Food and Agriculture Organization of the United Nations

European Commission

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# FOOD SYSTEMS AT RISK

## NEW TRENDS AND CHALLENGES

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Published by
the Food and Agriculture Organization of the United Nations
and
Le Centre de Coopération Internationale en Recherche Agronomique pour le Développement
and
the European Commission

Rome, 2019

Citation:

Dury, S., Bendjebbar, P., Hainzelin, E., Giordano, T. and Bricas, N., eds. 2019. *Food Systems at risk: new trends and challenges.* Rome, Montpellier, Brussels, FAO, CIRAD and European Commission. DOI: 10.19182/agritrop/00080



ISBN 978-2-87614-751-5 (CIRAD)

ISBN 978-92-5-131732-7 (FAO)

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CHAPTER 2.1

# FOOD SYSTEMS EMISSION AND CLIMATE CHANGE CONSEQUENCES

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## SUMMARY

Food systems are responsible for up to one-third of anthropogenic greenhouse gas (GHG) emissions. These emissions include carbon dioxide ($CO_2$), methane ($CH_4$) and nitrous oxide ($N_2O$) and are therefore a major driver of climate change. The environmental pressures on food systems are likely to intensify, as humanity is arguably already operating beyond planetary boundaries. The projection for changes between 2010 and 2050 shows that these pressures will result in an increase of between 80 and 92 percent in GHG emissions in the absence of technological change and other mitigation measures. Apart from being a significant source of GHG emissions, food systems are significantly impacted by climate change. Uneven climate change effects, in combination with differences in adaptation capacity, could exacerbate existing inequalities between High-Income (HI), Low-Income (LI) and Lower Middle-Income (LMI) countries.

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## Contribution of food systems to climate change

Food systems are a major driver of environmental effects, including climate change. They have contributed to the crossing of several of the proposed 'planetary boundaries' that attempt to define a safe operating space for humanity on a stable Earth system, in particular those concerning climate change (Springmann *et al.*, 2018). The Agriculture, Forestry and Other Land-Use sector (AFOLU) is responsible for just under a quarter (≈10–12 $GtCO_2eq/yr$) of anthropogenic GHG emissions, mainly from deforestation and agricultural emissions from livestock, soil and nutrient management (Smith *et al.*, 2014). Annual direct GHG emissions from agricultural production in 2000–2010 have been estimated at 5.0–5.8 $GtCO_2eq/yr$ (Smith *et al.*, 2014), including emissions from biomass burning (12 percent) and energy use in agricultural machinery (Vermeulen *et al.*, 2012). Indirect GHG emissions from the pre-production stages (mainly the manufacture of fertilisers) have been estimated at 0.35-0.77 $GtCO_2eq/yr$ and post-production stages (processing, packaging, transport, refrigeration, retail, catering, food management and waste disposal) at 1.1 $GtCO_2eq/yr$ (Vermeulen *et al.*, 2012). So, food systems contribute between 19 and 29 percent of total anthropogenic GHG emissions. Agricultural production is by far the main source of emissions in LI and LMI countries, while post-production stages emit GHG emissions equal to the production stages in HI countries (Vermeulen *et al.*, 2012).

Although there is little information available, an estimated one-third of the food produced in the world for human consumption is lost or wasted during the production to consumption stages (Gustavsson *et al.*, 2011; HLPE, 2014). In HI countries, most food loss and waste (FLW) occurs at the downstream stages of the food supply chain (retail and consumption) and is related to patterns of over-production and over-consumption. In LI and LMI countries, FLW is supposed to mostly occur at the upstream stages (harvest, storage, transport and processing) due to infrastructural, financial and technical constraints (Gustavsson *et al.*, 2011). FLW represents a significant use of natural resources along food supply chains and pollution is emitted in vain. FLW contributes to GHG emissions in two ways: through waste management activities (for example, disposal in landfill) and through the embedded emissions associated with its production, processing, transport, retailing and consumption. The latter are far more important in terms of impact than the former. The carbon footprint of FLW has been estimated at 3.3 $GtCO_2$ equivalent (excluding GHG emissions from land-use changes). Reducing FLW by one half would reduce environmental pressures by between 6 and 16 percent compared with the baseline projection for 2050 (Springmann *et al.*, 2018).

