GLOBAL CHALLENGES OF FOOD AND WATER SECURITY

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17 Sustainable Development Goals with emphasis on sustainable and equitable food systems
Changes in the relative global production of crops and animals since 1961

Godfray et al. 2010
Science;327:812-818
WORLD CEREALS PRODUCTION AND YIELDS

Million metric tonnes / million hectares

- Red line: Production (MMT)
- Blue line: Yield (Tonnes/Ha)
- Green line: Area Harvested (Million Ha)

Year
1961
1971
1981
1991
2001

Tonnes / hectare
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0

SOURCE: UN Food and Agriculture Organization
Despite these successes –
Figure 2: Number of hungry people in the world (in millions)

Source: FAO
Moving from 8 MDGs to eradicate extreme poverty by 2015 to...
Ethiopia's government has increased to 10.1 million the estimated number of people who desperately need food aid because of a drought.

More than half of them are children, Save the Children says.

The drought, blamed on the El Nino weather phenomenon caused by Pacific Ocean warming, was the worst in 50 years, the charity added.

In November, the UN children's charity put the number of Ethiopians threatened by hunger at 8.2 million.

The government has launched a huge national effort, allocating nearly $200m to deal with the food crisis.
Projected impacts of climate change

Global temperature increase (relative to pre-industrial)

0°C  +1°C  +2°C  +3°C  +4°C  +5°C  +6°C

Food
- Falling crop yields in many areas, particularly developing regions
- Possible rising yields in some high latitude regions
- Falling yields in many developed regions

Water
- Small mountain glaciers disappear, impacts on water supplies
- Significant decreases in water availability in many areas, including Mediterranean and Southern Africa
- Sea level rise threatens major cities

Ecosystems
- Extensive damage to coral reefs
- Rising number of species face extinction

Extreme weather events
- Rising intensity of storms, forest fires, droughts, flooding and heat waves

Risk of abrupt and major irreversible changes
- Increasing risk of dangerous feedbacks and abrupt, large-scale shifts in the climate system

Source: Stern Review (2008)
Influence of extreme weather disasters on global crop production

Corey Leisk, Pedram Rowhani & Navin Ramankuty

Extended Data Figure 4 | Time series of the number of extreme heat and drought disasters per year from the EM-DAT database. The EM-DAT database is based on a compilation of disaster reports gathered from various organizations including United Nations agencies, governments and the International Federation of Red Cross and Red Crescent Societies. The time series of reported disasters per year exhibits an increasing trend, probably the result of more complete disaster reporting in more recent decades with a possible contribution from increasing disaster incidence. There is also large inter-annual variability in the number of disasters.
Influence of extreme weather disasters on global crop production

Corey Lesk¹, Pedram Rowhani² & Navin Ramankutty¹,³

1964–2007. We show that droughts and extreme heat significantly reduced national cereal production by 9–10%, whereas our analysis could not identify an effect from floods and extreme cold in the national data. Analysing the underlying processes, we find that production losses due to droughts were associated with a reduction in both harvested area and yields, whereas extreme heat mainly decreased cereal yields. Furthermore, the results highlight ∼7% greater production damage from more recent droughts and 8–11% more damage in developed countries than in developing ones. Our
Influence of extreme weather disasters on global crop production

Corey Lesk1, Pedram Rowhani2 & Navin Ramankutty1,3

During 1964–2007, these estimated EWD effects represent a loss of 1,820 million Mg due to droughts (approximately equal to the global maize and wheat production in 2013), and 1,190 million Mg due to extreme heat disasters (more than the global 2013 maize harvest). Over
## Yield Sensitivity to Warming and CO2 Increases

(Source: Fischer et al., 2014)

<table>
<thead>
<tr>
<th>Crop</th>
<th>Yield sensitivity to 1 °C rise relative to 2000 yield (%)</th>
<th>Overall yield response by 2050 relative to 2000 yield (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>From regression studies (Table 10.1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>From simulation models (Table 10.3)</td>
<td></td>
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<tr>
<td></td>
<td>Average regression and simulation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>‘Best bet’ after rounding</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 °C warming</td>
<td>+100 ppm CO₂</td>
</tr>
<tr>
<td>Wheat</td>
<td>–4.1</td>
<td>–7.7</td>
</tr>
<tr>
<td>Rice</td>
<td>–2.3</td>
<td>–7.4</td>
</tr>
<tr>
<td>Maize</td>
<td>–4.9</td>
<td>–4.1</td>
</tr>
<tr>
<td>Soybean</td>
<td>–0.3</td>
<td>–3.1</td>
</tr>
</tbody>
</table>
World population expected to be around 9 billion by 2050
Developing countries in Asia and the Pacific will need to increase food production by up to 77%
Growing Population & Increasing Food Demand

- Least developed countries
- Emerging countries
- Developed countries

Billion population for the years 2010, 2030, and 2050, with an increase in food demand for emerging and least developed countries.
Makeup of total food waste in developed and developing countries

Godfray et al., Science 2010;327:812-818

- Developing countries
  - On-farm
  - Transport and processing
  - Retail
  - Food Service
  - Home and municipal

- USA

- UK
One in three people on every continent affected by water scarcity
Limited land base for food production expansion
Land Available for Crop Expansion is Limited
Global Irrigated and Rainfed Cropland Statistics

- 1,500 million ha of global cropland
- 275 m ha irrigated (17%)
- Irrigated lands produce 40% of world’s food
- 1,250 m ha of rainfed lands producing 60% of the world’s food
Projected percentage gain and losses in rainfed cereal production potential by 2080

Source: UNEP (2006)
FIGURE 1.2: EVOLUTION OF LAND UNDER IRRIGATED AND RAINFOD CROPING (1961-2008)
(Source: FAOSTAT, 2013)
<table>
<thead>
<tr>
<th>Food Commodity</th>
<th>Demand 2000 million ton</th>
<th>Demand 2025 million ton</th>
<th>Percentage increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cassava &amp; other roots &amp; tubers</td>
<td>106.5</td>
<td>196.8</td>
<td>85%</td>
</tr>
<tr>
<td>Sweet potatoes</td>
<td>43.8</td>
<td>82.4</td>
<td>88%</td>
</tr>
<tr>
<td>Maize</td>
<td>37.8</td>
<td>75.4</td>
<td>99%</td>
</tr>
<tr>
<td>Other grains</td>
<td>35.0</td>
<td>78.6</td>
<td>125%</td>
</tr>
<tr>
<td>Wheat</td>
<td>13.6</td>
<td>24.8</td>
<td>82%</td>
</tr>
<tr>
<td>Rice</td>
<td>12.0</td>
<td>22.5</td>
<td>87%</td>
</tr>
</tbody>
</table>

Source: deFraiture (2005)
Global Average Yields – Annual Percent Change

(Pardey, 2009)