decades in some sub-Saharan countries, it seems to be difficult for many of them to achieve the goals on full enrolment in primary education and gender parity in secondary education (World Bank, 2011b).

A fragile agricultural sector needs further investments

Agricultural productivity, per capita, has remained stagnant, especially in areas where smallholders dominate the agriculture sector. These smallholders are provided with limited technical and economic opportunities, have farms on degraded land and are located far from existing rural infrastructure and services and consequently from extension programmes. Public investment in agriculture has dropped significantly, in many countries, to levels below 5% of total public expenditures. This is partly due to declining agricultural and rural development aid (Islam, 2011).

Furthermore, the World Bank's total lending dropped from around 31% in the 1979–1981 period to less than 10% in 1999 to 2000. Recently, however, this tide seems to be turning. In 2003, the African Union launched its Comprehensive Africa Agriculture Development Programme (CAADP), which binds participating countries

to allocating 10% of public expenditure to agriculture, and, by 2009, certain countries (Malawi, Tanzania, Rwanda, Mali, Ethiopia, Ghana and Nigeria) had reached this goal. The 2008 World Development Report, 'Agriculture for Development' (World Bank, 2008a), also put agriculture firmly on the agenda again of multilateral and bilateral donors. In addition, private and public investors from China, India and Brazil have become increasingly interested in investing in African agriculture. Nevertheless, in order to halve hunger, analysis shows that African governments will need to increase their annual agricultural spending by 20% (Prieto Rodao, 2009).

Decline in natural resources and climate change will put further pressure on food security

The natural resources needed to produce sufficient food are under pressure. Conversion of remaining forest areas into agricultural land, with its concomitant biodiversity loss; increasing demand for water for irrigation, and exhaustion of fertile land, all represent possible limitations to the ability to feed an additional 2 billion people, 1 billion of which in sub-Saharan Africa. The complexity of water and food security is not only exacerbated by climate change – something that affects both water availability and agricultural yields – but also by climate change mitigation strategies; in particular, the production of biofuels to reduce greenhouse gas emissions. The use of certain crops, such as corn and sugar, for biofuel production may cause the scarcity of staple food, and thus to an increase in food prices and possible competition and conflicts over land.

1.3 Dutch Development Cooperation focuses on food security

Current policies of the Dutch Development Cooperation

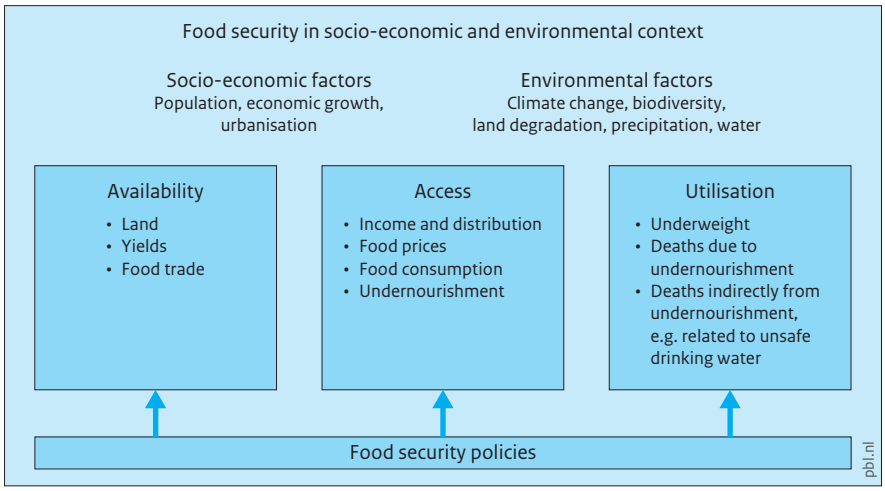
With the formation of a new government in 2010, the Netherlands also initiated a change in international cooperation policy (Ministry of General Affairs, 2010). This resulted in a focus on bilateral aid for 15 partner countries and a focus on the themes of water and food security (Ministry of Foreign Affairs, 2011a). At the same time, these themes were put in the broader international context of global challenges related climate change, migration and poverty, in line with recommendations by the Scientific Council for Government Policy (WRR) (Van Lieshout et al., 2010). Recommending a global public goods approach for international cooperation implies coherence between development cooperation and other foreign policies; for example, those on trade, agriculture and climate (Kok et al., 2010a). Furthermore, solutions to certain global issues, such as climate change, require broad collaboration, while others, such as global food production, could be approached more efficiently by an individual country or group of countries taking the lead. A recent OECD review of Dutch Development Cooperation supports the policy shifts made in 2010 and recommends to make different policies more coherent in a strategy for i) the achievement of development targets, ii) the alignment with international cooperation, and iii) communication between private sectors, civil societies and governments (OECD, 2011).

Food security as a major policy priority

The Dutch Government has set food security as one of the priorities for international development cooperation. Food security is locally important but has characteristics of global public goods (Ministry of Foreign Affairs, 2011b). Dutch development cooperation defines specific targets with respect to food security. For this report, the target concerning availability of food is relevant. Development cooperation should contribute to an increase in food production that is based on management of natural resources and technology development. Another target concerns access to and utilisation of food. The indicators relevant to this target cover access through poverty alleviation (employment and income), and utilisation through targeted food programmes. In addition, a decrease in the number of malnourished children is one of the result indicators.

In development cooperation, improvement of food security and the development of the agricultural sector are closely related. Conservation of production potential and improvement of productivity are named as main priorities, in particular for sub-Saharan Africa (Ministry of Economic Affairs - Agriculture and Innovation and Ministry of Foreign Affairs, 2008). Eradication of poverty and hunger is a key issue in bilateral cooperation, and policies oriented at sustainable production chain management seek to better incorporate the private sector in development efforts (Ministry of Foreign Affairs, 2011c). For international commodities, national governments in developing countries need to be supported in facilitating private sustainable development initiatives (Ministry of Economic Affairs - Agriculture and Innovation, 2011).

Figure 1.4
Conceptual model to analyse food security



Source: PBL

1.4 Methodology and outline of this report

This report explores how the complex socio-economic, environmental and institutional factors may be linked to various aspects of food security to address the new policy priorities of the Dutch Development Cooperation. To realise these priorities, connections must be made between different scales, from global to national to regional and local and vice versa, taking into account future risks and opportunities.

Food security in sub-Saharan Africa is regarded along the lines of availability, access, and utilisation of food (see Box 1), reflecting different facets of food security, from agricultural production and the means to produce to distributional aspects and purchasing power, and to the effects of undernourishment in the context of other related environmental diseases burden. Given the analytical framework at hand, the analysis was limited to the more structural aspects of stability. Short-term factors, such as price shocks and extreme weather events, are beyond the scope of this study.

Research objective and questions

The objective of this study has been to support development policy on alleviation of food insecurity in sub-Saharan Africa. Formulation of such policy could benefit from a medium- to long-term perspective on development trends, as well as from geographically explicit analysis to identify population groups specifically prone to food insecurity. The research questions addressed in this report are:

- What will be the general perspectives for sub-Saharan Africa for the coming decades, with respect to food security given future environmental and socio-economic conditions?
- Which population groups are specifically vulnerable to food insecurity?
- Which policy challenges and opportunities can be identified, in order to combine policies for environment and food security?

Conceptual framework to analyse food security and policy options

Food security, for this report, is analysed along the dimensions of availability, access and utilisation. Availability refers to production and imports of food in sub-Saharan Africa. Main points of attention for the analysis of food production in sub-Saharan Africa are the quality and availability of the natural resources land and water, biodiversity and related climate issues. Access refers to food prices, income levels, infrastructure and urbanisation. Utilisation is considered by analysing poverty and health indicators related to hunger (e.g. people being underweight and child mortality). These three dimensions are not considered in isolation, but in a socio-economic and environmental context, and linked to possible entry points for various policies on food security. The resulting conceptual model (Figure 1.4) serves as an organising framework for the different facets of food security.

Text box 1
The concept of food security: Availability-Access-Utilisation

Food security was defined in the 1996 Rome Declaration as 'Food security, at the individual, household, national, regional and global levels exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life'. Three aspects are commonly addressed in food security studies:

- Availability addresses the supply side of food security and is determined by the level of domestic food production, stock levels, and net food trade.
- Access to food is ensured when all households and all individuals within those households have sufficient resources for acquiring the appropriate foods that make up a nutritious diet. Whether this can be achieved depends on the level of household resources (capital, labour and knowledge), food prices and the presence of social safety net. And most important is the ability of households to generate sufficient income which, together with own production, can be used for meeting their nutritional needs.
- Utilisation of food has a socio-economic and biological aspect. If sufficient and nutritious food is available and accessible, households must decide which foods to consume and in which proportions. Appropriate food intake (balanced and micronutrient-rich food) for young children and mothers is very important for nutritional status. This requires not only an adequate diet, but also a healthy physical environment, including safe drinking water and adequate sanitary facilities, as well as an understanding of proper health care, food preparation and storage processes. In addition, health-care capacity, behaviours, and practices are equally important.

Policy options to improve food security

The policy options to improve food security may look numerous, from the transfer of agricultural technology to providing meals at schools, and from lowering trade barriers to women's education (e.g. FAO, 2006; World Bank, 2008b; Prins et al., 2011). The concept of food security provides a framework for a better positioning of these policy options along the lines of availability, access and utilisation. The so-called twin-track approach of the FAO (2006) is also organised along these lines, although the approach takes access and utilisation as one category of policy options. Although our report does not contain an exhaustive overview of food security policies, the positioning of certain policies in our analyses does provide better insight into the extent to which they may be focused on the various policy aspects.

With respect to improved availability, this report focuses on the agricultural production capacity related to natural resources, such as soil, water and biodiversity that need to be restored or protected. Examples are the re-greening based on limited use of external inputs (Reij et al., 2009b), soil water conservation techniques, plus the use of fertiliser (such as evaluated for the Mali cotton region by (Bodnár, 2005) and interventions targeted at forestry based livelihood systems (Sunderlin et al., 2008)).

Regarding improved access, the focus is on the role of international commodity chains, high value niche crops and markets in the increasingly urbanised sub-Saharan countries. Generic economic growth reduces poverty but attention is needed for lower income population groups. Economic growth is more inclusive in high-growth regions and growth is more inclusive when it takes place in the agricultural sector (IMF, 2011). Local market orientations seem more appropriate in regions where agricultural production is based on cereals, root and tuber crops, and other vegetables.

With respect to improved utilisation, the focus is on policies related to the World Food Programme; school feeding programmes (AUC/ECA/AfDB/UNDP, 2011); and health and water programmes. An example of a success story is how Ghana managed to alleviate hunger with the nation-wide school feeding programme (WFP, 2010a). These targeted transfer programmes need to be considered where economic growth is not inclusive (IMF, 2011).

An integrated analysis over time and scale

For this report, we analysed food security from different perspectives with an integrated approach, which is visible in the framework where food security is considered in the socio-economic and environmental context. This report uses outputs from the modelling suite of PBL (i.e. IMAGE (MNP, 2006), GISMO (Hilderink and Lucas, 2008), and GLOBIO (Alkemade et al., 2009), see the appendix for more info)), which enabled analysis of the whole causal chain, from population growth to climate change and impacts on hunger, as well as of the inherent feedbacks in this chain; for example, from climate change on agricultural productivity. Moreover, this modelling suite

also enabled us to explore medium- to long-term developments. Exploration of the future was done by making use of the 'Environmental Outlook to 2050' (OECD/PBL, 2012) with special attention to the environmental aspects of food security. This Environmental Outlook describes the most important future developments for the world regions, including for sub-Saharan Africa.

In addition, the aspect of matching different scales comprises the connection between a top-down and a bottom-up approach. We used the analysis on global and continental levels for combining macro development trends of economy, demography, environment, and climate, with food security. At the lowest level, we analysed grid-based vulnerability to obtain a better understanding of how these macro factors work on a local level, with the purpose of identifying the most vulnerable groups and the most important external stress factor determining their vulnerability. Both the continental and grid-based levels were then used for deriving implications for policy strategies on a national scale. The insights developed from the model-based analyses at these three scales (global-continental, national and grid-local), were complemented and enriched by qualitative, in-depth knowledge provided by the Africa Studies Centre.

Niches in studies on food security

Food security analysis has been the subject of various other studies (FAO, 2011; OECD and FAO, 2010; (InterAcademy Council, 2004; Keyzer and Wesenbeeck, 2007b; Von Braun et al., 2008; Fischer, 2009; IFPRI, 2010)). Different from the focus in key publications by the FAO, this report specifically focuses on sub-Saharan Africa. We zoom in on the sub-Saharan regions from a global, longer term perspective, using the OECD Environmental Outlook, and from a geographical perspective, applying grid-based vulnerability analyses. Different from the more macro-economic approaches by the OECD, we tried to regard food security in a more integrated way, by including explicitly physical aspects, such as demography, land availability and impacts on biodiversity.

IFPRI studies use a more detailed physical model (IMPACT) and consider different scenarios concerning different paces of climate change and economic growth (Nelson et al., 2010). In this study, we used only one scenario for the future. For our geographical and country level analyses, we made use of other studies by IFPRI that focus on soil degradation and land management in sub-Saharan Africa (Fan et al., 2008; Spielman and Panya-Lorch, 2009; Nkonya et al., 2011a).

Studies by the Dutch Centre for World Food Studies (SOW-VU) provide more detailed insight into indicators for and prevalence of child malnutrition and food insecurity (Nubé and Sonneveld, 2005; Keyzer and Wesenbeeck, 2007a; Wesenbeeck et al., 2009). This report offers less detailed information on the prevalence of child malnutrition and seeks to provide a quick comparison of different regions and countries in sub-Saharan Africa. This can be justified by the observation that sub-national data on food insecurity is only scarcely available, in most cases only in specific scientific studies and not in systematic monitoring programmes.

Lastly, this report seeks to build on the global action for food security as proposed by IFPRI and SOW-VU to the level of policies for sub-Saharan Africa (Von Braun and Keyzer, 2006; Von Braun et al., 2008). Especially the use of country-specific knowledge, which is commonly more qualitative, is complementary to the quantitative analyses. Country-specific information used in this report provides context information and thus better insight into possible future developments. This should help in the identification of possible successful policy directions.

Structure of the report

The report is organised as follows. Chapter 2 provides an outlook on food security in sub-Saharan Africa. The analysis reflects on the underlying socio-economic and environmental trends and their impact on food security. We used a set of indicators for the dimensions of availability, access and utilisation to explore food security up to 2050. Chapter 3 presents integrated analyses of these three dimensions used to identify the different vulnerability groups according to their geographical characteristics. These analyses are then translated into their possible implications for food security policies. Chapter 4 presents the main findings of the analyses and the recommendations for further research.

Note

1 There is a broad use of terminology on the topic of hunger. For the purpose of this report, we considered hunger, undernourishment and malnourishment as interchangeable, referring to a lack of food, and being underweight as the status of a person affected by chronic undernourishment.

TWO

Sub-Saharan Africa towards 2050

Sub-Saharan Africa has, compared to the rest of the world, the highest population growth, the highest poverty levels, a large land endowment, a critical water situation in several parts and important biodiversity. The region is also prone to important climate change effects while its contribution to the greenhouse emissions is very low. In this chapter, we present an outlook on food security in sub-Saharan Africa towards 2050. Most of this future exploration is based on the OECD Environmental Outlook (OECD/PBL, 2012) which provides a baseline scenario for important global developments of the economic indicators (OECD, 2011), environmental indicators (IMAGE, GLOBIO), as well as social indicators (GISMO). The Baseline Reference Scenario presents a projection of historical and current trends into the future. This Baseline indicates how the future world would look like if currently existing policies were maintained, but no new policies were introduced. Within the Environmental Outlook the indicators specified for the most important world regions and countries having a global coverage. In this chapter, the focus is on sub-Saharan Africa. Sub-Saharan Africa is divided in three or four sub regions, depending on the model providing the different indicators. The conceptual framework, as presented in Chapter 1, is followed to present the dimensions of food security (availability, access and utilisation) in the socio-economic and environmental context. Although the Environmental Outlook does not focus on food security specifically, many of the food security indicators are included. Focusing on sub-Saharan Africa will therefore also provide insights to what extent global assessments are useful for a regional assessment. These reflective insights are given in the concluding section of this chapter.

