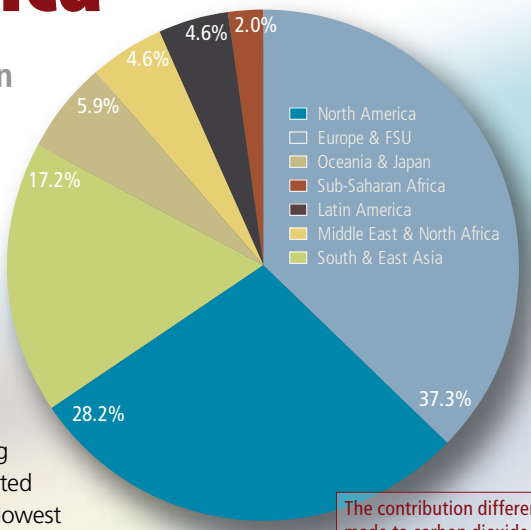
Climate change and agriculture in Africa

Climate change poses serious threats to food production in Sub-Saharan Africa and risks further impoverishing many of the world's poorest countries. IIASA's research addresses the food security and climate change challenges for this region.



The contribution different regions have made to carbon dioxide emissions between 1951 and 2004.

Food prices are rising alarmingly. The World Bank estimates that over the past three years, food prices overall have risen 83%. Some of the rising prices can be attributed to poor weather conditions and extreme weather events that have resulted in lower harvests in a number of countries. At the same time, rapidly increasing demand—especially for livestock feed from fast-growing Asian economies and for ethanol production in developed countries—has aggravated the mismatch between global supply and demand. World food stocks are at their lowest level in three decades and major food exporting countries have adopted measures to protect domestic markets. Food import bills in many of the poorest developing countries have doubled.

Rising food prices have a far more devastating impact on people in the developing world where often more than 70% of the household budget is for food, compared to 15% of people's expenditure in developed countries. Already an estimated extra 100 million people have recently joined the 820 million chronically undernourished and hungry in the developing world. The situation in Sub-Saharan Africa (SSA) is particularly dire. About 40% of the total population in SSA is undernourished, of which about 85% depends on rain-fed agriculture and agriculture-based rural activities. Agriculture is the mainstay of the economies of many SSA countries, accounting for 30% of GDP and even half of total export earnings.

Climate change poses serious threats to food production, and SSA is the most exposed to the negative impacts of climate change. Yet SSA has contributed very little to the causes of climate change—a mere 2% of the world's aggregate anthropogenic CO_2 emissions over the last 50 years, whereas developed countries have contributed over 70% (diagram, *top left*).

Ongoing research in IIASA's Land Use Change and Agriculture (LUC) Program addresses the food security and climate change challenges in the 21st century. Based on the IIASA–FAO spatial global agro-ecology model and the national and regional world food economy modeling framework, the major findings for SSA are summarized below.

FRAGILE ECOSYSTEMS Two-thirds of the global land surface suffers rather severe constraints for rain-fed crop cultivation due to unfavorable weather conditions, steep topography, or poor soil quality. Climate change will have positive and negative impacts, as some constraints will be alleviated while others may increase.

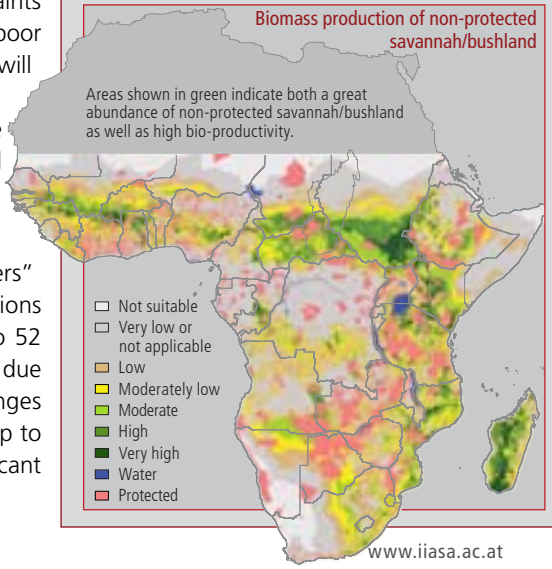
Southern Africa is among the most severely affected regions with some 11% of the land at risk of being lost for crop agriculture due to climate change induced environmental constraints. Our research estimates an increase of areas with severe dry conditions in SSA by about 5–8%, or 60–90 million hectares in the 2080s (diagram, *top right*).

