

THE CHALLENGES FOR AGRICULTURE IN THE NEXT DECADES OF THE 21ST CENTURY

PROFESSOR
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In key ways, the next few decades of the 21st Century are already determined

Demographic momentum:
An extra billion people by 2030



Continuing increase in overall prosperity:
Global middle class to increase to nearly 5bn people by 2030



Urbanisation:
global urban:rural ratio ~60% by 2030

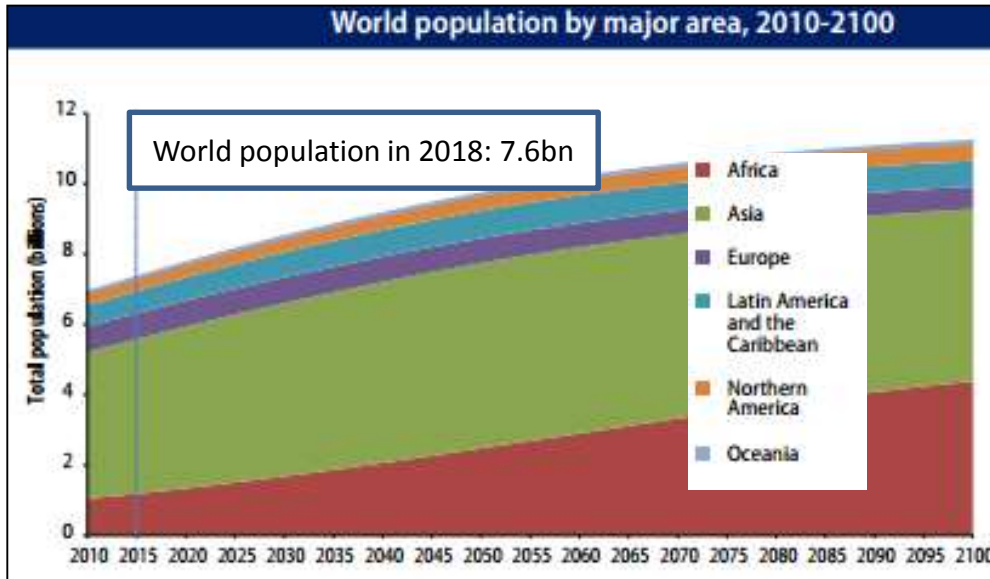


Alemao Shanty Town, Brazil

Climate change:
GHG in the atmosphere now will drive changes up to 2030



The projected population will be very different by key geographical regions



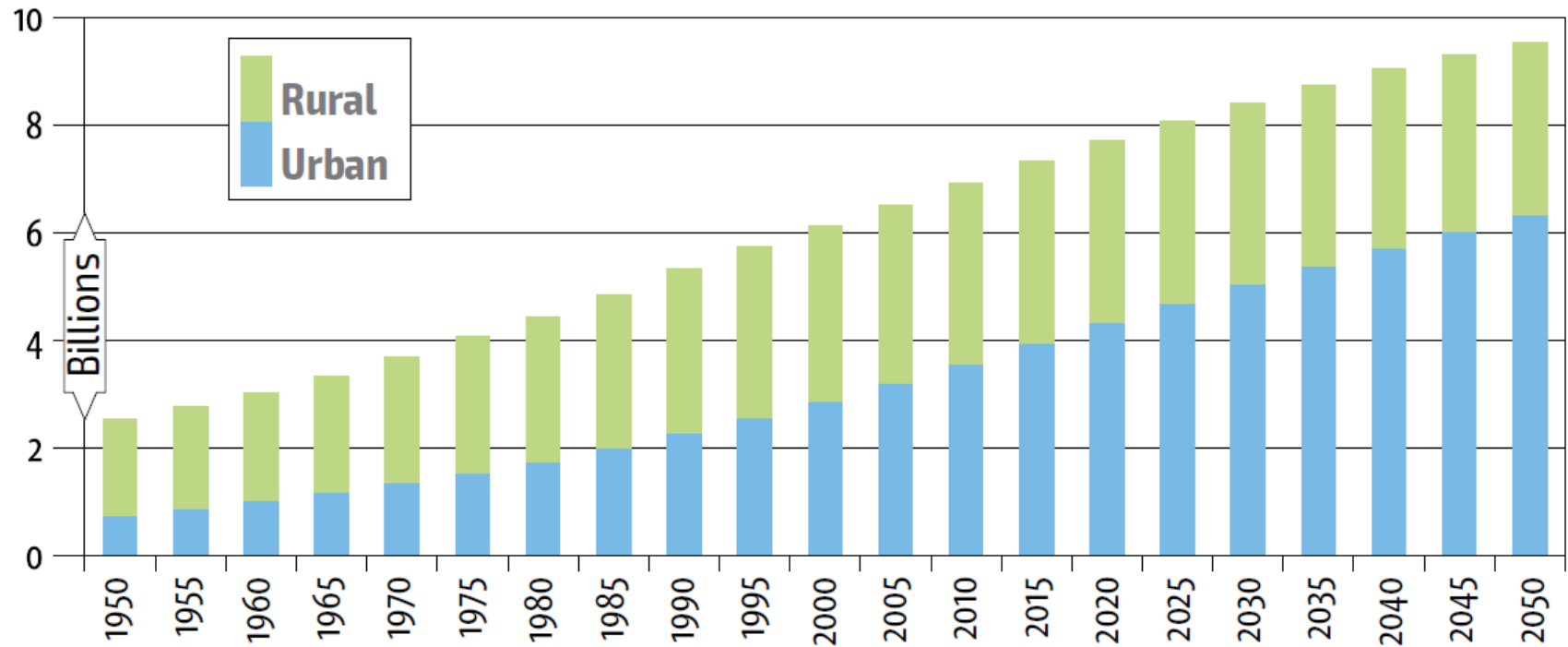
Source: World Population Prospects 2015, UN