2.1 Socio-economic context

One of the main drivers of socio-economic change in Africa is the high population growth. In combination with economic growth, this will lead to an enormous increase in food demand by 2050, of over four times the current level.

More than doubling of the population in the coming decades

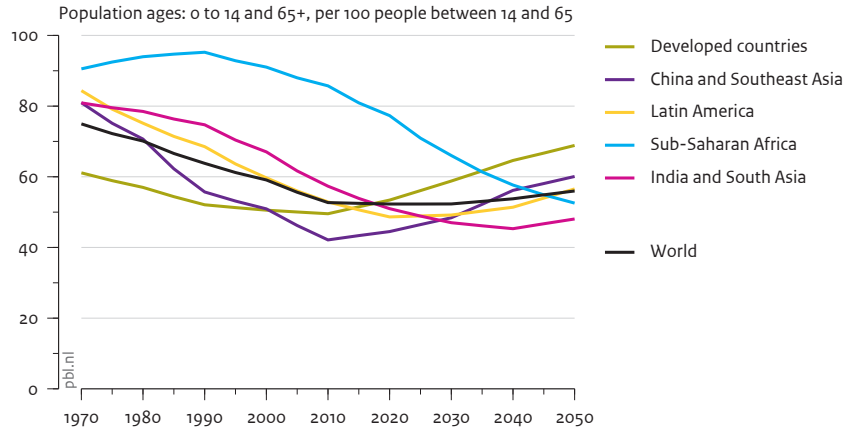
The sub-Saharan Africa population is projected to more than double from 814 million people in 2010 to 1.7 billion by 2050, increasing its share of the global population from 12% to 18% (UN, 2011). Around 40% of the global total population growth between 2010 and 2050 will take place in sub-Saharan Africa. The most populous country is Nigeria, which housed 18.5% of the sub-Saharan population of 2010 and is expected to increase up to 27% by 2050 (Table 2.1). Niger is included as one of the fastest growing countries, currently by 3.5% annually, and is expected to reach 55 million by 2050, which implies a population that is 3.5 times the size of the current one. The most important reason for this projected population growth is the relatively high levels of fertility; in 2010 this was almost 5 children per woman (UN, 2011). Although fertility levels are declining and expected to decline

Table 2.1
Most populous countries in sub-Saharan Africa, including Niger

		Population (millions)		
Ranking in 2010	Country	2010	2030	2050
1	Nigeria	158	258	390
2	Ethiopia	83	119	145
3	Congo DR	66	106	149
4	Republic of South Africa	50	55	57
5	Tanzania	45	82	138
6	Kenya	41	66	97
7	Uganda	33	60	94
8	Ghana	24	37	49
9	Mozambique	23	36	50
10	Madagascar	21	35	54
15	Niger	16	31	55

Source: UN, 2011

Figure 2.1
Dependency ratios



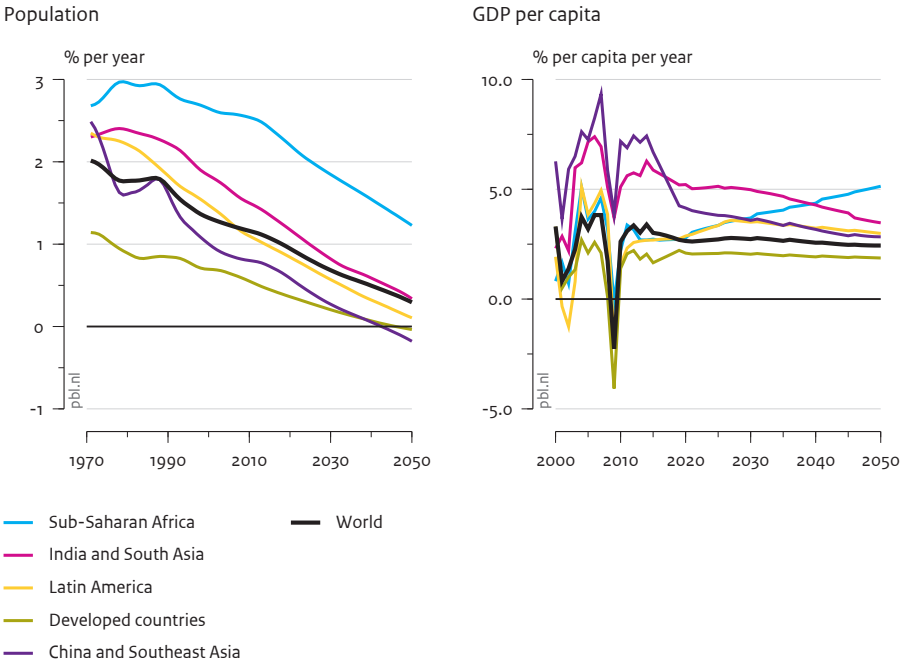
Source: UN, 2009b

further, it is not until somewhere around the end of this century that they are expected to reach replacement levels, resulting in a stabilising or even declining population in the decades to follow.

The share of the workforce in the total population in sub-Saharan Africa will increase

The workforce expressed in numbers of persons aged between 15 and 65 years will increase stronger than the number of dependent people, persons younger than 15 and elder than 65 years. The decline in fertility has also more immediate effects on the population, namely a changing age structure. This will lead to an age pyramid which becomes much smaller at the bottom, where the children are, and work out positively for the age dependency ratio, i.e. ay, in sub-Saharan Africa, this ratio is about 0.9 indicating that every person aged between 15 and 65 years has to support almost one other person. This ratio is expected to almost halve by 2050 (Figure 2.1). In the more developed regions the picture is reversed due to ageing populations. Now, every two potentially economically active persons have to support only one

Figure 2.2
Population and economic growth



Source: OECD/PBL, 2012

dependent (mainly old). Consequently, the workforce as percentage of the population starts decreasing before 2040 in most regions (OECD, FSU and China even already in 2010), while the workforce in sub-Saharan Africa is expected to still be increasing over the coming decades, giving sub-Saharan Africa a demographic window of opportunity which may results in higher economic growth.

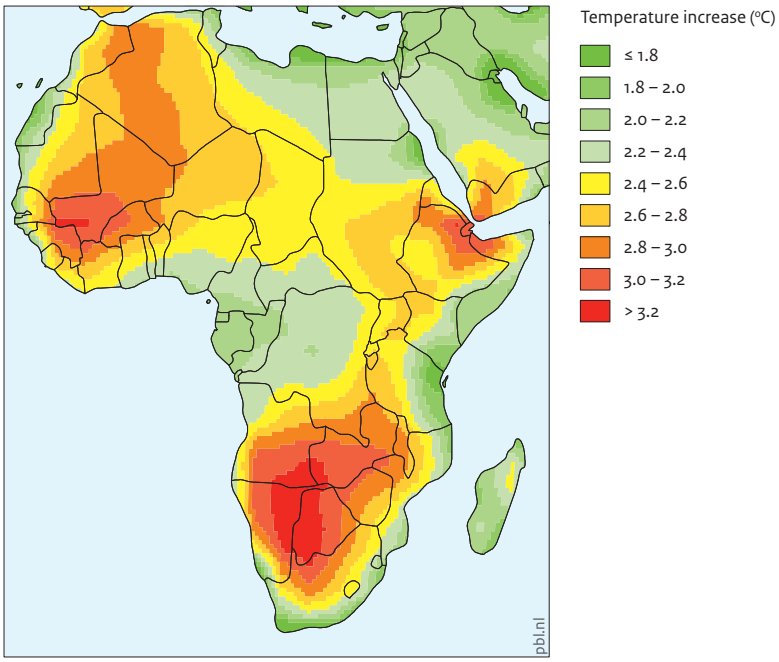
Africa will become an urbanised continent

Currently, only 37% of populations in sub-Saharan Africa live in urban areas, which makes this region one of least urbanised regions (UN, 2010). In the coming decades this percentage will increase to around 60% by 2050, although sub-Saharan Africa remains one of least urbanised regions. In absolute numbers, this is more than a tripling, from 321 million in 2010 to 1052 million people by 2050, implying that most of the future population growth (700 from the 900 million) will occur in urban areas. The fact that such an increase brings along enormous challenges in urban planning is beyond the scope of this study. Concerning food security its relevance is that with the urbanisation the nature of the population changes from rural, possibly food producing to urban mainly food consuming. An urban population can be much more vulnerable for increase in food prices, whether they are the result of higher demands at the world markets or due to crop failure. Contrary, urban areas are in general an important engine for economic growth.

Economic growth is projected to become highest in sub-Saharan Africa

The world's GDP, expressed in markets exchange rates, is projected to increase by a factor of 3.6 between 2010 and 2050, in the baseline scenario, representing an average annual growth of 3.2%. The share of sub-Saharan Africa in the world economy was 1.4% in 2010 and is expected to increase to 3.27% by 2050. These growth rates are the result of changing age structures and higher share of the workforce in the population which are in favour of sub-Saharan Africa. The economy in sub-Saharan Africa is expected to grow by 5.6% annually, over the same period. More important for food security is the per-capita GDP growth in purchasing power parity (Figure 2.2) which will gradually increase to more than 6%. These growth rates are relatively high compared to the world's average, China and in particular India have per-capita growth rates as high as 5% to 10%, annually, and will only be surpassed by sub-Saharan Africa growth rates somewhere in the 2030s.

Figure 2.3
Temperature increase by 2050, compared to 1990



Source: IMAGE

2.2 Environmental context

Next to the socio-economic, the environmental context of food security will be elaborated on. We consider here climate change, water availability and biodiversity as the main constituents.

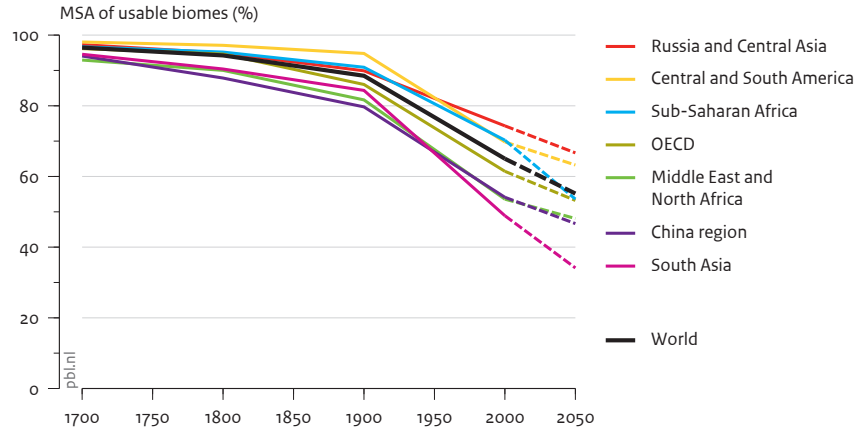
Climate change increases risks, especially in the longer term

Climate change scenarios generally indicate higher temperatures for most of Africa, up to 3.5 oC by 2050, in certain areas of Africa (Figure 2.3), although regional projections for precipitation trends vary (Washington et al., 2004; Stige et al., 2006; IPCC, 2007). A 1 to 2 oC increase in temperature may, in combination with more erratic rainfall patterns, already lead to sharp fall in yields for staple cereals (Cane et al., 1994; Stige et al., 2006). Especially the effects of increasing variability of climate would likely result in increasing inter- and intra-seasonal droughts, flood events, uncertainty about the onset of the rainy seasons leads to increased risk of crop failure (Clover, 2003; UNEP, 2003; UNDP, 2006). In the IMAGE model, the effect of climate change (e.g. monthly effect of CO^2, moisture and temperature on plant growth and soil respiration) is taken into account (MNP, 2006) except for climate variability.

Biodiversity loss is accelerating in sub-Saharan Africa, mainly due to agricultural expansion

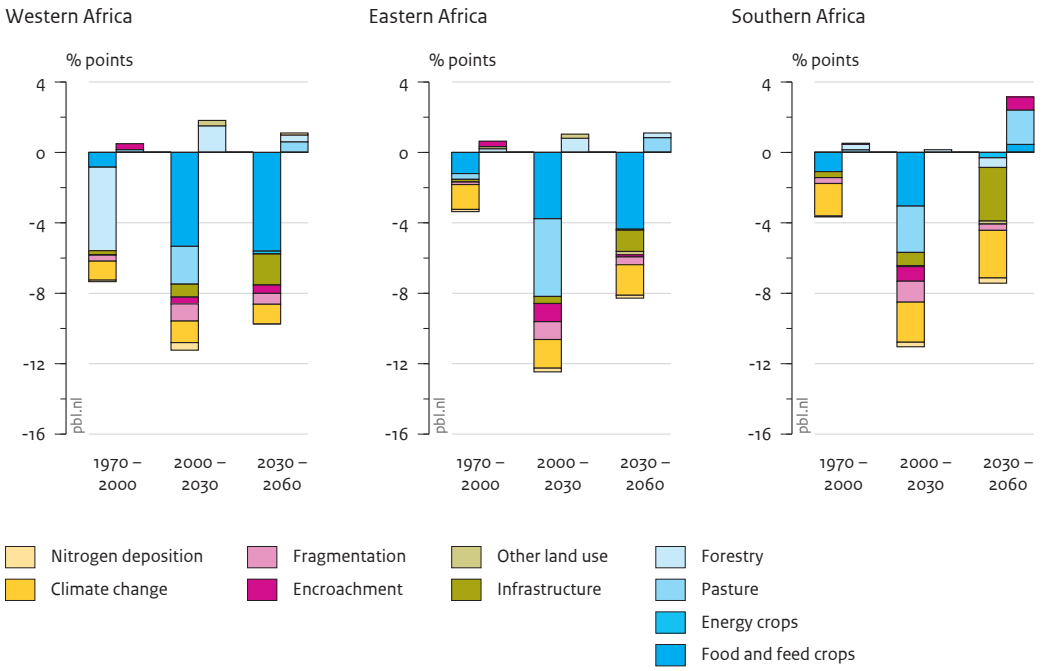
The importance of biodiversity for development is recognised by Millennium Development Goal 7, which includes targets to 'reverse the loss of environmental resources' and 'reduce biodiversity loss'. Despite the global policy target to stop biodiversity loss (CBD, 2007), biodiversity is projected to continue its decline. In the coming decades, largest losses of biodiversity are expected in Central and South America, south Asia, and sub-Saharan Africa (Figure 2.4). Especially in sub-Saharan Africa, the indicator for biodiversity (Mean Species Abundance, MSA (Alkemade et al., 2009) shows acceleration on species loss in the coming decades (World Bank, 2011b). The loss of biodiversity and higher development levels seem to go hand in hand but the relationship between poverty and biodiversity is still difficult to interpret adequately (Tekelenburg et al., 2009). Higher levels of development usually have as a consequence higher biodiversity loss; for example, because of expansion of agricultural land and better infrastructure, although these consequences may be limited (Ten Brink et al., 2010). For sub-Saharan Africa, half of the additional loss in the period up to 2030, compared to 2000 levels, may be attributed to agriculture (through crops and pasture). Between 2030 and 2050,

Figure 2.4
Biodiversity index



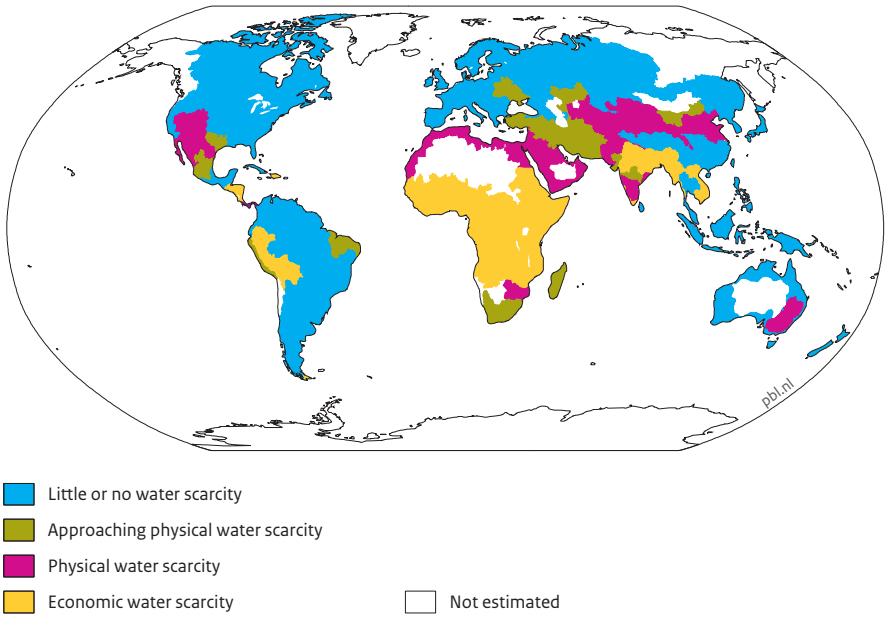
Source: GLOBIO

Figure 2.5
Biodiversity change in sub-Saharan Africa by underlying factors



Source: GLOBIO

Figure 2.6
Physical and economic water scarcity, 2025



Source: Molden, 2007

especially infrastructure and climate change will become relevant factors (Figure 2.5).