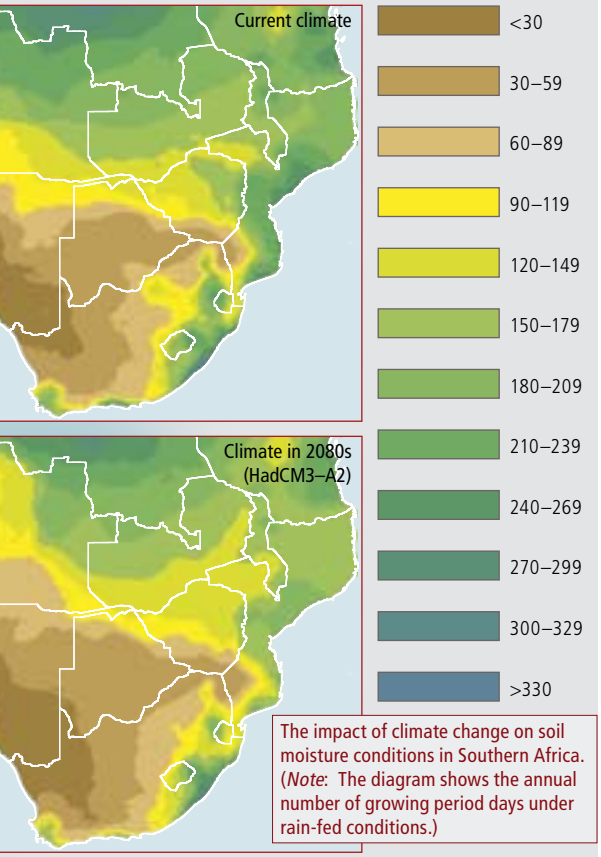
UNDERNOURISHMENT There is a clear distinction between the "gainers" and the "losers" of the impact of climate change on agriculture production. In the case of projections using HadCM3—the UK Hadley Centre's global climate model—globally some 27 to 52 countries will lose cereal production potential while some 42 to 59 countries will gain due to projected climate change in the second half of this century. The net balance of changes in cereal-production potential for SSA is projected to be negative, with net losses of up to 12%. Overall we estimate that more than a third of SSA countries is at risk of significant declines in food crop and pasture production due to climate change.

Is there enough land for food and energy in Sub-Saharan Africa?

In Africa, less than 9% of the total land area of 3 billion hectares is currently used for crop production. Of the remaining 91%, about 45% is covered by water bodies, desert, steeply sloped, and otherwise unproductive land. Pastures, savannah, and bush covers 22%, about 18% is under forest, 6% is protected non-forest land, and less than 1% is urban and built-up areas. Pastures, savannah, and bush—in total about 650 million hectares—is from environmental and agricultural perspectives most suitable for conversion to cropland, although it covers a wide range of bio-productivity (map, *bottom*). We estimate that about half of the annual biomass produced in these areas is currently needed to support ruminant livestock. Up to one third of this savannah and bush, some 200 million hectares, could be used for expansion of food and possibly energy production. Yet, the key to enhancing food security will be achieving sustainable yield increases on current cultivated land. ■

Biomass production of non-protected savannah/bushland





The impact of climate change on soil moisture conditions in Southern Africa. (*Note*: The diagram shows the annual number of growing period days under rain-fed conditions.)

The burden will undoubtedly fall disproportionately on the poorest and the most vulnerable. Climate change in the second half of this century could result in an additional 17 to 50 million undernourished people in SSA.

The Millennium Development Goal's target of reducing hunger by half is highly unlikely to be met in SSA. On the contrary, by 2080 between 25% and 50% of the additional number of undernourished due to climate change in developing countries could be in SSA.

AGRICULTURAL GDP AND TRADE The impact of climate change on agricultural GDP is relatively small for the aggregate global level (between –1.5% and +2.6%). However, large variations are expected between regions. Developing regions, with the exception of Latin America, are confronted with strong negative impacts on agricultural GDP. By 2080, climate change could reduce Asia's projected agricultural GDP by 4% and SSA's by up to 8%.

Baseline scenarios indicate a growing dependence of developing countries on net cereal imports ranging from 170 to 430 million tons. In a number of developing countries, some 10% to 40% of cereal consumption will have to be met through imports. Many of these countries lack the foreign exchange to finance food imports, thus putting them at risk of increased food insecurity.