More than half of global population growth between now and 2050 is expected to occur in Africa

Of the additional 2.4bn people projected to be added to the global population between 2015 and 2030, 1.3bn will be added in Africa

Total Population	Year	Interval
3 billion	1959	
4 Billion	1974	15 years
5 Billion	1987	13 years
6 Billion	1998	11 years
7 Billion	2011	13 years
8 Billion	2022	11 years
9 Billion	2040	18 years
10 Billion	2055	15 years

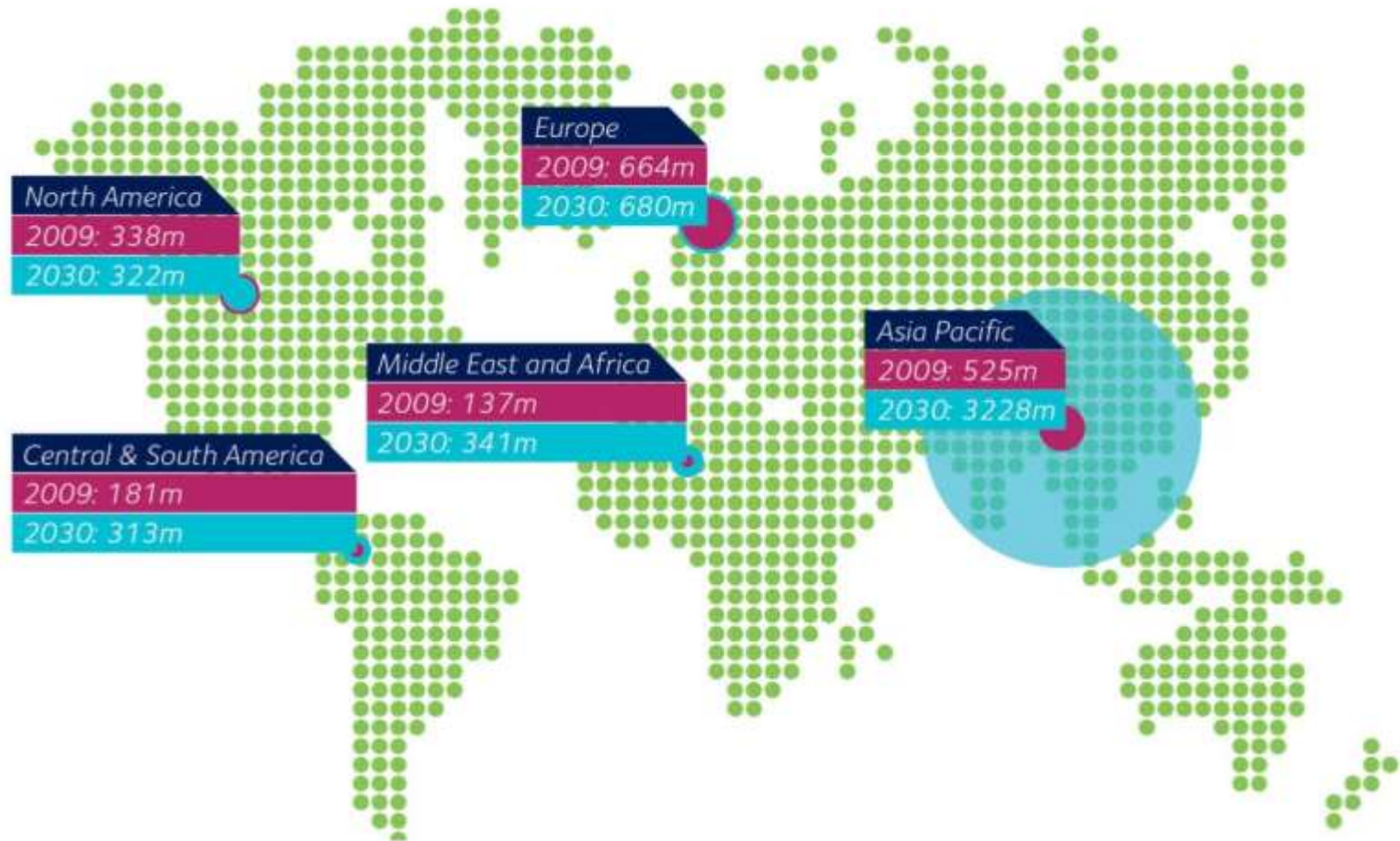
The geographical location of the population is changing markedly