Water availability is projected to decrease in sub-Saharan Africa

There are several ways to express water scarcity or water shortages but the results of various studies give a similar picture for sub-Saharan Africa. Water availability is projected to decrease for all Africa regions (UNEP, 2002). The International Water Management Institute expects water to become scarce in most parts of sub-Saharan Africa (Figure 2.6), although the nature of this scarcity is different in the various zones (Molden, 2007). Physical water scarcity occurs in southern Africa. Most of the future scarcity occurs because of economic reasons, i.e. the main obstacle to prevent water scarcity is the lack of investments in adequate infrastructure and maintenance (Molden, 2007). An important symptom of economic water scarcity is scant infrastructure development to provide enough water for agriculture or drinking. Furthermore, even where infrastructure exists, the distribution of water may be inequitable or insufficient to meet growing demand (Prins et al., 2011). It is unclear, however, how this scarcity will affect agricultural productivity and/or health impacts.

2.3 Availability dimension

Given that in most developing countries most of the food consumed is produced locally, to provide sufficient quantities of food on a consistent basis it is necessary to look at the production factors for agriculture. One of the most important factors is the availability of land of good quality which can -at least potentially- have an adequate yield. These two factors determine the total agricultural production, now and in the future.

Sufficient agricultural land available

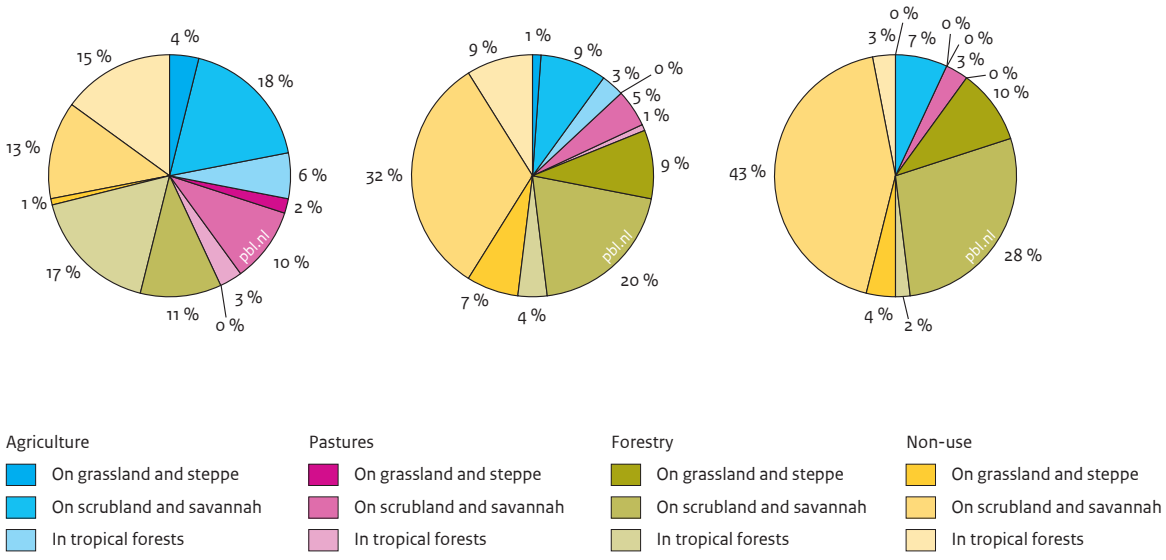
Increase in demand for food results in a substantial expansion of agricultural land, especially in western and southern Africa. Agricultural land is expected to increase by 2.7 million km^2 (or 29% of the current agricultural area) in the coming 20 years, with an enormous increase up to 2030, and stabilise thereafter. West Africa has the most limited potential for further expansion of agricultural land (Figure 2.7).

....but agriculture expands onto less-productive land

One of the causes behind this expansion is the projected modest progress in yield improvements. While most regions show high levels of agricultural productivity, in sub-Saharan regions the average yields are and will be lagging behind. Although, there is ample land of good

Figure 2.7

Land use per potential ecosystem type in sub-Saharan Africa, 2010



Source: IMAGE

Note: The total area of agricultural land, grassland, savannah and forest for west Africa is 8.3 million km², for east Africa 4.5 million km² and for southern Africa 6.6 million km² (2010 data).

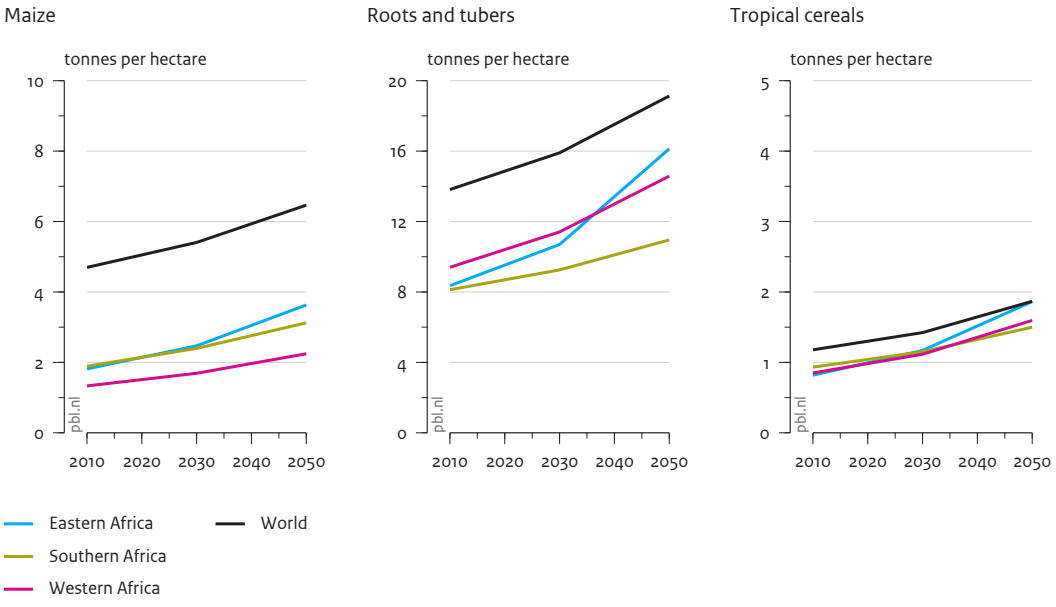
quality in sub-Saharan Africa, in some regions the most suitable land classes are already exhausted and the potential expansion can only take place at areas of lower quality. This entails a relatively greater expansion of agricultural land since the productivity of these areas is lower. Farmers resort to cultivating unsuitable areas, such as erosion-prone hillsides and semi-arid areas, and tropical forests where crop yields on cleared fields drop sharply after just a few years. Yet, many of these marginal lands are crucial to livelihoods of the poor and in watershed and biodiversity conservation.

Fertiliser use in sub-Saharan Africa substantially lower and the yield gap remains

The yield gap in Africa is evidence of the untapped potential for increasing production and productivity of agriculture. However, high price of inputs (fertilisers and pesticides), absence of liquidity or credit facilities, little or no access to supplementary irrigation, insecure land tenure rights often serve as a serious disincentive for farmers to invest in soil amendments or soil and water resource conservation measures in areas also increasingly affected by climate change. These limitations result in a 50% gap between potential and actual crop yields for staples such as maize, cassava, sorghum, and rice in many sub-Saharan countries. Because of little use of inputs, yield increases with improved crop varieties are estimated at 88% for Asia, but only at 28% for Africa. Between 1980 and 2000, fertiliser consumption in sub-Saharan Africa increased only slightly, by around 5%, although the population grew by 75% (Jayne et al., 2003). In contrast, fertiliser consumption grew by more than 12% annually in the countries included in the Association of Southeast Asian Nations – with a slightly smaller total population than Africa. These differences are also represented in the average annual fertiliser application, which is less than 10 kg/ha in sub-Saharan Africa while other regions have substantial higher levels – e.g. 54 kg/ha in Latin America; 80 kg/ha in south Asia; 40 kg/ha in Asia; and 87 kg/ha in Southeast Asia (Jayne et al., 2003). Future projections show that yield improvements will be achieved in the region (Figure 2.8). These improvements will be relatively higher than the world average, although absolute production will still be lower than world average. Yield increases for the three most important crops (maize, roots and tubers, and tropical cereals) are expected to be the highest in eastern Africa.

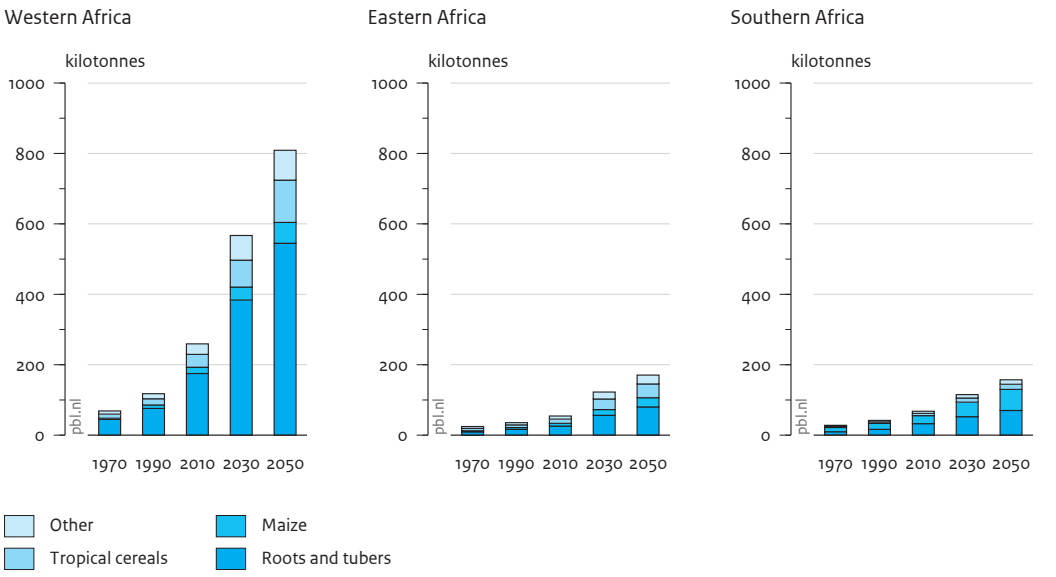
OWT

Figure 2.8
Agricultural yields



Source: IMAGE

Figure 2.9
Agricultural production in sub-Saharan Africa



Source: IMAGE

Total food production expected to increase

Despite improvements in agricultural productivity, yields in sub-Saharan Africa will still be lower than the world average. In order to meet the more than fourfold increase in food demand, as depicted in Figure 1.3, the growth of the total food production will come from the expansion of agricultural land. This growth in production is visible in the main crop types: roots and tubers, tropical cereals and maize (Figure 2.9).

2.4 Access dimension

The access dimension is about having sufficient resources for individuals and households to obtain appropriate foods for a nutritious diet and is strongly interwoven with poverty and the purchasing power that people have to buy food on the market. Indicators, such as income and income distribution, food prices, access to food markets, and infrastructure, are used to illustrate this dimension. The final outcome is the level of undernourishment which is derived from the average availability of food in calories per person per day.

Poverty eradication will be accelerated by high economic growth

Despite a relatively low GINI coefficient of around 0.4 indicating a relatively equal income distribution, the very low income levels varying from 900 to 1700 US$ per person (PPP) result in high poverty levels in sub-Saharan Africa. In 2005, 400 million people (51.2% of total population) lived below the extreme poverty line of 1.25$ / day, of which 35 million in Congo DR, 88 million in Nigeria and 10 million in RSA (Hillebrand, 2009). Having a per-capita income growth of around 3 to 6%, annually, will double the income over the coming 20 years, which means reaching income levels which, by 2050, will range from USD 4,600 in western and eastern Africa to USD 8,500 (PPP) in southern Africa. Assuming that the current GINI coefficients remain the same, such income increases will have a strong impact on poverty reduction. The percentages of the population living in extreme poverty will more or less be halved by 2030, compared to 2010, and reach levels of around 10% by 2050. Looking at the absolute numbers, part of this progress is undone due to the higher population growth. The population living in poverty is expected to only decrease slightly from 380 million in 2010 to 270 million by 2030. The progress is expected to accelerate somewhat in the two subsequent decades, reaching 75 million by 2050.

Poverty still a rural phenomenon, but becoming more urban

Poverty is still more a rural than an urban issue. The World Bank estimates that 75% of the developing world's poor live in rural areas, although there are some marked regional differences (World Bank, 2008c). However, the urban share of poverty is rising over time (Ravallion et al., 2007). Is this a positive or negative trend? In general, high urbanisation is correlated with lower levels of poverty since it generally comes with higher incomes or the higher potential to generate income. However, this correlation does not seem to be valid for sub-Saharan Africa. This may be the outcome of a more anarchistic urbanisation process leading to slums instead of well-provided and organised economic centres of activity. For example, in Ethiopia, children in both slum urban areas and rural settlements are four times (48%) more often malnourished than those in non-slum urban areas; also in Democratic Republic of Congo, 41% of children from poor urban areas were malnourished compared with 16% in non-slum urban areas (UN-Habitat, 2008). At the same time, urban areas in sub-Saharan Africa are generally characterised by high levels of inequality, something that may make them more susceptible, for example, to price shocks (UN-Habitat, 2008).

Food prices may decrease

The last component of influence on the actual potential to buy food, next to income and income distribution, is the price of food. Especially the poor spend more than 60% to 70% of their income on food, which makes them vulnerable even to small increases in food prices (FAO, 2011). Projections of food prices in the baseline scenario show a decline which is in line with OECD projections (KPMG, 2012), although food prices are assumed to be subjected to large uncertainties (Prins et al., 2011). Prices of the different food commodities determine not only the amount that people can afford but also the mix of these commodities which determine a person's diet. Assuming that people are dependent on buying their personal needs on the market may not totally reflect the reality in sub-Saharan Africa where many of the smallholder farms have a certain level of self-sufficiency and in case of a good harvest year have the possibility to sell part of their production on the (local) market (See Box 2). In a more macro economic model, as used in this scenario study, where food prices indicate the balance between demand and supply, these facets are not reflected.

Average food intake will go up, resulting in low levels of undernourishment

Average food intake levels are projected to go up, especially in west and southern Africa (Figure 2.10). Central Africa and, to a lesser extent east Africa, will lag behind, although food intake will also go beyond 3000 Kcal per person per day, compared to the current Central African level of only 1800. Based on the FAO distribution function the average food intake levels can be expressed in the number of people being undernourished taking into account the required level of dietary energy[1]. The high intake levels will be effective in reducing undernourishment: the almost 200 million Africa people that were undernourished in 2010 will have halved by 2030 and be reduced to 30 million by 2050 (Figure 2.11). Although improvements are great in east Africa, this region will still accommodate the majority of undernourished people.