## Impact of climate change on food systems

Apart from being a significant source of GHG emissions, climate change is affecting people and the environment around the world, as shown by the 2018 report of the Intergovernmental Panel on Climate Change (IPCC). The State of Food Security and Nutrition in the World (FAO, 2018) also found climate change to be one of the key drivers behind the rise of hungry people in the world, reaching 821 million people in 2017. By the middle of this century, higher average temperatures, changes in precipitation, rising sea levels, as well as the possibility of an increase in damage from pests and diseases, are expected to affect several agricultural sectors.

In particular, the number and frequency of recorded natural disasters are increasing significantly. These events often destroy critical agricultural assets and infrastructure, disrupting production cycles, trade flows and livelihoods. This affects food security and causes additional disruptions throughout value chains (FAO, 2017). Indeed, extreme weather events and geopolitical crises are the dominant drivers of food production shocks, even if their relative importance varies across sectors (Cottrell *et al.*, 2019). Over half of all shocks to crop production systems have been the result of extreme weather events, reinforcing concern about the vulnerability of arable systems to climatic and meteorological volatility around the globe.

In addition, climate change will impact livestock production, as well as fisheries and aquaculture, the performance of small- and medium-sized food and agribusinesses, transportation infrastructure with consequent disruption to food supply chains and the exodus of climate refugees. This impact will be uneven across regions and countries. Arid and semi-arid regions will be exposed to even lower precipitation and higher temperatures and, consequently, experience yield losses. Conversely, countries in temperate areas are expected to benefit from warmer weather during their growing season.

Faced with climate change, LI and LMI countries are the most vulnerable and it could exacerbate the food security challenges they already experience. For example, South Asia and sub-Saharan Africa, particularly West Africa, have been found to be the hardest-hit regions, partly due to higher climate-induced crop yield losses and because their national economies depend on agriculture for a significant share of GDP and employment. Simultaneously, small-scale family farmers have little access to innovative technologies, services and inputs, which limits their capacity to adapt to a changing climate. As a result, these regions are expected to experience a significant drop in agricultural production due to climate change (*cf.* Map 7) and imports of agricultural products are expected to increase. Uneven climate change effects, in combination with differences in adaptation capacity, could exacerbate existing inequalities and further widen the gap between HI and LI and LMI countries (FAO, 2018). ●