Source: UN, 2015.

By 2030, the world is projected to have 41 mega-cities, with 60% of the world's population living in urban areas – another billion city dwellers

The rise of the global middle class

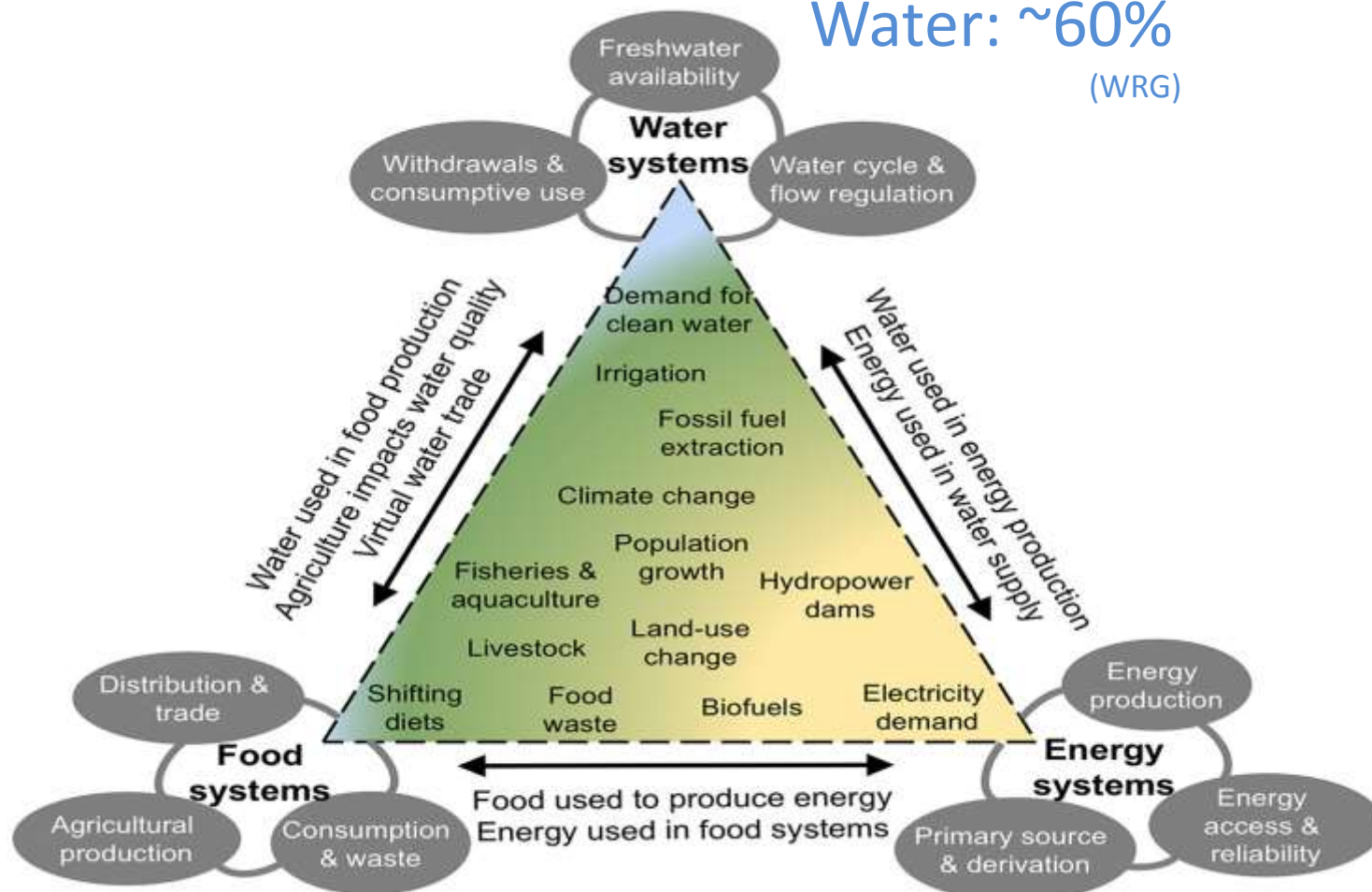


2009: 1.845 billion households