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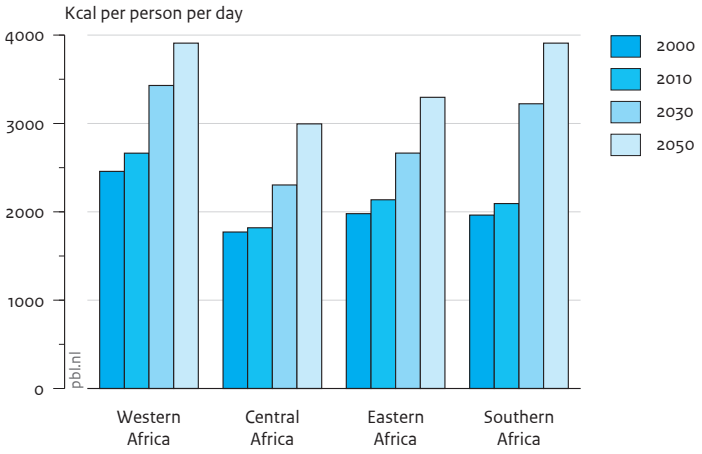
Figure 2.10
Food availability in sub-Saharan Africa



Source: GISMO

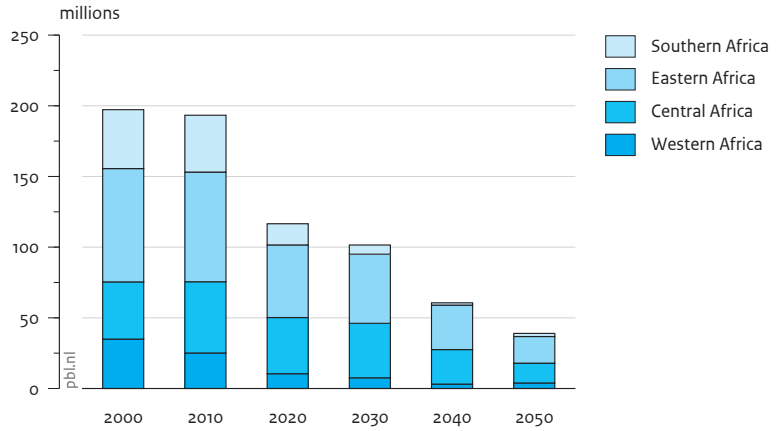
Text box 2
Markets bring opportunities and risks

One way for Africa to increase its competitiveness is to invest in infrastructure and market development. Poorly functioning markets, stringent demands for grades and standards of produce, and lack of export possibilities are major constraints on Africa's agricultural growth prospects. Other constraints for the development of the private sector include i) poor infrastructure; ii) low levels of human capital resulting in high training costs; and iii) small scale production resulting in high contracting costs per unit production.

Since the 1990s, many African countries undertook market reforms but these reforms have generated less than anticipated supply response and competitiveness (Belieres et al., 2002). Reducing trade barriers in African countries and improving market efficiency could enhance intraregional agricultural trade, and increase per-capita agricultural incomes by 0.9%, annually (Diao and Yanoma, 2003; Abdulai et al., 2005).

Global retail companies (supermarkets) increasingly influence agricultural processes and marketing in developing countries, through foreign investments and/or by imposing their private standards. A survey of the impact of supermarkets on 10,000 farmers with production contracts in the highlands of Madagascar shows positive results. As part of a global supply chain, these farmers produce vegetables for supermarkets in Europe. Their contracts are combined with intensive farm assistance and supervision programmes to fulfil the complex quality requirements and phyto-sanitary standards of supermarkets. It was found that smallholder farms that participate in these contracts experience greater welfare, more income stability and shorter lean periods. In addition, there are significant effects on improved technology adoption, better resource management and on the productivity of the staple crop rice. Integration in global market also involves risks. For example, in April 2010, air traffic delays due to the ash cloud cost the flower-export industry in Kenya about USD 2 million per day, which resulted in disengagement of thousands of local workers, with implications for both local and national economy (Ellis, 2011).

Figure 2.11
Undernourished population in sub-Saharan Africa



Source: GISMO

2.5 Utilisation dimension

Having or, more specifically, not having adequate intake levels of food does not point directly to impacts of food insecurity. Undernourishment can lead to people becoming underweight, especially children. Even having an adequate amount of food may still lead to malnutrition; for example, when the diet is unbalanced. The fact of being underweight, in itself, already causes harm, and it is also tied to other adverse risk factors, such as unsafe drinking water (Smith and Haddad, 2000a). UNICEF estimates that about 50% of child mortality is related to children being underweight (UNICEF, 2007). Indicators, such as underweight, hunger-related mortality and the relation with other risk factors, are discussed in this section.

Number of children who are underweight as the result of chronic undernourishment will decline

A decline in the proportion of underweight children is projected to continue, especially in southern Africa, where high intake levels are expected to lead to the eradication of underweight within three decades. The associated number of underweight children is expected to decline from 33 million in 2010 to 20 million by 2030 and 6 million by 2050. Underweight in children – here expressed as 'low weight for age' (wasting) – is the result of chronic undernourishment which can lead to 'small height for age' (stunting) (WHO, 1997). This is not only determined by the amounts of food that are consumed; there are also other relevant factors, such as educational attainment of the mother and access to water supply and sanitation facilities (Smith and Haddad, 2000a).

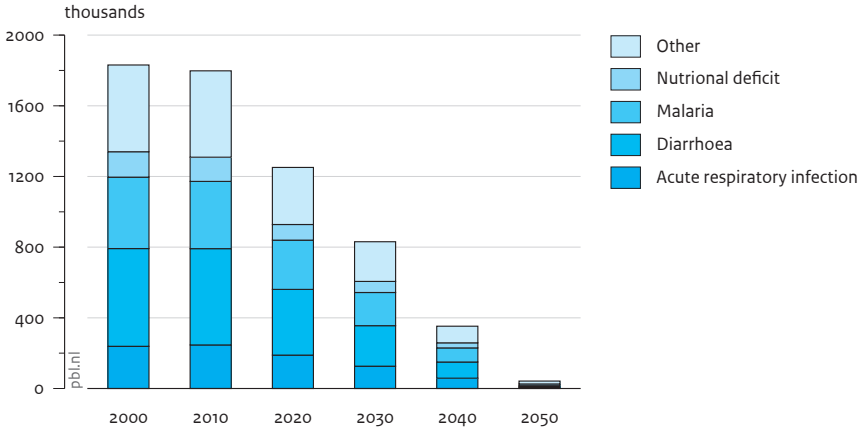
Disease burden of hunger and from being underweight remains substantial

Even though the prevalence of people being underweight is projected to decrease substantially, it remains a factor of importance over the coming decades. This importance is not only due to the direct effects on people, but also to the effects of other health risks factors. Particularly, the increased risks related to unsafe drinking water and lack of sanitation are the most critical, but also health risks related to malaria and indoor air pollution are well-documented. In the coming decades, child deaths, directly or indirectly related to malnutrition are projected to reduce substantially and almost eradicated by 2050 (Figure 2.12).

2.6 Reflections on future developments for sub-Saharan Africa

The exploration of the most important developments for the coming decades, according to the OECD baseline scenario, results in a mixed picture. Food security is expected to improve, as food production and access to food will increase, thus increasing current consumption levels and feeding an additional large number of people. At the same time, some environmental aspects show trends with less positive perspectives. Biodiversity loss will continue, climate change will affect agriculture and water may become scarcer in the whole of sub-Saharan Africa. Crucial, of course, in creating this future scenario is the starting point for economic growth. This has been done from a macro-economic perspective with the

Figure 2.12
Child deaths due to malnourishment in sub-Saharan Africa



Source: GISMO

combination of demographic changes and progress in labour productivity in which sub-Saharan Africa is considered to follow typical economical patterns. In this section, we will reflect on the assumptions behind and the outcomes of the developments presented in the previous sections.

The future for sub-Saharan Africa looks promising

The baseline scenario shows an economic growth for sub-Saharan Africa which has been observed before in Asian countries but is unprecedented for Africa. This economic growth path is based on the current and future (labour) productivity in combination with a demographic window of opportunity reflected by an increase in the number of people of working age from 470 million today to over 1.1 billion by 2050 (UN, 2009a). The sheer increase in Africa's population is creating larger markets for consumer goods, making it more interesting for foreign suppliers to consider establishing production plants on the African continent (Ellis, 2011). This would lead to a 35% increase in spending power and 221 million extra basic-needs consumers by 2015. The number of middle-class households is rising and infrastructure investments on the continent have quadrupled over the past decade, to a total of $12 billion in 2008. The IMF expects this outperformance of markets, such as those of Brazil, Russia and eastern Europe, to continue in the future (Dietz, 2011). Also, medium-scale farms are on the increase. National rural household surveys have identified distinct classes among the smallholder population of larger sized farms, with a greater market orientation and much more reliance on hired labour than poorer smallholder farms in the same villages. The latter, also referred to as small to medium-scale rural capitalists, are thought to hold the key to the expected successful integration of smallholders in high-value agribusiness chains (Oya, 2007; World Bank, 2007).

Moreover, a quarter of the world's arable land lies in Africa, and the acreage of almost all African crops has increased considerably in the last five decades (Dietz, 2011). The growth of non-traditional agricultural exports (fruits and vegetables and cut flowers) has also been impressive since the 1990s (Oya, 2007; Dietz, 2011). A combination of transnational agri-business demand and state support particularly in Kenya, Zambia, Côte d'Ivoire and more recently Ethiopia, partly led by global agribusiness underlie successes in Africa's horticultural, fruit and cut flower export drive. Equally important, the economic and agricultural growth recovery is not just accelerating, but also spreading to more countries. Overall, between 2003 and 2005, 13 countries including oil-rich Angola and Nigeria in sub-Saharan Africa achieved annual agricultural growth rates greater than 5% (Badiane, 2008).

Relevant conditions to sustain long-term development and reduce food insecurity

Closer examination of the impressive economic achievements in sub-Saharan Africa reveals certain contradictions. We recapitulate seven possible relevant conditions to sustain current developments.

Condition 1: Inclusive growth

The low income groups should benefit form the trickle down of macro level progress. Currently micro level

progress is insufficiently visible, and the poverty level remains high and is slowly declining despite high GDP growth rates. This may have to do with the nature of macro development, such as much hinging on mineral extraction and oil, capital-intensive industries with few backward and forward linkages, and low impact on employment. For example, recent discovery of commercial quantities of crude oil in Ghana and Uganda will boost national income, yet it is estimated that only a limited number of people will be directly employed in the oil sector.

Condition 2: To take benefit of the large workforce requires an educated and healthy population

Having an educated and healthy population is essential to be able to take benefit of the larger workforce and potentially higher labour productivity. Education and health are important factors influencing the quality of human capital, and so is nutrition as part of the health factor (Psacharopoulos and Patrinos, 2004; Gyimah-Brempong et al., 2006). Sub-Saharan Africa is not expected to achieve the millennium development goal of having all children at school by 2015. Also concerning health, sub-Saharan Africa faces quite a challenge. Communicable diseases (e.g. AIDS, respiratory infections) are expected to remain important by 2030, while the non-communicable diseases (e.g. cardiovascular diseases and cancers) will gradually become equally important in numbers of deaths (WHO, 2006). Given the current level of health expenditures, which is for many countries only around USD 20 per person per year (World Bank, 2011c) the challenge of achieving a healthy population is obvious.

Condition 3: Modern agriculture to drive economic growth

NEPAD (NEPAD, 2010) recognises that accelerated agricultural growth is crucial to achieve food security, reduce hunger, and generate employment and trade. While some countries have attained impressive agricultural growth rates – Côte d'Ivoire, Benin, Burkina Faso, Kenya, Nigeria and Malawi – for a variety of reasons, others have performed worse, as they were severely affected by conflict (e.g. Sierra Leone and Congo DR). Moreover, according to Karshenas (2001), most African countries lack infrastructure and production conditions required for agricultural modernisation. These variations have been influenced by factors, such as differences in agrarian structures, agro-industrial linkages and policy regimes. Nevertheless, in the short run it cannot be expected that Africa will follow an export-led industrialisation path (as some Southeast Asian countries did) and therefore agriculture is still the mainstay of many African economies, except for the oil and mineral exporters.

Condition 4: Competing claims on land should not lead to lower food production and higher food prices

Competing claims for land increase between farmers, urban dwellers, companies and foreign parties. Yet, land is not always acquired for productive purposes. Many - mostly urban elite - buy land for speculation or for having a fall back position. Foreign investors are not only interested in food security but also in energy security. For instance, industrialised countries are putting increasing demands on land in Africa, for the growth of energy crops for biofuels at the expense of traditional food crops (Jumber et al., 2009). However, few countries in sub-Saharan Africa have included biofuels strategies in their national energy development policies, despite having huge comparative advantage in land, labour and favourable climatic conditions for cultivating energy crops. In sub-Saharan Africa, prices for the staple food cassava, which is the cheapest source of calories for one-third of its population, is also used for production of ethanol. The price of cassava is projected to soar by 135% due to its expected use as biofuel. The number of food-insecure people is expected to rise by over 16 million for every percentage increase in the real prices of staple foods (Boddiger, 2007).

Condition 5: Promote institutional settings to provide stable incomes and investment incentives

Within the context of liberalisation and less political room for manoeuvre, adequate institutions are needed to reduce income volatility and to encourage investments. Many African countries have adopted a market-led development model, almost by default. However, significant numbers of farmers and producers in poor agrarian communities have been affected by market failures. In addition, decline in resources devoted to agriculture by governments and donor agencies have resulted in loss of policy space in agricultural policies. Also in the last quarter of the twentieth century, the World Bank reduced its lending portfolio for the agricultural sector from a peak of 32% of World Bank lending in 1976-78 to only 6.5% during the 2000–2005 period (Pincus, 2004).

Condition 6: Environmental feedback mechanisms should be anticipated

Policy makers need to anticipate on environmental feedbacks on development that are expected to be important, yet not understood well enough. We have depicted the environmental context in which future food security takes place. The effects of climate change are taken into account through averages in temperature increase and precipitation patterns. However, climate variability and extreme weather events can be as important for agricultural production. In sub-Saharan

Africa, which includes parts of east Africa, several ecosystems, particularly grass and shrub savannahs, are shown to be highly sensitive to short-term availability of water due to climate variability (Vanacker et al., 2005). Similarly, the consequences of future water availability are difficult to asses. Most studies show an increasing pressure on water leading to increased water stress and scarcity. This can have repercussions on yields, health and economic activity but the extent of these effects are unclear. The last uncertainty to discuss here is the feedback of biodiversity loss, although there are many indications that lower levels of biodiversity may lead to lower agricultural productivity and larger health impacts (CBD, 2007).

Condition 7: Political stability

Political stability and prevention of conflict are required to create an attractive investment climate both for domestic and international investors. Related to the issues mentioned above, is that of political instability, which can be seen both as a cause and a consequence of food insecurity (Brinkman and Hendrix, 2011) and may lead to a so-called conflict trap (Collier, 2007). Until recently, the poor investment climate in sub-Saharan Africa has discouraged investors, but over the last decade this has changed and large increases in foreign direct and private equity investment were observed across the continent (IFC, 2007). Africa has also shown an upward trend concerning conflicts since the mid 20th century, with a peak in 1993, when over 40% of African countries were affected by war (Marshall, 2005). Since then, the number of armed conflicts has declined steadily, reaching about half that of the 1993 peak by 2004. Prospects for future stability and conflict prevention depends on various demographic, economic, institutional and environmental factors (see e.g. Cincotta et al., 2003; State Failure Task Force, 2003; Urdal, 2006). Especially, a large youth bulge, rapid urban growth, high mortality among working-age adults and low-availability of cropland and fresh water, are crucial factors for sub-Saharan Africa, subjecting it to instability (Cincotta and Hummel, 2003).

Note

1 The FAO data and methodology are subjected to uncertainty that can affect the results Wesenbeeck C.F.A., Keyzer M.A. and Nubé M. (2009) Estimation of undernutrition and mean calorie intake in Africa for 2005: methodology, findings and implications, SOW, Amsterdam.