MITIGATION OF CLIMATE CHANGE At the same time as climate change reduces the availability of agricultural land, strong population increases and income growth will cause increasing food crop and meat demand. Unless sustainable yield increases materialize, this will intensify the pressure to deforest and clear land to expand crop and livestock production, in turn resulting in further greenhouse gas emissions. Additional emissions from agriculture in part will be unavoidable in SSA to meet the basic human right for food. Yet for another part, reductions could be achieved through, for instance, precision agriculture that ensures efficient use of fertilizers or the rehabilitation of degraded crop and pasture land. Specific efforts are required to mobilize funds to provide incentives for climate change mitigation activities, especially in agricultural areas across SSA.

ADAPTATION TO CLIMATE CHANGE To facilitate adaptation to climate change, national governments in SSA, together with their bilateral and multilateral development partners, need to create mechanisms that provide climate information and forecasting as well as strengthen scientific research and policy analysis at the national and regional levels. Due to the long time lag between the development of adaptation strategies and technologies and their adoption in the field, investments and sustained international funding will be needed to establish and prioritize agricultural research, agricultural knowledge systems, applied climate research for policy actions, and, in particular, agricultural extension, infrastructure, and marketing services.

A WAKE-UP CALL Many of the poor SSA countries, already struggling to cope because of low and declining agricultural yields, will be particularly affected by climate change. The World Bank, UN, and many governments and international organizations are now calling for additional emergency aid of at least US$500 million from donor governments to close the immediate gap. In the long term, however, international effort is needed to coordinate policies to integrate climate change issues in national and international development planning and policymaking to achieve food security and reduce rural poverty.

The current food crisis is a loud wake-up call for national governments and the international community. Agriculture and the rural sector must be given a high priority in terms of resource allocation and adoption of development polices that are locally relevant and globally consistent. Such effective policies can only be devised if developing countries, assisted by international organizations and NGOs, thoroughly assess the impact of climate change on their own economies and natural resources. Only then can agricultural vulnerability to climate change be reduced and progress made to world-wide food security and sustainable agriculture (see box, "The way forward"). ■

Further information Shah M, Fischer G, & van Velthuizen H (2008). Food Security and Sustainable Agriculture. Presented at a side event at the UN Commission on Sustainable Development in New York on 8 May 2008. (www.iiasa.ac.at/Research/LUC)

Dipl. Ing. Günther Fischer is the leader of IIASA's Land Use Change and Agriculture Program. **Dr. Mahendra Shah** and **Dr. Harrij van Velthuizen** are senior scientists in IIASA's Land Use Change and Agriculture Program.

The way forward in Sub-Saharan Africa

Progress in SSA agriculture has been hampered for multiple reasons over the past decades, and future prospects of more frequent droughts due to climate change add to a gloomy outlook. SSA can master its formidable development tasks, provided several contributing bottlenecks are tackled in a coordinated and simultaneous approach by the governments concerned with scientific, technological, and financial support from international organizations. The main cornerstones of a development strategy in SSA must include:

- Infrastructure expansion and improvements to enable crop production and agricultural inputs distribution
- Increased input use, e.g. ensuring that fertilizer use is affordable and available to farmers (currently some 5 kg/ha as compared to 92 kg/ha worldwide)
- Increased water conservation management and irrigation development (currently only 2% of SSA arable land is irrigated)
- Improved agricultural extension services to achieve sustainable yield gains, as current yields of main food crops are less than half compared to globally-achieved yields
- Expansion of agricultural R&D capacity and efforts to focus on region-specific adaptation and development needs
- Creation of production and marketing incentives to guide and foster investment decisions in agriculture

Developed countries will have to make important contributions as well, implementing policies that:

- Achieve substantial GHG reductions, especially in North America, Europe and Asia, to effectively mitigate speed and magnitude of climate change
- Prioritize resources to facilitate adaptation and promote development in SSA
- Avoid policy measures that accentuate market imbalances and put the resulting burden of high commodity prices on poor, import-dependent economies
- Coordinate biofuel policies according to a "food first" approach by supporting modes and means of bio-energy production that are GHG effective and minimize land competition
- Monitor, review and redefine policies for strategic food commodity reserves

Agriculture in SSA has been, and is frequently, severely disrupted through civil conflicts and poor governance. Illiteracy is high and prospects for improvement will also heavily depend on the development of human capital. ■