2030: 4.884 billion households

using World Bank definitions
(\$10-100 daily expenditure)

Resource demand growth in the next 20-30 years

Water: ~60%
(WRG)

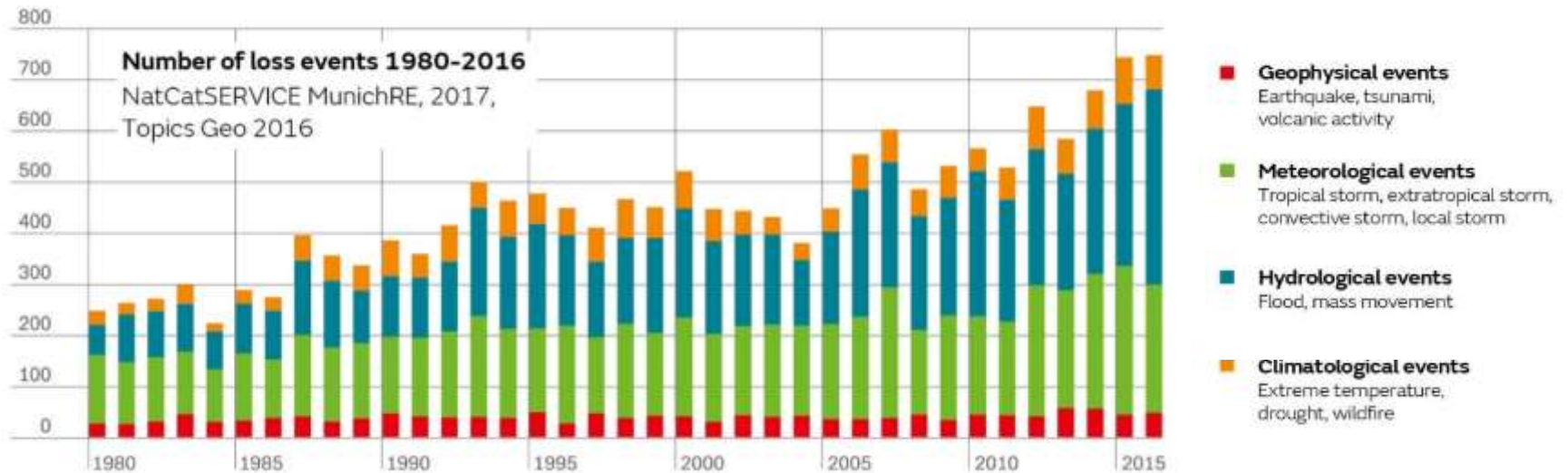


Food: ~60%
(FAO)

Energy: ~30%
(IEA)

What is the consequence of climate change for the next few decades?