THREE

Geographical distribution of food insecurity

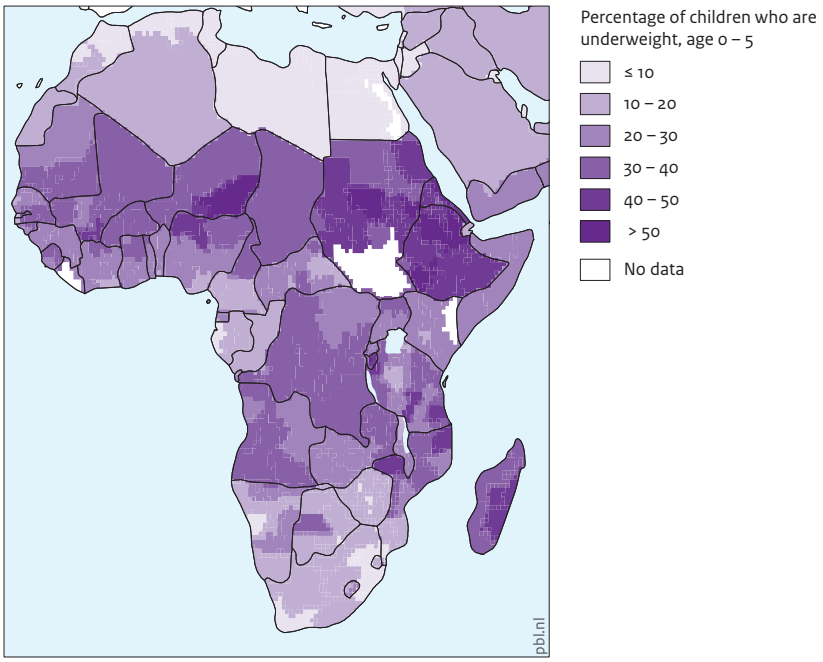
Geographically, specific information is needed to solve the issue of food insecurity. Food insecurity, represented by the indicator of underweight children under five (Figure 3.1), is unevenly spread across Africa. In absolute numbers spots of food insecurity are found in northern Nigeria and southern Niger, in the Horn of Africa, in the central African highlands and in some regions in Madagascar and Angola. In relative numbers, high prevalence of child malnutrition is commonly found in less populated and more remote areas (Nubé and Sonneveld, 2005). Higher income groups and urban populations are more food secure compared to the population in remote rural areas. To capture this geographic distribution of food insecurity, this chapter clusters regions according to characteristics related to food insecurity.

The focus of this chapter is on arid and semi-arid drylands and the sub-humid and humid forested agricultural areas. These regions represent about half of the population in sub-Saharan Africa (about 450 million people). In the drylands food availability is a major bottleneck for achieving food security. Production systems are characterised by limited agricultural potential due to low water supply, erratic rainfall patterns and low soil fertility levels. Population density is commonly low. In this harsh production environment with limited non agricultural income opportunities, there is an urgent need to alleviate the persistent and widespread prevalence of hunger and food insecurity. In the forested agricultural regions there are conflicting claims on land for conserving forests and biodiversity versus economic agricultural exploitation. Production systems in these regions rely on adequate natural resource management (availability) but, compared to the drylands, there are more opportunities for inclusive growth thus improving access to food. Malnutrition and food insecurity occurs within specific regions or population groups.

3.1 Vulnerability analysis to assess food insecurity

Vulnerability analysis examines exposures and sensitivities of people to socio-economic and environmental changes, and their ability to cope with or adapt to the potential impacts (Turner et al., 2003). Analysis of vulnerability patterns contributes to a better understanding of the conditions that are related to food insecurity thus allowing for an assessment of potential impacts of socio-economic and environmental changes on food insecurity. The method looks for common vulnerability creating mechanisms in a multitude of cases that are archetypical and identifies specific groups that show how certain combinations of natural and socio-economic factors lead to specific vulnerability outcomes. The results flag the most vulnerable regions thus providing information on regional context factors (Kok and Jäger, 2007; UNEP, 2007).

Figure 3.1
Child malnutrition, 2005



Source: CIESIN, 2005a

Vulnerability analysis is carried out by the statistical tool of cluster analysis, which is further elaborated by Kok et al (2010b).The data for the cluster analysis are given at grid level identified by geo-coordinates and consist of three specific sets of indicators and two generic indicators (Table 3.1). The sets of indicators concern proxies for food availability, access and utilisation. Population density and a governance indicator are added as generic determinants of food security. The indicators used in the analysis were selected according relevance and availability. First, the indicators reflect the most important underlying factors affecting food security and second the indicators needed to be available geographically explicit at national and sub national levels (data at 0.5° by 0.5°). For drylands, nine indicators and for forest agriculture areas 11 indicators were selected.

3.2 Regions characterised by food insecurity

Analysis of the indicators of food security results in nine clusters for drylands and six for forest agriculture areas (Figure 3.2). Concerning the drylands, cluster analysis roughly distinguishes the semi-arid areas in southern Africa, the arid and semi-arid in the Sahel region and in eastern Africa and the urban centres with their surrounding areas. The forest based regions are divided in the forest core areas with mostly natural forests; the mosaics of forest and agricultural land; the urban centres with their surrounding areas; and the high-income areas in Gabon and southern Africa.

The resulting 15 clusters are listed according to child nutrition status (Table 3.2). Table 3.2 shows that i) a high prevalence of food insecurity in the more remote and more dry areas (South Africa not included), with somewhat better situations in urban centres; ii) medium levels of food insecurity in western and central African forest based systems (Gabon excluded); and iii) a relatively favourable situation in South Africa and Gabon. The figures on population growth in Table 3.2 show the largest relative increase in population in the forested agricultural areas and urban areas. Population growth in rural arid areas is less strong, compared to that in urban arid areas.

Three types of clusters are analysed in more detail: i) the arid areas in the northern part of the Sahel countries; ii) the semi-arid areas in the southern parts of the Sahel countries and in parts of eastern and southern Africa; and iii) the forested agricultural areas in sub-humid and humid regions. Regions that will be only briefly

Table 3.1
Indicators of food insecurity

Indicator	Measure[3)]	Source
Generic:		
Population pressure	Population density	(Klein Goldewijk et al., 2010)
Governance and policy	Worldwide Governance Indicators	(Kaufmann et al., 2008)
Availability:		
Water availability [1)] Only for dryland systems	Renewable water resource: water runoff per river basin in a river basin for domestic, industrial or agricultural use (irrigation)	(Alcamo et al., 2000)
Quality of the soil for rain fed agricultural production	Agro-potential: fraction of the productivity of a grassland compared to the maximum feasible	(MNP, 2006)
Forest productivity [2)]	Profit opportunity for wood extraction: NPP (net primary productivity)	(MNP, 2006)
Pressure for land use change [2)]	Average travel km to the closest agricultural area (km)	(Bakkenes and Ten Brink, 2009)
Deforestation [2)]	Biodiversity left: fraction of mean species abundance left in comparison to unexploited areas.	(Alkemade et al., 2009)
Soil quality / erosion	Index for water erosion sensitivity of the soil	(Hootsman et al., 2001)
Soil conservation	Land degradation classes	(Oldeman et al., 1991)
Access:		
Income	Average GDP per capita	(UNSTAT, 2005; World Bank, 2006)
Non-farm income opportunities	Urban population fraction	(Klein Goldewijk et al., 2010)
Access to markets for products and technology	Distance to markets: Travel distance in hours to the nearest city of 100,000 inhabitants (hours)	(Letourneau et al., 2010)
Utilisation:		
Child nutrition status	100 minus % prevalence of child malnutrition	(CIESIN, 2005b)

Notes: 1) Only for dryland systems. 2) Only for forest-agricultural areas. 3) To unify the measure scale for the indicators a min-max normalisation rescales the data to values between zero and one. The zero value refers to worse conditions and the one value to favourable conditions.

mentioned in this report are the urban and peri-urban areas and the relatively well developed regions in South Africa and in Gabon. South Africa and Gabon are regions with relatively low prevalence of child malnutrition in both rural and urban areas. As presented shortly, other characteristics of these regions include: relatively good governance, high GDP per capita and relatively well developed markets. On characteristics such as population density, agro-potential and water availability these relatively better developed areas do not stand out compared to neighbouring regions.

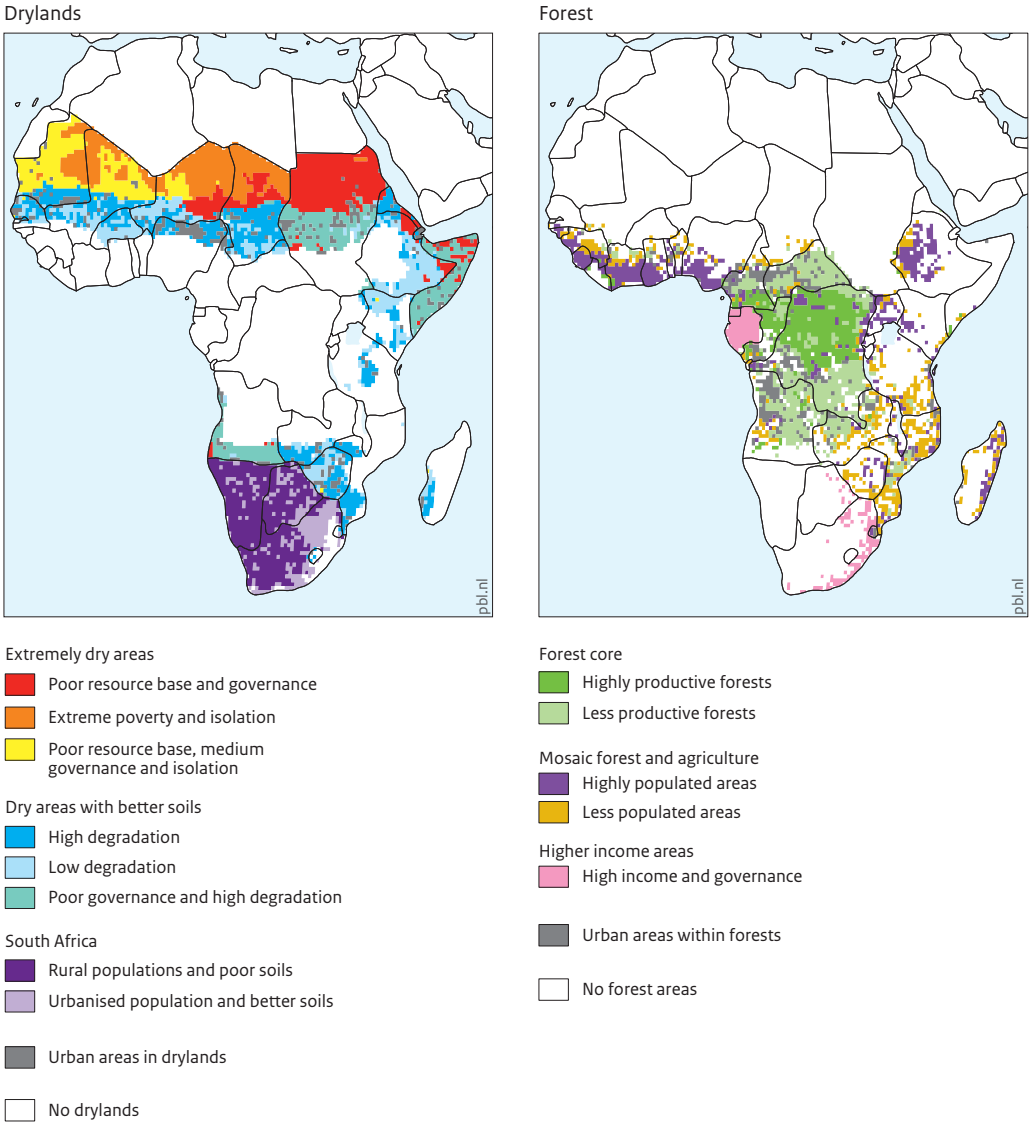
3.3 Food insecurity in arid and semi-arid areas

Table 3.4 shows the results of the cluster analysis for the arid and semi-arid areas. We distinguish arid areas, semi-arid areas and urban and peri-urban areas. In the arid areas in the northern parts of the Sahel countries food availability appears as a critical factor: limited agricultural resources and water scarcity determine the region's potential to improve food availability. Population density is low and urban areas are non-existent. The production system is based on pastoralism with cultivation of millet as the main food crop. In this region climate change is expected to be most pronounced with less rainfall, increasingly variable within and across seasons (World Bank, 2010). For the entire sub-Saharan region, arid areas cover about 37% of sub-Saharan Africa, containing 5.3% of the rural population (Nkonya et al., 2011b).

The most obvious characteristic of the arid areas is the limited agricultural production due to low and erratic rainfall and to low soil fertility. The region is characterised by extremely low income, the highest prevalence of child mortality in sub-Saharan Africa and low population densities. The area represents a minor share of population with five million people in the poor governance areas of Chad and Sudan, 600,000 people in the north of Mauritania, Mali, Niger and Sudan, and 1.6 million people in other Sahel regions in Mauritania, Mali and Niger. The levels of governance and isolation are additional determinants of low food security. For example, in Sudan and Somalia the low score on the governance indicator is combined with highest levels of child malnutrition. In the arid areas in the north of Chad, Mali and Niger isolation and remoteness are important factors that hamper development.

Figure 3.2

Vulnerability profiles for food security in sub-Saharan Africa



Source: PBL

The semi-arid areas are characterised with better soils, more rainfall, and hence have a better agricultural production potential. Food security still relies on availability of food from agricultural production, but access factors become more important. In these semi-arid areas rural livelihoods are based on a more diversified cropping pattern (maize, cotton, and vegetables) and farmers generate more cash income thus enabling them to buy agricultural inputs. Within in this cluster of semi-arid areas, soil degradation sensitivity appears to be scattered with more soil degradation sensitivity in east African countries such as Sudan, Ethiopia, Kenya and Somalia compared to west African countries such as Mali en Burkina Faso.

Food security in the semi-arid areas is better compared to the arid Sahel areas, yet prevalence of child malnutrition is high. The agricultural potential is higher but at the same time sensitivity of soil erosion is higher. Although population density and degree of urbanisation are low, there is better access to markets because of a better road infrastructure. The poor governance regions (mainly in Sudan and Somalia) stand out with relatively high sensitivity to soil erosion.

Table 3.2
Vulnerability clusters/regions and their child nutrition status and population

Region with corresponding color on maps	Child nutrition status	Population (millions and percentage)					
		2000		2025		2050	
Urban and peri urban regions							
Southern Africa	0.80	30	6.2%	38	4.4%	42	3.3%
Arid and semi-arid areas	0.39	75	15.4%	149	17.3%	249	19.6%
Forested agricultural areas	0.49	29	5.9%	54	6.3%	84	6.6%
Dry areas							
High sensitivity to erosion	0.40	41	8.4%	69	8.0%	93	7.3%
Low sensitivity to erosion	0.37	32	6.5%	57	6.6%	83	6.5%
Poor governance and high sensitivity to erosion	0.34	15	3.1%	21	2.5%	26	2.0%
Southern Africa	0.75	4.0	0.8%	3.9	0.5%	3.1	0.2%
Extremely dry areas							
Extreme poverty and isolation	0.34	0.7	0.1%	1.0	0.1%	1.2	0.1%
Medium governance and isolation	0.46	2.0	0.4%	3.2	0.4%	4.5	0.4%
Poor resource base and poor governance	0.23	5.0	1.0%	7.8	0.9%	10	0.8%
Forest core							
Southern Africa and Gabon	0.83	11	2.2%	17	1.9%	18	1.5%
High productivity	0.48	29	5.9%	54	6.3%	84	6.6%
Low productivity	0.47	16	3.3%	25	2.9%	29	2.3%
Forested agricultural areas							
Low populated areas	0.46	14	2.8%	19	2.2%	20	1.6%
High populated areas	0.45	185	37.9%	342	39.7%	522	41.1%
Total		488	100%	861	100%	1,269	100%

Note: Child nutrition status: Green indicates a favourable condition; red an unfavourable condition. The numbers refer to the average rescaled indicator with a value of between zero and one (see note Table 3.1)

The semi-arid areas in southern Africa, rural as well as urban areas, stand out by favourable basic conditions (good governance, high GDP per capita and well-developed markets) with consequently a relatively high level of food security.