### BOX 1

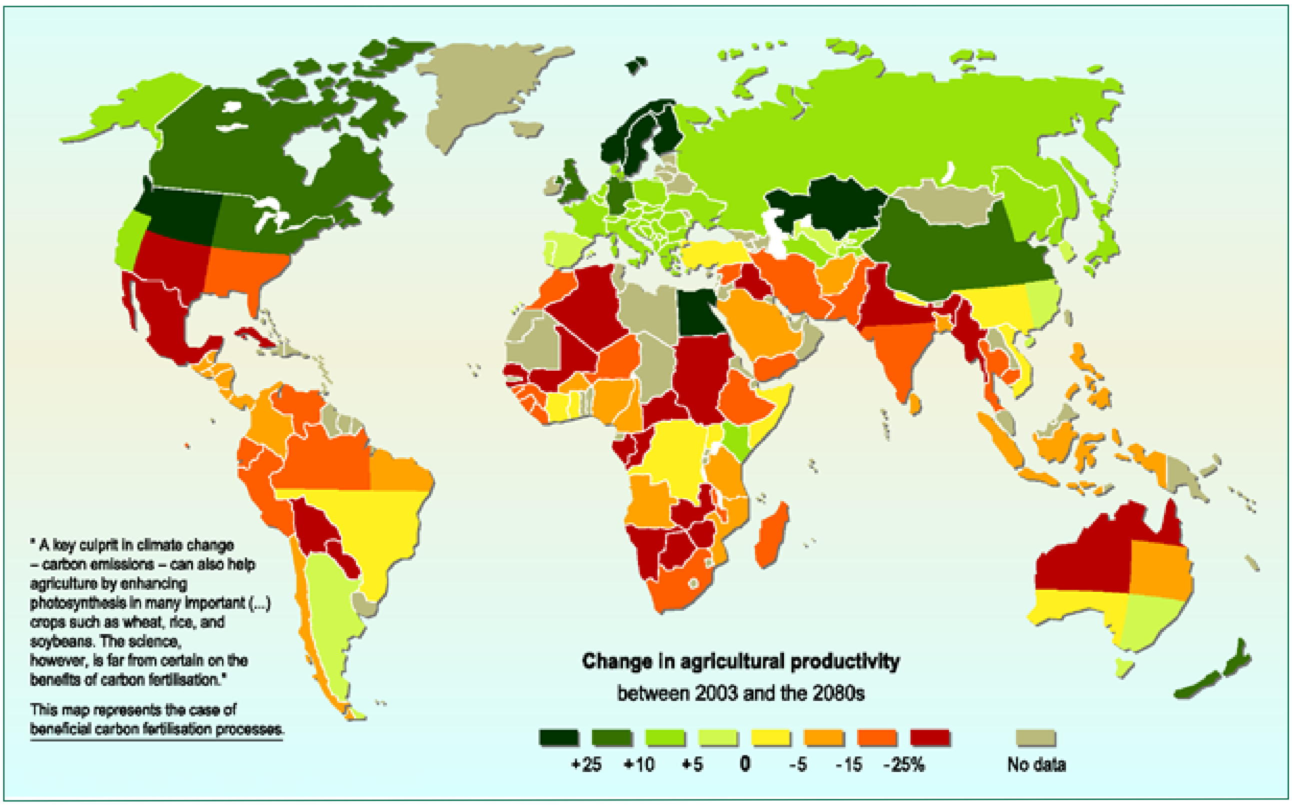
FUTURE CLIMATE RISK IN SOUTHERN MALI[1]

Crop yield losses caused by climate change are expected to be high in many regions of sub-Saharan Africa and smallholder farmers, who rely heavily on agriculture for their livelihoods, have been identified as highly vulnerable to climate change. In southern Mali, a study has assessed the future climate change risk according to farm type and degree of food self-sufficiency. It shows that cereal crop production in the region of N'Tarla in southern Mali is gravely threatened by climate change. Some 40 percent of the country's population lives in this region, which represents half of Mali's cultivable land.

The current climate is typical of the Sudano-Sahelian zone of West Africa with conditions that are already drier and temperatures, which are warmer. Predictions suggest that the current climate warming trend will continue and even accelerate. By mid-century (2040-2069) annual maximum and minimum temperatures are expected to increase by 2.9 °C and 3.3 °C respectively compared with the climate trend of the past 30 years (1980-2009). Rising temperatures are expected to have a critical impact on crop yields by reducing the length of the crop growth cycle and increasing the intensity and duration of droughts due to larger soil water evaporation losses. Under these future climate conditions and without changing current cropping practices, simulation models predict crop yield losses and a reduction of food availability for all farm types, and this is in an area where most of the population of is already facing food insecurity problems.

However, the adverse impact of climate change will differ among farmers if coping strategies are adopted. Projections show that large- and medium-sized farms can offset the yield losses induced by climate change and remain food self-sufficient with crop management solutions such as early planting and increased fertiliser use. In contrast, results show that any of these adaptive crop management measures would not be enough to protect small farms from the negative consequences of climate change on crop productivity and food self-sufficiency. These smallholders will remain food insecure. Farmers will need off-farm employment or other forms of social support to cope with climate change. The results of this study are in line with many other studies and model predictions showing that agricultural performance in sub-Saharan Africa is likely to be strongly affected by future climate change.

*1. Based on Traore* et al., *2017*




**Map 7:** *Projected impact of climate change on agricultural productivity.*
*Source: Cline, 2007.*

*Projections include the effect of $CO_2$ fertilisation. No effects of technical progress on agricultural productivity were assessed.*

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