Some types of extreme weather have become more frequent or more severe



How will the demand for food be met?

OECD-FAO predicts that global agricultural production will grow at an average of 1.5% annually over the next 10 years compared with 2.1% in the last decade. Growth is expected to be slower in all crop sectors as well as in livestock production, reflecting rising costs, growing resource constraints, and increasing environmental pressures.

Increasing crop production

Reducing waste and changing diets

increase land use

increase yields

increase the frequency of cropping (e.g. using irrigation)

Agriculture uses 37% of global landmass (excluding Antarctica)



Sub-Saharan Africa currently has the world's lowest cereal yields: 1.25 tonnes/ha versus developed countries, developing Asia and Latin America which all attain around 4 tonnes/ha

Agriculture accounts for 70% of all freshwater drawn from rivers, lakes and aquifers



Around 30% of the food produced globally is wasted – around 1.3bn tonnes. Food waste in high-income countries is dominated by consumer waste. Food waste in developing countries is at the pre- and post-harvest and processing stages due to spoilage





<https://doi.org/10.17226/25059>

Breakthrough 1: A **systems approach** to understand the nature of interactions among the different elements of the food and agricultural system can be leveraged to increase overall system efficiency, resilience, and sustainability

Breakthrough 2: The development and validation of precise, accurate, field-deployable sensors and biosensors will enable rapid **detection and monitoring** capabilities across various food and agricultural disciplines.

Breakthrough 3: The application and integration of data sciences, software tools, and systems models will enable **advanced analytics** for managing the food and agricultural system.

Breakthrough 4: The ability to carry out **routine gene editing** of agriculturally important organisms will allow for precise and rapid improvement of traits important for productivity and quality.

Breakthrough 5: Understanding the relevance of the **microbiome** to agriculture and harnessing this knowledge to improve crop production, transform feed efficiency, and increase resilience to stress and disease.

How might Yields increase through Crop Science in next 10-20 Yr?

At The Level of Single Plants

- Breeding Disease Resistance
- More and Larger Grains
- Better Stem Architecture
- Enhanced Photosynthesis
- Enhanced Nutrient Use Efficiency



Stem rust



Leaf rust



Yellow rust

Globally 6.2 million tonnes lost
Most common and widely distributed
Globally 47 million tonnes lost
~ \$1.12 billion per yr. >SR or YR per yr. ~ \$1 billion per yr.

Needs: Introduction of more genetic diversity: genomically-informed predictive breeding
Targetted mutational approaches (TILLING)
GM, Genome editing