Arid areas in Mali and Niger

The Sahel zone in Mali is an example of an arid area. This zone covers 320,000 km² (26% of the area of Mali) and receives precipitation between 200 and 600 mm. The provinces Tomboctou, Kidal and Gao count about 1.3 million inhabitants (10% of the total population of Mali). Under-five child mortality, with more than 200 per 1,000 births, is highest in sub-Saharan Africa. Niger is another example of a country with a largely arid environment. In Niger 77% of the land area consists of desert and the remaining 23% is arid. Eight per cent of rural areas is protected and only 27% of irrigable areas is actually irrigated. Its environmental and social economic conditions are comparable with those of the Sahel zone in Mali and northern parts of Burkina Faso. Niger is a country with the lowest population densities and degrees of urbanisation. Prevalence of child malnutrition is high, compared to countries, such as Mali, Burkina Faso and Benin, yet this situation is considerably better than, for example, in Chad and Ethiopia. Land is relatively abundant, yet of inferior quality, and fertiliser use is virtually non-existent.

Text box 3
Country examples of the regional clusters

The regions that are discerned in the cluster analysis are scattered across and within countries. The information given on these regions is useful to obtain better insight into food insecurity conditions within countries. For selected countries the following overview matches national indicators (Table 3.3) with in-country information on regional socio-economic and environmental conditions.

Countries in the arid areas include Ethiopia, Chad, Sudan, and Eritrea as examples of severe hunger levels, poor governance and Mali (northern part) and Niger as examples of countries with medium and severe hunger levels respectively. The region is highly prone to the consequences of climate change.

Countries in semi-arid areas include Mali (southern part), Burkina Faso and Benin (the northern part) as examples of relatively low hunger levels, medium agricultural potential and both subject to the consequences of climate change. Mali is a vast and diverse country in terms of climate and ecosystems. We focus on the zone known as the Soudan Savannahs with population densities higher than in Niger but far below the population density in Ghana, Burkina Faso and Uganda. Cropping systems include a variety of crops such as millet, sorghum, maize, cotton, groundnuts and other niche crops. A relatively high share (31% for all of Mali) of the population lives in urban areas.

Countries with mosaics of forests and agriculture include Ghana, Ivory Coast, and Benin, with a relatively low level of malnutrition, limited exposure to climate change risks and better agro-potential. In addition, Uganda and Kenya, included in this cluster, are characterised by medium levels of malnutrition, important exposure to climate change, mixed agro-potential and high population density. Lastly, Mozambique encounters severe levels of malnutrition and exposure to climate change risks. Mozambique has a relatively high agro-potential and low population density.

Table 3.3
Characteristic of selected countries in sub-Saharan Africa

	Population & economy				Availability			Access		Utilisation
	Population (million, 2005)	Urbani sation (%, 2005)	GDP/cap (USD, 2009)	GDP/cap growth (%, 2009)	Arable land per capita (ha, 2005)	Fertilzer use (kg/ha, 2005)	Forest area (%, 2005)	Extreme Poverty (%, 2001-2006)	Road density (km road / km2 land, 2003-2005)	Child Underweight (%, 2007)
Ethiopia	74.7	16	848	5,9	0,2	7.0	12.7	39.0	3	41
Sudan	38.7	41	2,007	2.2	0.5	2.6	27.9	n/a	n/a	22
Chad	10.0	25	1,181	-4.2	0.4	n/a	9.3	61.9	3	37
Niger	13.1	16	613	-2.9	1.1	0.4	1.0	65.9	1	20
Mali	11.0	31	1,077	1.9	0.4	0.0	10.1	51.4	1	12
Burkina Faso	13.7	18	1,078	0.1	0.4	15.4	24.7	56.5	34	9
Ghana	21.9	48	1,410	2.5	0.2	5.9	23.2	30.0	24	5
Côte d Ivoire	19.2	47	1,545	1.2	0.1	17.8	32.8	23.3	25	14
Benin	7.9	40	1,369	0.6	0.3	0.0	20.1	47.3	17	12
Cameroon	17.8	54	2,002	-0.3	0.3	7.9	44.0	32.8	11	21
Mozambique	20.8	35	804	4.0	0.2	1.6	24.4	74.7	n/a	38
Kenya	35.8	21	1,428	-0.1	0.1	38.8	6.1	19.7	11	31
Uganda	28.7	13	1,105	3.6	0.2	1.1	17.5	51.5	17	21

Source: World Bank, 2011c

Table 3.4
Specific combinations of indicators of vulnerability to food insecurity, for the profiles identified in semi-arid and arid areas

Characteristics	Arid areas			Semi-arid areas				Urban areas	
	Extreme poverty and isolation	Medium governance and isolation	Poor resources and poor governance	Low sensitivity to erosion	High sensitivity to erosion	Poor governance and high sensitivity to erosion	Sourthern Africa (rural)	Southern Africa	Arid and semi-arid areas
Child nutrition status	0.34	0.46	0.23	0.37	0.40	0.34	0.75	0.80	0.39
Governance	0.54	0.64	0.29	0.50	0.53	0.15	0.89	0.90	0.39
GDP per capita	0.04	0.06	0.06	0.05	0.06	0.08	0.63	0.71	0.08
Proximity markets	0.23	0.61	0.69	0.82	0.83	0.73	0.81	0.88	0.83
Population density	0.00	0.01	0.01	0.06	0.07	0.04	0.01	0.12	0.25
Urban population fraction	0.00	0.02	0.02	0.07	0.08	0.10	0.03	0.45	0.59
Water availability	0.01	0.03	0.07	0.13	0.11	0.13	0.05	0.07	0.15
Agropotential	0.00	0.00	0.01	0.39	0.33	0.25	0.11	0.41	0.29
Land conservation	1.00	0.97	1.00	0.85	0.35	0.44	0.68	0.52	0.48

Note: Green indicates a favourable condition; red an unfavourable condition. The indicators of population density and urbanisation respectively concern high versus low population densities and degree of urbanisation. The numbers refer to the average rescaled indicator with a value of between zero and one (see note below Table 3.1)

Improved availability of food relies on conservation and improvement of the limited agricultural production potential. A best policy practice is re-greening the rural environment with a successful example of reforestation at the scale of 3 to 4 million hectares in Niger (Spielman and Panya-Lorch, 2009; Van Haren et al., 2010). Between 1990 and 2005 Niger witnessed a loss of 26% of the forest and woodland habitat. Through the nation-wide re-greening initiative, farmers have re-valued agro-forestry techniques. Estimations indicate that at limited costs of USD 20 per hectare food security for 2.5 million people in Niger has been considerably improved (Reij et al., 2009b; Reij et al., 2009a). Otherwise, in the arid areas in Niger there are little opportunities to cope with climate change in agriculture. Some examples are practices such as alley cropping and the construction of small terraces (Nkonya et al., 2011b). Another issue is the prevailing overgrazing which could be considerably reduced at costs of about 20% of the costs that will be the result of inaction (Nkonya et al., 2011a).

The options to stimulate economic development and to improve access are limited but important. These ecosystems provide dryland endemic species such as Neem, Aloe Vera and Shea Butter. Livestock production systems are harsh but provide opportunities for income generation (Van Haren et al., 2010). A bilateral development cooperation programme in the north of Mali has resulted in better governance of pastures, less livestock mortality, higher prices and availability of commercial fodders. However, lack of infrastructure, roads and means of transport, remain a major bottleneck for development (Ministry of Foreign Affairs, 2011c).

Policies to improve utilisation of food in the arid areas are not systematically reported. Policy documents of the WFP concern national figures and do not report on regional programmes.

Semi-arid areas in Mali

As an example of a semi-arid region we use the Sudan savannas in Mali (215,000 km^2, 17% of the total land area of Mali), situated in the centre of Mali with varying average precipitation between 600 and 1200 mm. Comparable agro-ecosystems are present in Burkina Faso and also in east Africa in some regions of Uganda (Text box 4). Food insecurity in this region is high in absolute numbers in the densely populated areas (e.g. south-east Mali) while the share of the population that is food insecure is high in the more remote areas (Meijerink and Shutes, 2011).

Mali has achieved a gradual increase in food production for more than four decades, from 1964 until 2004. Before 1984, area expansion (3.2% annually) compensated for a yield decrease (of 0.7%). From 1984 to 2004, the agricultural area expanded with 2.5% while yields improved annually by 1.8%. Total increase in food production outweighed demographic growth. The increase in food production is mainly attributed to an increase in the area and yield of rice (OECD, 2008). In spite of intensification efforts, cotton and maize yields decreased by 10% to 17%, between 1993 and 2002, partly due to decreasing rainfall and due to cultivation on more marginal lands. Expansion of the areas of these crops has compensated for the declining yields (Bodnár, 2005). Cotton production is, in particular since 2000, highly variable from one year to another. Since the privatisation of the semi-government cotton board, cotton production has showed a more than 40% decrease in production from one year to another (OHDV, 2010).

Policies to improve food availability by natural resource management and technology development are put into practices since the 1970s. Research projects, integrated rural development plans and extension programmes generally combined typical technologies such as i) erosion control through stone bunds and hedges, ii) integration of livestock and crop activities, iii) agricultural mechanisation mainly in the form of animal traction, and iv) crop management practices, fertiliser use and improved varieties (Bodnár, 2005).

Agricultural GDP per worker increased slowly from about USD 170 in 1968 to USD 220 in 2004 (2000 USD prices), the lowest in sub-Saharan Africa (OECD, 2008). Rural poverty rates in 2006 remained high (about 50%). Income diversification in rural areas is one of the reasons for reductions in poverty rates. Cotton production allows for improving food security through policies within the production chain (Fair Trade Foundation, 2010). Likewise, irrigated rice production is an opportunity for further developing the agricultural sector (OHDV, 2010; Panel de Revue Technique du PDDAA, 2010).

Policies to improve utilisation of food in the dry areas are not systematically reported. Policy documents of the WFP concern national figures and do not report on regional programmes.

3.4 Food insecurity in forested agricultural regions

In the forested agricultural regions, population density is the most important factor that creates differences within the region (Table 3.5). On the one hand, regions that rely on agriculture include west Africa, the Ethiopian highlands and east African countries, such as Mozambique and Tanzania. Uganda, Rwanda and Burundi fall also in this category. On the other hand, the less densely populated regions in central Africa are forest core regions to which we devote less attention in this report. The absence of good governance is a major reason for food insecurity in the latter regions.
The mosaics of forest and agricultural land include agro-forestry and agricultural systems based on maize, root and tree crops. The low populated areas are located in the northern parts of west African countries from Sierra Leone to Nigeria, in east African countries, such as Mozambique, Tanzania and Uganda and in the high land areas of Ethiopia. The more densely populated areas are located along the west African coast, in the highlands of Ethiopia and in some areas in east and central African countries, such as in Uganda (Text box 4).

The regions are characterised by medium prevalence of malnutrition with large differences across and within countries. In the west African countries, in particular in Ghana, malnutrition has been considerably reduced. In Mozambique food insecurity is severe and unevenly spread throughout the country. Three provinces in the south of Mozambique (Manica, Inhambane and Gaza) have the highest prevalence of food insecurity. Between 60% and 70% of households cultivate land in the highlands (WFP, 2010b).

The densely populated areas with forest and agriculture represent areas where agro-ecological conditions, access to markets, and possibilities to generate income outside agriculture are relatively good. The challenge of land conservation is more an issue compared to the forest core areas. In areas with cash crop production the replacement and exploitation of forests in these areas has lowered the biodiversity to medium levels (they have the lowest biodiversity left of the forested areas) and have increased land degradation. The outcomes in terms of food security and poverty in this group indicate situations in which food production is mostly oriented to markets and people do not sufficiently benefit from better production due to low prices to generate enough income. People may also work as labourers and not benefit from the revenues of commercialisation due to low wages and therefore cannot have access to food.

The areas of low population density correspond to areas where more subsistence agriculture is practiced. These mosaic lands of agriculture for subsistence have a less developed agricultural frontier, which is reflected in a higher biodiversity and lower land degradation than areas with cash crops. The lack of opportunities to

Table 3.5

Specific combinations of indicators of vulnerability to food insecurity, for the profiles identified in forested agricultural and forest areas

Characteristics	Forested agricultural areas			Forest areas		
	Low populated density	High populated density	Urban and peri-urban areas	High productivity	Low productivity	High income regions South Africa and Gabon
Child nutrition status	0.46	0.45	0.49	0.48	0.47	0.83
Governance	0.50	0.43	0.31	0.12	0.25	0.77
GDP per capita	0.06	0.05	0.08	0.04	0.06	0.86
Proximity agriculture	0.67	0.87	0.11	0.69	0.04	0.68
Proximity markets	0.80	0.87	0.81	0.71	0.75	0.86
Population density	0.28	0.92	0.45	0.18	0.13	0.39
Urban population fraction	0.12	0.42	0.57	0.10	0.05	0.49
Agropotential	0.44	0.52	0.41	0.43	0.39	0.49
Net Primary Porductivity	0.42	0.56	0.50	0.84	0.48	0.56
Mean species abundance	0.75	0.57	0.76	0.77	0.82	0.72
Land conservation	0.60	0.50	0.65	0.92	0.77	0.74

Note: Explanation of colours: Green indicates a favourable condition; red an unfavourable condition. The indicators of population density and urbanisation respectively concern high versus low population densities and degree of urbanisation. The numbers refer to the average rescaled indicator with a value of between zero and one (see note below Table 3.1)

generate income outside agriculture and the limitation to benefit from the services of the ecosystem (being that from forest products or adequate levels of production) are the most important factor for the low populated groups.

Forested agricultural areas in Benin and Ghana

Agricultural growth potential is moderate and production technologies for this system are not yet fully developed. Soil fertility problems emerge (InterAcademy Council, 2004). Market prospects for agricultural products are attractive: urban demand for root crops, vegetables and cereals and international demand for industrial tree crops are growing. Yet, recent institutional problems have blocked progress in the development of cash crop sectors. For example, in Benin, 60% to 70% of the population works in the agricultural sector and cotton generated in 40% of the export revenues in 2007. Due to problems similar to the Mali case, cotton production has decreased from 2004 to 2010 by more than 50%, from 570,000 to 200,000 tonnes. The official target is 600,000 tonnes in 2012 (Ministry of Foreign Affairs of the Netherlands, 2011c).

Ghana is a middle-income country with a real per-capita GDP of USD 547 in 2010 and a growth of 5% in 2010 which is expected to have been 10.7% in 2011 (IMF, 2011) Total cereal output in Ghana increased by 4.4%, annually, between 1984 and 2004. Of this annual increase, 2.6% is attributed to yield increases. Agricultural GDP per worker declined up to 1983, and remained stable between 1983 and 2004 (about USD 350 in 2000 prices). Incidences of rural poverty declined from over 50% in the early 1990s to 28.5% in 2006. Ghana has the best track record in poverty alleviation in sub-Saharan Africa. Earnings per agricultural worker in 2005 were almost three times the agricultural GDP per agricultural worker, pointing toward diversification to non-farming sectors. Food insecurity in 2010, was less than official statistics suggest and concerns some five per cent of households in some selected provinces in the north (Republic of Ghana, 2010).

Text box 4
Food security in Uganda

Uganda is a densely populated country with a high population growth. Economic growth over the last two decades has been around 7% per year; GDP per-capita growth about 3.3% per year. The percentage of population below the national poverty line had decreased from 56% in 1990 to 25% in 2009. Traders from west Kenya, southern Sudan, Rwanda and eastern Congo exert a large demand for food products from Uganda leading to sharp increases in food prices in Uganda. Many of the food insecure people can be found in the northern districts where semi-arid conditions are less favourable for agricultural production. This also applies to the agro-pastoral and pastoral regions in the northeast of the country.

Population growth has increased pressure on the environment. Although Uganda has abundant water resources, its distribution is uneven. Water stress in the semi-arid regions is aggravated by recent prolonged and severe droughts. Climate change is expected to lead to increased yet more erratic rainfall. Soil fertility depletion, especially in the highlands, is among the highest in sub-Saharan Africa. In the long run, land degradation also increases in the central and western districts and in the highlands.