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At a Systems Level

In field diagnostics

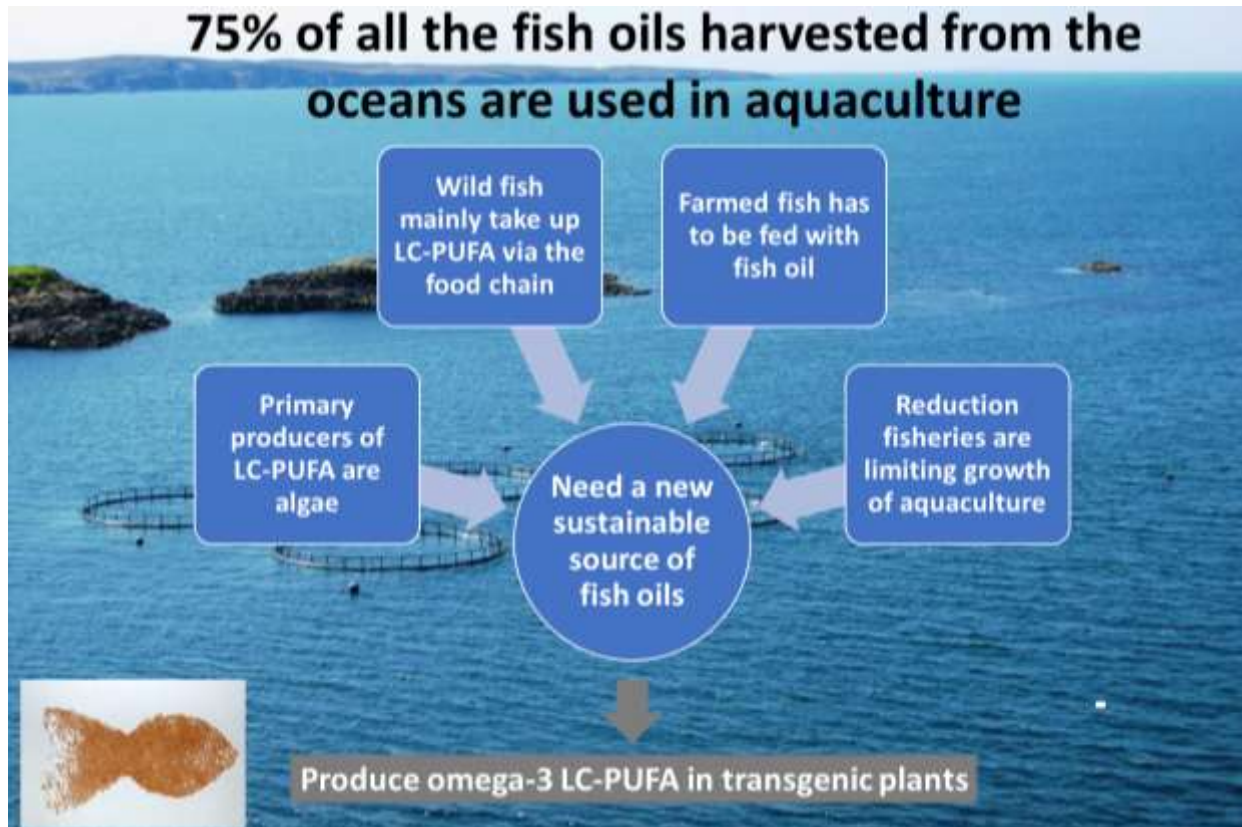


- Better weed control
- Healthier soils and microbial interactions
- Better understanding of growth in the field
- Pest surveillance and control

Needs: New chemicals?
Understanding of plant-microbe
interactions in the soil
Field phenotyping
Biological control