Food availability should not be a problem for Uganda. It is estimated that Uganda could feed seven times its current population. Sharp regional disparities exist; in the semi-arid areas food production is more problematic than in the more fertile highlands in the central and western districts. Increased production has mainly been realised by expansion of cropland, yet land degradation has intensified. Despite favourable agro-climatic conditions, yields are low compared to those in other sub-Saharan countries. Fertiliser use is limited.

Poverty is mainly located in the rural areas (in 2009 the poverty headcount ration in rural areas was 27%, in urban areas 9%). With the political turmoil in Kenya, Ugandan maize prices surged in 2008, inducing consumers to substitute plantains and cassava for maize in their local diets. Cassava, because of its capacity for harvest season and for inter-annual in-ground storage, moderated volatility of food prices. The urban population was affected most by the increase in maize prices.
Food utilisation is characterised by substantial variation in food and micronutrient intake across regions of Uganda. Currently, 28.3% of the population are under the correct height for their age. Of the under-five-year-old children 16% suffer from being moderately underweight, and 4% suffer from being severely underweight (2003-2009). The main micronutrient intake gaps in Uganda are for the vitamins and minerals that would most often be supplied by foods of animal origin; these include vitamin A, vitamin B-12, iron, zinc, and calcium. In general, the diet in the rural central and south-west, where plantains dominate, provided larger amounts of most nutrients, and thus the population there had the lowest prevalence of inadequate intakes. In refugee camps in the north, dietary patterns were restricted to such an extreme that food aid from the WFP was necessary.

Farmers expect government to play three main roles to improve production and thus enhance availability: information and extension, access to credit, and supply of improved seeds and fertilisers. Confronting land degradation should be a priority, given its long-term negative effects on food production. Access to food would be warranted by the introduction of agricultural insurance schemes that generate a more stable income for farm households. Regionally, the northern districts should receive priority. Specific target groups to improve food utilisation include women and youth. School feeding programmes may further help to reduce undernourishment among children.

3.5 Coherence between availability, access and utilisation

Policy options for improving availability, access and utilisation are relevant in the three regions that we have distinguished, yet differ on criteria such as environmental sustainability, economic opportunities and poverty alleviation. In the table below the keywords for the above-mentioned combinations are presented.

In the remote arid areas, proposed priorities are to improve availability by avoiding desertification with low-technology solutions that fit in the poorly developed local economies. Better access through economic development is desirable but costly due to weak

infrastructures. Policies to improve utilisation need to address basic needs for staple foods for large shares of local populations. Poverty is commonly prevailing across large proportions of the population in regions with low population density.

In contrast, in the semi-arid areas, policies to improve availability of food involve larger investments per unit area. Previous integrated rural development projects in Burkina Faso and Mali were examples of relatively large investments in erosion control and crop-livestock integration. However, rural economies based on a few cash crops (e.g. cotton and maize) remain weak. The integrated rural development programmes have shifted towards improving access to economic resources and agricultural product chain development. An example is an integrated rural development project in the rural areas near to Bamako (Mali), part of bilateral development cooperation between Mali and the Netherlands (Ministry of Foreign Affairs, 2011c). Policies directed at improving utilisation take place in these areas but are less integrated in rural development programmes.

Lastly, in the forest agriculture areas policies that improve access through exploitation of cash crops such as cocoa, coffee, pineapple have large potential. Sustainability issues are commonly addressed within sustainable chain management initiatives. Policy options to assure food availability through natural resources management need to be integrated in the access policies. Options to improve utilisation concern focused policy efforts such as school feeding programmes.

THREE

Conclusions and recommendations

In the previous chapters, analyses at the world regional level, the grid level and the translation of these results to the national situation have been presented. Based on these analyses several findings or conclusions can be drawn. Since this study was explorative in nature, these conclusions are followed by a list of recommendations which could result in a better understanding of food security in sub-Saharan Africa.

4.1 Framework to position and analyse food security issues

The food security framework, that distinguishes the dimensions availability, access, and utilisation, facilitates the analysis of the most crucial aspects in improving the food security situation in sub-Saharan Africa. Using a framework systematically for analysing food security dynamics proves to be helpful to identify most important issues and dynamics of food insecurity. This study made explicit how these prerequisites differ across and within countries in sub-Saharan Africa. The focus for availability was on agricultural production as a combination of land and productivity. Access issues included food prices, income distribution and. Utilisation issues concerned symptoms of inadequate utilisation of food, in particular the prevalence of child malnutrition, and its interaction with other risks such as access to safe drinking water.

4.2 Trends signal short-term and long-term policy priorities

Economic and population growth will increase food demand

The population growth in sub-Saharan Africa, in combination with the relatively high income growth is expected to result in a more than fourfold increase in total food demand by 2050, compared to 2000. With such an increased level of food consumption, malnutrition is expected to be eradicated almost entirely but only by 2050. In west Africa such an increase in agricultural production is achieved by expansion of agricultural land, while in east Africa, where the potential for agricultural expansion is smaller, the productivity is projected to increase. Such a projection is based on the OECD baseline scenario for the Environment Outlook and assumes that sub-Saharan Africa will benefit from their so-called demographic window of opportunity: the ratio of active to non-active people is likely to increase over the next two decades.

Development policies address availability, access and utilisation

The food security framework gives entry points for development policies targeting food insecurity. As shown, improving availability in sub-Saharan Africa will mainly come from expansion of current agricultural land and improvements in agricultural productivity will show improvements but still the yield gap remains. As

consequence, the expansion of agricultural land reduces forest cover 29% (between 2010 and 2030) and biodiversity loss will not be halted and likely to even accelerate until 2030, despite international policy goals on halting biodiversity loss. The impact of this loss on the development process in general is still not well-enough understood to be able to capture its possible drawbacks; for example, on land productivity. Access to food is projected to improve given the relatively high income growth and assuming that income distribution will not change. Yet, projections are uncertain about food prices and income inequality seems to increase. Concerning utilisation, the projected progress will not be enough to reach the MDG target by 2015, although prospects are promising for the following period, with large reductions in the number of underweight children. The disease burden directly or indirectly related to food insecurity is projected to be alleviated substantially. This is the consequence of progress in the other related factors as malaria, diarrhoea and respiratory infections, induced by the high economic growth. The relatively high growth prospects for the economy are under the assumption that sub-Saharan Africa will be able to adequately build on its potential.

Important conditions for development

Sub-Saharan Africa will have to take into account factors which, historically, were seen as blocking progress, but also to ensure that factors necessary for success will be stimulated. The most important factors are: 1) a healthy and educated population, essential to be able to capitalise to demographic dividend through higher labour productivity; 2) inclusive growth to let progress at macro level trickle down to poorer population segments; 3) modernisation of agriculture including adequate infrastructure and production conditions; 4) address competing claims, both for energy with biofuels as for water and irrigation; 5) institutional settings that provide stable incomes and incentives to invest in agriculture; 6) environmental sustainability and ways to mitigate and cope with biodiversity loss and climate variability; and 7) political stability and conflict resolution. These seven conditions are necessary, although maybe not sufficient, for achieving food security.

4.3 A geographical analysis of food insecurity is necessary to target food security policies

Geographic analysis underlines the need for a better regional perspective on food insecurity in sub-Saharan Africa (Nubé and Sonneveld, 2005). Current policies combine insufficiently quantitative information on the state of available natural resources, on the opportunities of specific agricultural production chains, and on specific and urgent problems of inadequate utilisation of food. By combining these issues and by taking a regional perspective, beyond national boundaries, policies would be more effectively targeted and better able to attune various development cooperation initiatives. An example of regional policies would include a clear development strategy for the Sahel region that combines the challenges of conservation and restoration of the natural resource base with effective improvement of food utilisation. A second example would be policies that warrant the inclusiveness of economic growth that is based on the development of a production chain of an international commodity. And a third example, is the need for policies that target specific spots of poverty such as can be found in Mozambique, Uganda or Kenya. These examples are further elaborated along the lines of availability, access and utilisation.

In arid regions, limited food availability causes high vulnerability for relatively few people

Vulnerable groups in sub-Saharan Africa live in the arid areas and represent a relatively small share of the population (less than 10 million people and about 1.5% of the total population). The situations in which these people live in are relatively bad from an environmental perspective (degradation, water scarcity, sensitive for climate change) as well as from a socio-economic perspective (high poverty, high population growth, no capital to invest). To improve the lives of this population requires great effort on targeting several of these factors at the same time but priority should be given to conservation and restoration of the natural environment. Recent promising initiatives to re-green the Sahel need to be systematically offered to national policy makers such that the entire Sahel region will benefit. In addition, food programmes should incorporate a strategy for structural alleviation of hunger that takes into account the region's environmental and economic carrying capacity.

In more productive regions, access to food, rather than its availability, is a constraint for many people

The groups that score somewhat better on the vulnerability indicators, but with higher shares of population, still show relatively high prevalence of malnutrition. In more productive areas higher economic growth is observed and population density is an important factor which, at the same time, determines the opportunities to improve access to food and the prevalence of malnutrition in absolute numbers. In the densely populated regions live almost 200 million people (40% of the population) and economic growth should potentially warrant access to food such that food insecurity is prevented. Food security policies should

focus on inclusiveness of economic growth; for example, by integration of environmental and socio-economic conditions in initiatives to make agricultural commodity chains more sustainable.

4.4 Suggested implications for food security policies and research

The expected demographic, economic and environmental changes in sub-Saharan Africa require concerted policies on food; to improve availability, access, and utilisation. These aspects of food security link to typical policy areas. First, availability of food links to natural resource management and agricultural policies; for example, in arid areas in the Sahel countries. Second, access to food links to policies that facilitate and stimulate inclusive growth; for example, in forested agricultural regions with important production of international agro-commodities. Third, utilisation of food links to social security policies and food aid for the most vulnerable populations; for example, in the remote Sahel regions or in specific spots of poverty in resource-rich regions.

The following priorities for policy and research are identified[1]:

- Expectations about development in Africa need to be further explored with a focus on a comparison of Africa with other world regions. Different scenarios should be developed to better account for key uncertainties such as climate change, urbanisation, economic growth, and agricultural production.
- More focus is needed on the issue of land degradation and water scarcity. On the one hand, food insecurity in sub-Saharan Africa is widely present, while, on the other hand, agricultural land is abundantly available and several countries, such as Uganda and Benin, have the potential to greatly increase food production. However, inefficient use of agricultural land and limited availability of external inputs (fertiliser, improved seeds, and pesticides) may lead to further land degradation and water scarcity. The issue needs to be analysed from a sub-regional perspective.
- Better understanding of production systems including the role of markets, infrastructure and livestock is needed. Key issues are the scale of production (smallholder versus more industrialised production), urbanisation, and, related to this, the role of agro-hubs (the infrastructure from producer to consumers within and between countries). Likewise, policies that concern international crop commodity chains, regional or sector policies, need to be aligned with generic policies with respect to the agricultural sector and to the management of natural resources.
- The actual number of undernourished people requires more a more careful analysis. There is an evident urgency in alleviating hunger and extreme poverty, yet to formulate and implement food security policies, there is a need for unambiguous and useful indicators on the number of undernourished people.
- Attention is needed for governance issues in national and in regional perspective. Within countries, governance structures should allow for stakeholders involvement, adequate capabilities to meaningfully participate in policy processes, and to generate adequate information. In addition, international organisations, such as NEPAD, could play a more pivotal role between donor and recipient countries. This would facilitate the alignment of development cooperation and ownership at the side of the recipient countries.

Note

1 These priorities were discussed in an expert workshop in January 2012. In the workshop experts participated from WUR-PRI, WUR-LEI, ECDPM, VU-SOW and ASC.

References

Abdulai A, Diao X and Johnson M. (2005). Achieving regional growth dynamics in African agriculture.

Alcamo J, Henrichs T and Rösch T. (2000). World Water in 2025 – Global modeling and scenario analysis for the World, Commission on Water for the 21st Century. no. 2, University of Kassel.

Alkemade R, Van Oorschot M, Miles L, Nellemann C, Bakkenes M and Ten Brink B. (2009). GLOBIO3: A Framework to Investigate Options for Reducing Global Terrestrial Biodiversity Loss. Ecosystems, 12: 374–390.

AUC/ECA/AfDB/UNDP (2011). Assessing Progress in Africa toward the Millennium Development Goals, African Union Commission (AUC), the United Nations Economic Commission for Africa (ECA), the African Development Bank (AfDB), United Nations Development Programme (UNDP) 152 pp.

Badiane O. (2008). Sustaining and accelerating Africa's agricultural growth.

Bakkenes M and Ten Brink B. (2009). A Green Development Mechanism: Biodiversity compensation within the globe, regions and biomes.

Belieres J, Bosc P, Faure G, Fournier S and Losch B. (2002). 'What future for west Africa's family farms in the world market economy?' International Institute for Environment and Development, Drylands Programme.

Boddiger D. (2007). Boosting biofuel crop could threaten food security. The Lancet, 370(9591): 923–924.

Bodnár F. (2005). Monitoring for impact: evaluating 20 years of soil and water conservation in southern Mali, Wageningen University and Research Centre, Wageningen.

Brinkman HJ and Hendrix CS (2011). Food Insecurity and Violent Conflict: Causes, Consequences, and Addressing the Challenges, World Food Prgramme 32 pp.

Cane MA, Eshel G and Buckland RW. (1994). Forecasting Zimbabwean maize yield using eastern equatorial Pacific seas surface temperatures. Nature, 370: 204–205.

CBD (2007). Global Biodiversity Outlook 3, Secretariat of the Convention on Biological Diversity, Montreal.

CIESIN (2005a). Global subnational rates of child underweight status. Center for International Earth Science Information Network (CIESIN). Columbia University, New York.

CIESIN (2005b). Gridded Population of the World Version 3 (GPWv3). Socioeconomic Data and Applications Center (SEDAC), Columbia University, sedac.ciesin.columbia.edu/gpw.

Cincotta RP, Engelman R and Anastasion D. (2003). The security demographic: population and civil conflict after the cold war, Population Action International, Washington D.C.

Cincotta RP and Hummel LJ. (2003). Africa's Youthful Population Age Structures and its Security Prospects. In: A.R. Krakowka and L.J. Hummel (Editors), Understanding Africa: A Geographic Approach, United States Military Academy, New York.

Clover J. (2003). Food Security in Sub-Saharan Africa. African Security Review, 12(1).

Collier P. (2007). The bottom billion: why the poorest countries are failing and what can be done about it. Oxford University Press, Oxford; New York.

Diao X and Yanoma Y. (2003). Exploring regional dynamics in Sub-Saharan African agriculture, IFPRI.

Dietz TD. (2011). Silverlining Africa. From images of doom and gloom to glimmers of hope; from places to avoid to places to enjoy, Leiden University and African Studies Centre.

Ellis S. (2011). Seasons of rains: Africa in the world, London.

Fair Trade Foundation (2010). The great cotton stitch-up.

Fan S, Johnson M, Saurkar A and Makombe T. (2008). Investing in African agriculture to halve poverty by 2015. 751, IFPRI.

FAO (2006). Food Security. Policy Brief, issue 2.

FAO (2008). The state of food insecurity in the world: High food prices and food security - threats and opportunities, Food and Agricultural Organization of the United Nations, Rome.

FAO (2011). The state of food insecurity in the world. How does international price volatility affect domestic economies and food security?

FAO/WFP (2010). The state of food Insecurity in the world: Addressing food insecurity in protracted crises, Food and Agriculture Organization of the United Nations (FAO); United Nations World Food Programme (WFP), Rome.

Fischer G. (2009). World Food and Agriculture to 2030/50: 'How do climate change and bioenergy alter the long-term outlook for food, agriculture and resource availability?' Food and Agriculture Organization of the United Nations. Economic and Social Development Department.