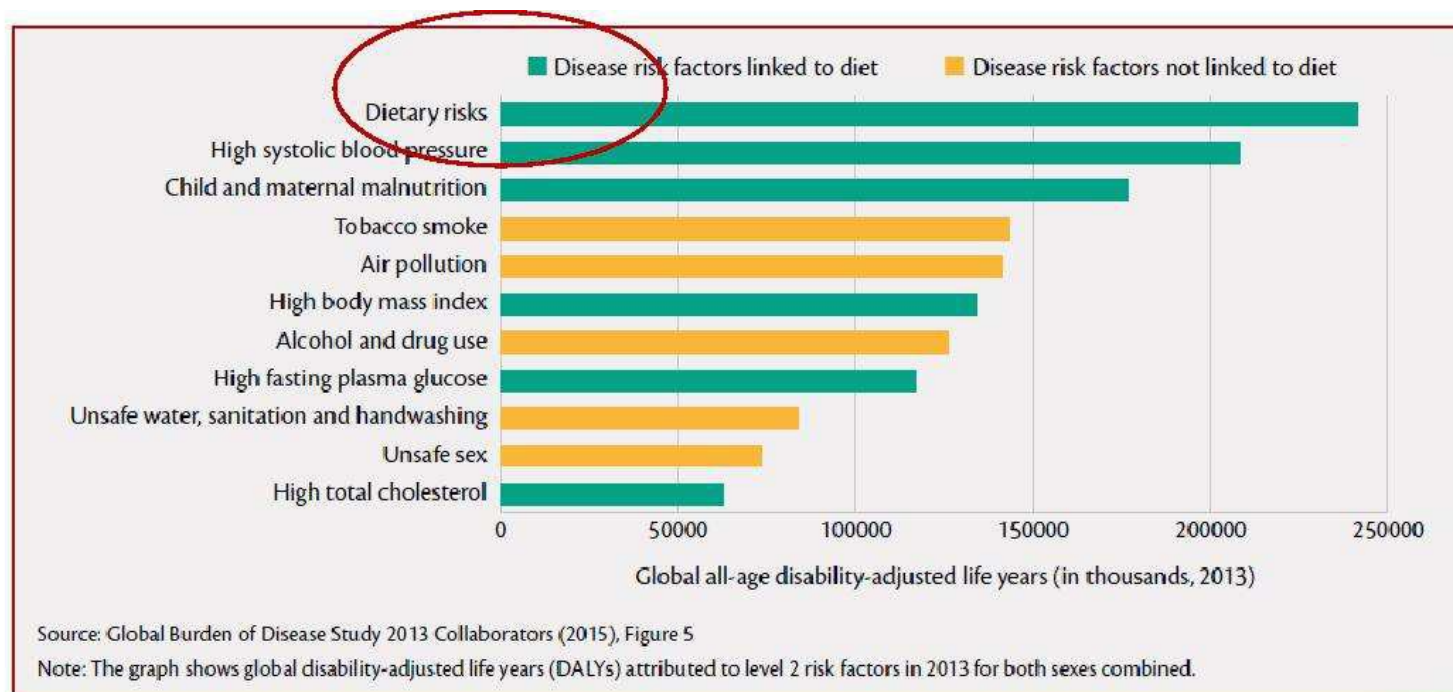


Making omega-3 LC-PUFAs (“fish oil”) in a plant



Johnathan Napier and team, Rothamsted Research

Most global burden of disease risk factors are linked to diet



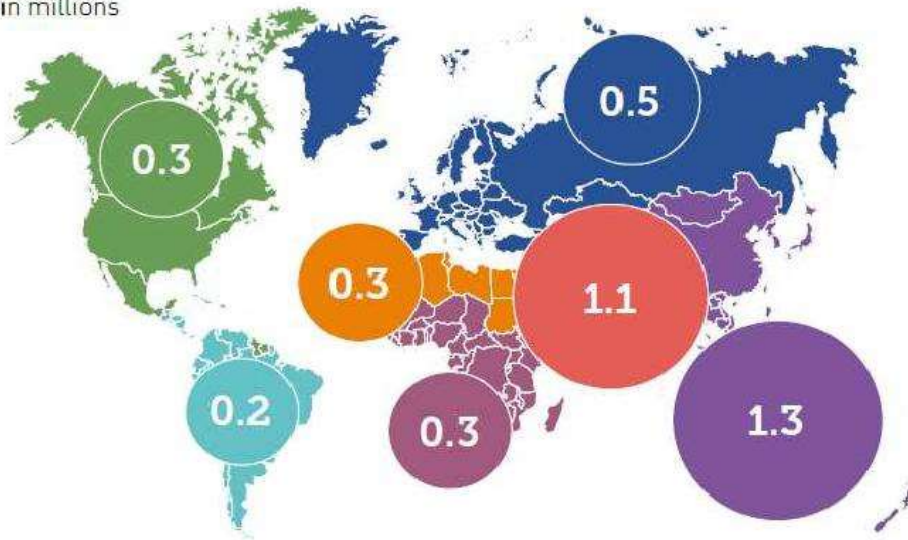
>5% of global mortality is attributable to diabetes