Gyimah-Brempong K, Paddison O and Mitiku W. (2006). Higher education and economic growth in Africa. Journal of Development Studies, 42(3): 509–529.
Hilderink HBM and Lucas PL, (editors). (2008). Towards a global integrated sustainability mdel: GISMO 1.0 status report. PBL Netherlands Environmental Assessment Agency, Bilthoven/The Hague.
Hillebrand E. (2009). Poverty, growth, and inequality over the next 50 years, Food and Agriculture Organization of the United Nations, Economic and Social Development Department.
Hootsman R, Bouwan A, Leemans R and Kreileman GJJ. (2001). Modelling land degradation in IMAGE 2. Report 481508009, National Institute for Public Health and the Environment, Bilthoven, 33 pp.
IFC (2007). The Business of Health in Africa, Partnering with the Private Sector to Improve People's Lives, International Finance Corporation, World Bank Group, 154 pp.
IFPRI (2010). Global Hunger Index: The Challenge of Hunger: Focus on the Crisis of Child Undernutrition, International Food Policy Research Institute, Bonn; Washington D. C.; Dublin.
IMF (2011). Regional economic outlook: Sub-Saharan Africa. Sustaining the expansion, IMF.
InterAcademy Council (2004). Realizing the Promise and Potential of African Agriculture.
IPCC (2007). Climate Change 2007: Impacts, Adaptations and Vulnerability – Contribution of Working Group II to the IPCC Fourth Assessment.
Islam N. (2011). Foreign aid to agriculture. Review of facts and analysis, IFPRI.
Jayne TS, Kelly V and Crawford E. (2003). Fertilizer consumption trends in Sub-Saharan Africa, Policy Synthesis(69).
Jumber CBL, Msiska FBM and Madjera M. (2009). Biofuels development in Sub-Saharan Africa: Are the policies conducive? Energy Policy, 37(11): 4980–4986.
Karshenas M. (2001). Agriculture and economic development in sub-Saharan Africa and Asia. Cambridge Journal of Economics, 25: 315–342.
Kaufmann D, Kraay A and Mastruzzi M. (2008). Governance Matters VII: Governance Indicators for 1996–2007.
Keyzer MA and Wesenbeeck L. (2007a). Food aid and governance, SOW-VU.
Keyzer MA and Wesenbeeck L. (2007b). The Millennium Development Goals. How realistic are they?
Klein Goldewijk K, Beusen A and Janssen P. (2010). Long-term dynamic modeling of global population and built-up area in a spatially explicit way: HYDE 3.1. The Holocene,, 20(4): 1–9.
Kok MTJ, Brons JE and Witmer M. (2010a). Exploring the implications of a global public good approach for Dutch foreign policy on global environmental issues and sustainable reduction, PBL Netherlands Environmental Assessment Agency; World Resource Institute (WRI); Directie Milieu, Water, Klimaat en Energie (DME), Bilthoven; Den Haag.
Kok MTJ and Jäger J. (2007). Vulnerability of people and the environment – challenges and opportunities: Background Report on Chapter 7 of the Fourth Global Environment Outlook (GEO-4). PBL Netherlands Environment Assessment Agency; United Nations Environment Programme (UNEP); Bilthoven; Nairobi.
Kok MTJ, Lüdeke MKB, Sterzel T, Lucas PL, Walter C, Janssen P and de Soysa I. (2010b). Quantitative analysis of patterns of vulnerability to global environmental change, PBL/PIK/NTNU, 92 pp.
KPMG (2012). Certification and biodiversity Exploring improvements in the effectiveness of certification schemes on biodiversity.
Letourneau AP, Verburg PH and Stehfest E. (2010). Global change of land use systems, IMAGE: a new land allocation module, WUR, Wageningen.
Marshall MG. (2005). Conflict trends in Africa, 1946–2004, A macro-comparative perspective, Center for Global Policy, Arlington, 29 pp.
Meijerink G and Shutes K. (2011). Mapping socio-economic factors in Mali, LEI, Wageningen UR, The Hague.
Ministry of Economic Affairs, Agriculture and Innovation (2011). Grondstoffennotitie, The Hague.
Ministry of Economic Affairs, Agriculture and Innovation and Ministry of Foreign Affairs (2008). Landbouw, rurale bedrijvigheid en voedselzekerheid, The Hague.
Ministry of Foreign Affairs (2011a). Focusbrief ontwikkelingssamenwerking, The Hague.
Ministry of Foreign Affairs (2011b). Kamerbrief uitwerking voedselzekerheidbeleid, The Hague.
Ministry of Foreign Affairs (2011c). Resultaten in ontwikkeling 2009–2010, Dutch contributin to international development goals, The Hague.
Ministry of General Affairs (2010). Vrijheid en verantwoordelijkheid regeerakkoord VVD–CDA, The Hague.
MNP (2006). Integrated modelling of global environmental change. An overview of IMAGE 2.4. Netherlands Environmental Assessment Agency (MNP), Bilthoven.
Molden D. (2007). Water for Food, Water for Life: A Comprehensive Assessment of Water Management in Agriculture, London: Earthscan, and Colombo: International Water Management Institute.
Nelson GC, Rosegrant MW, Palazzo A, Gray I, Ingersoll C, Robertson R, Tokgoz S, Zhu T., Sulser TB, Ringler C, Msangi S and You L. (2010). Food security, farming, and climate change to 2050. Scenarios, results, policy options, IFPRI.

NEPAD (2010). CAADP Review, Renewing the commitment to African agriculture, NEPAD Planning and Coordinating Agency, 64 pp.
Nkonya E, Gerber N, Von Braun J and De Pinto A. (2011a). Economics of land degradation, The costs of action versus inaction, IFPRI.
Nkonya E, Place F, Pender J, Mwanjololo M, Okhimamhe A, Kato E, Crespo S, Ndjeunga J and Traore S. (2011b). Climate Risk Management through Sustainable Land Management in Sub-Saharan Africa, IFPRI, Environment and Production Technology Divisison.
Nubé M and Sonneveld BGJS. (2005). The geographical distribution of underweight children in Africa, SOW-VU, Amsterdam.
OECD (2008). Agricultural Progress in Cameroon, Ghana and Mali, OECD Publishing.
OECD (2011). Development Assistance Committee (DAC), Peer review 2011, the Netherlands.
OECD and FAO (2010). OECD/FAO Agricultural outlook 2010–2019.
OECD/PBL (2012). OECD Environmental Outlook, Organisation for Economic Co-operation and Development.
OHDV (2010). Crise alimentaire: enjeux et opportunités pour le développement du secteur agricole.
Oldeman LR, Hakkeling RTA and Sombroek WG. (1991). World map of the status of human-induced soil degradation: an explanatory note (second revised edition), International Soil Reference and Information Centre, Wageningen, United Nations Environment Programme, Nairobi.
Oya C. (2007). Stories of Rural Accumulation in Africa: Trajectories and Transitions among Rural Capitalists in Senegal. Journal of Agrarian Change, 7(4): 453–493.
Panel de Revue Technique du PDDAA (2010). Commentaires preliminaires sur le PNIA de la Republique du Mali.
PBL (2009). Beyond 2015: Long-term development and the Millennium Development Goals, PBL Netherlands Environmental Assessment Agency, Bilthoven/The Hague, 84 pp.
Pincus J. (2004). Review of Rural Capitalists in Asia: A Comparative Analysis on India, Indonesia and Malaysia by M. Rutten. Journal of Agrarian Change, 4(3): 407–409.
Prieto Rodao E. (2009). Effects of soil scarification on the regeneration of commercial tree species in the moist tropical forest of La Chonta, Santa Cruz, Bolivia.
Prins AG, Slingerland S, Manders AJG, Lucas PL, Hilderink HBM and Kok MTJ. (2011). Scarcity in a sea of plenty? Global resource scarcities and policies in the European Union and the Netherlands, PBL Netherlands Envrionmental Assessment Agency, Bilthoven/The Hague, 85 pp.
Psacharopoulos G and Patrinos HA. (2004). Returns to investment in education: a further update. Education Economics, 12(2): 111–134.
Ravallion M, Chen S and Sangraula P. (2007). New evidence on the urbanization of global poverty, World Bank, Washington.
Reij C, Tappan G and Smale M. (2009a). Agroenvironmental transformation in the Sahel another kind of 'green revolution', IFPRI.
Reij C, Tappan G and Smale M. (2009b). Re-greening the Sahel farmer-led innovation in Burkina Faso and Niger.
Republic of Ghana (2010). 2008 Ghana Millenium Development Goals report.
Smith L and Haddad L. (2000a). Explaining Child Malnutrition in Developing Countries: A Cross-Country Analysis. Research Report 111, International Food olicy Research Institute, Washington D.C.
Smith LC and Haddad L. (2000b). Overcoming Child Malnutrition in Developing Countries: Past Achievements and Future Choices. Food, Agriculture, and the Environment Discussion Paper 30, International Food Policy Research Institute, Washington D.C.
Spielman DJ and Panya-Lorch R, (editors). (2009). MillionsFed. Proven successes in agriculture.
State Failure Task Force (2003). State Failure Task Force Report: Phase III Findings.
Stige LC, Stave J, Chan KS, Ciannelli L, Pettorelli N, Glantz M, Herren HR and Stenseth NC. (2006). The effect of climate variation on agro-pastoral production in Africa. Proceedings of the National Academy of Sciences of the United States of America, 103(9): 3049–3053.
Tekelenburg T, Ten Brink B and Witmer M. (2009). How do biodiversity and poverty coincide? An explorative study, PBL Netherlands Environmental Assessment Agency, Bilthoven/The Hague.
Ten Brink B, Van der Esch S, Kram T and Van Oorschot M, (editors). (2010). Rethinking Global Biodiversity Strategies: Exploring structural changes in production and consumption to reduce biodiversity loss. PBL Netherlands Environment Assessment Agency, Bilthoven/The Hague.
Turner BL, Kasperson RE, Matson PA, McCarthy JJ, Corell RW, Christensen L, Eckley N, Kasperson JX, Luers A, Martello ML, Polsky C, Pulsipher A and Schiller A. (2003). A framework for vulnerability analysis in sustainability science. PNAS, 100(14): 8074–79.
UN-Habitat (2008). State of the world cities 2008/09, United Nations Human Settlements Programme (UN-HABITAT), Nairobi, Kenya.
UN (2009a). The Millennium Development Goals Report 2009, United Nations, New York.
UN (2009b). World Population Prospects: the 2008 revision. United Nations, Department for Economic and Social Information and Policy Analysis, New York.

UN (2010). World Urbanization Prospects: The 2009 Revision Highlights, United Nations, New York, 56 pp.
UN (2011). World population prospects: the 2010 revision. United Nations, Department for Economic and Social Information and Policy Analysis, New York.
UNDP (2006). Human development report. Beyond scarcity: Power, poverty and the global water crisis, United Nations Development Programme, New York, 440 pp.
UNEP (2002). Global Environmental Outlook 3, United Nations Environmental Programme, EarthScan, London, 416 pp.
UNEP (2003). Action Plan of the Environment Initiative of the New Partnership for Africa's Development (NEPAD). United Nations Environment Programme, Midrand, South Africa, 85 pp.
UNEP (2007). Global Environment Outlook 4 : environment for development. United Nations Environment Programme, Nairobi, Kenya, 572 pp.
UNICEF (2007). The state of the world's children 2008: child survival, 164 pp.
UNSTAT (2005). National Accounts Main Aggregates Database. United Nations Statistics Division.
Urdal H. (2006). A clash of generations? Youth bulges and political violence. International Studies Quarterly, 50(3): 607–629.
Van Haren N, Oettle N, Van der Werff T, Bosch MJ and Wolvekamp P. (2010). Agriculture and food security in Africa's drylands. Meeting the realities of small-scale farmers, Both Ends.
Van Lieshout P, Went R and Kremer M. (2010). Less pretension, more ambition. Development policy in times of globalization. Wetenschappelijke Raad voor het Regeringsbeleid (WRR)/Amsterdam University Press, The Hague/Amsterdam, 352 pp.
Vanacker V, Linderman M, Lupo F, Flasse S and Lambin E. (2005). Impact of short-term rainfall fluctuation on interannual land cover change in sub-Saharan Africa. Global Ecology and Biogeography, 14: 123–135.
Von Braun J, Fan S, Meinzen-Dick R, Rosegrant MW and Nin Pratt A. (2008). International agricultural research for food security, poverty reduction, and the environment. What to expect from scaling up CGIAR investments and 'best bet' programs?
Von Braun J and Keyzer MA. (2006). Global action for food security, SOW.
Washington R, Harrison M and Conway D. (2004). African climate report. Report commissioned by the UK Government to review African climate science, policy and options for action.
Wesenbeeck CFA, Keyzer MA and Nubé M. (2009). Estimation of undernutrition and mean calorie intake in Africa for 2005: methodology, findings and implications, SOW, Amsterdam.
WFP (2010a). Learning from experience. Good practices from 45 years of school feeding.
WFP (2010b). Mozambique Comprehensive Food Security and Vulnerability Analysis. Rep.
WHO (1997). WHO global database on child growth and malnutrition, Geneva.
WHO (2006). Projections of mortality and burden of disease to 2030: Data. World Health Organization, Geneva, www.who.int/healthinfo/statistics/bodprojections2030/en/index.html.
World Bank (2006). World Development Indicators (WDI). World Bank, Washington D.C.
World Bank (2007). World Development Report 2008: Agriculture for Development, World Bank, Washington, D.C.; London.
World Bank (2008a). Agriculture for Development, Washington, D.C.
World Bank (2008b). Rising food prices: Policy options and World Bank response, WB, Washington D.C., 12 pp.
World Bank (2008c). World Development Report 2008. Agriculture for development.
World Bank (2010). Sub-Saharan Africa Managing Land in a Changing Climate An Operational Perspective for Sub-Saharan Africa.
World Bank (2011a). Africa's Future and the World Bank's Support to It, Washington D.C..
World Bank (2011b). Global Monitoring Report 2011. Improving the Odds of Achieving the MDGs World Bank, Washington D.C.
World Bank (2011c). World Development Indicators (WDI), World Bank, Washington D.C.

Appendices

A.1 Integrated assessment models

PBL Netherlands Environmental Assessment Agency uses a variety of models and methods for their research. These models and methods differ in subject and discipline and range from natural science to policy research. The following models have been used.

A.1.1 GISMO: Global integrated sustainability model

GISMO is a modelling framework to analyse developments in Quality of Life in relation to social, economic and environmental changes (the three sustainability domains: People-Planet-Profit). The GISMO model enables analysis of the effects of specific policies on human development, such as poverty, health and education, and the interlinkage with the environment.

http://www.pbl.nl/en/model/GISMO

A.1.2 IMAGE: Integrated model to assess the global environment

IMAGE is an ecological-environmental framework that simulates the environmental consequences of human activities worldwide. It represents interactions between society, the biosphere and the climate system to assess sustainability issues, such as climate change, biodiversity and human well-being. The objective of IMAGE is to explore the long-term dynamics of global change as the result of interacting demographic, technological, economic, social, cultural and political factors. For the OECD Environmental Outlook 2012, the IMAGE model has been closely linked with the computed general equilibrium model LEITAP of the LEI-Agricultural Economics Institute.

http://themasites.pbl.nl/en/themasites/image

A.1.3 GLOBIO3: A global biodiversity model

The GLOBIO3 model uses quantitative relationships between environmental pressure factors and biodiversity, based on state-of-the-art knowledge from literature. By combining the results related to individual pressures, the overall change in biodiversity is calculated in terms of Mean Species Abundance of original species (MSA) and the extent of eco¬systems.

http://www.globio.info/

A.2 Regional breakdown

In the GISMO model the regional breakdown is applied as presented in the table below. In IMAGE central Africa in included in western Africa and the Republic of South Africa is included in southern Africa.

Western Africa	Central Africa	Eastern Africa	Southern Africa
Cape Verde	Cameroon	Burundi	Angola
Chad	Central African Republic	Comoros	Botswana
Benin	Congo	Ethiopia	Lesotho
Gambia	Congo, Democratic Republic of the	Eritrea	Malawi
Ghana	Equatorial Guinea	Djibouti	Mozambique
Guinea	Gabon	Kenya	Namibia
Côte d'Ivoire		Madagascar	Zimbabwe
Liberia		Mauritius	Swaziland
Mali		Réunion	Tanzania, United Republic of
Mauritania		Rwanda	Zambia
Niger		Seychelles	
Nigeria		Somalia	
Guinea-Bissau		Sudan	
Saint Helena		Uganda	
Sao Tome and Principe			
Senegal			
Sierra Leone			
Togo			
Burkina Faso			

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