Annual deaths due to undernutrition = 3 to 4 million

Annual deaths due to diabetes = 3 to 4 million

Annual deaths from ambient air pollution = 4 million

Number of deaths due to diabetes (20-79 years) in 2017
in millions

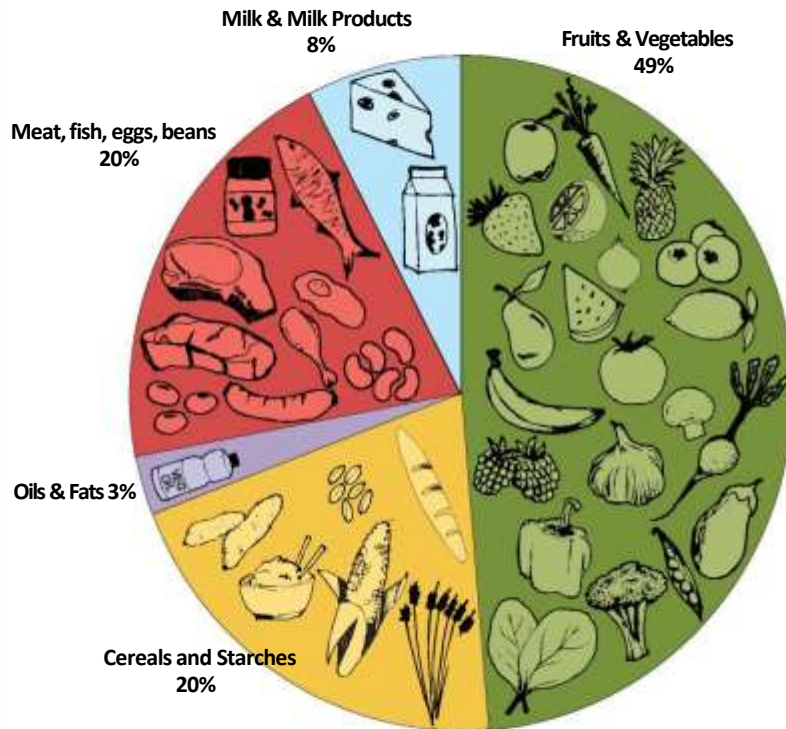


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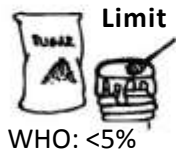
Source: IDF Diabetes Atlas 2017

What we should be eating

(Harvard's Healthy Eating Plate Model)

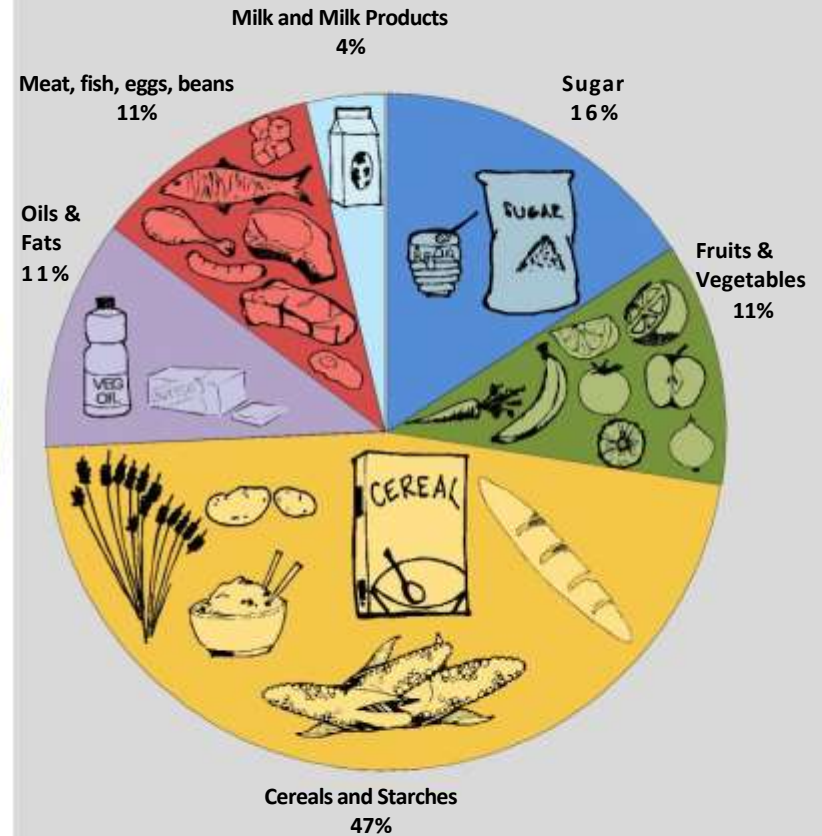


Limit
WHO: <5%



What we are actually producing

(According to 2011 FAO)



Citation: KC KB, Dias GM, Veeramani A, Swanton CJ, Fraser D, Steinke D, et al. (2018) When too much isn't enough: Does current food production meet global nutritional needs? PLoS ONE 13(10): e0205683. <https://doi.org/10.1371/journal.pone.0205683>

Future of UK farming





 Department for Environment Food & Rural Affairs

Health and Harmony: the future for food, farming and the environment in a Green Brexit

Summary of responses

September 2018

“Respondents widely supported greater government involvement to boost collaborative and farmer-led research and develop innovative solutions to productivity problems. Key themes raised included environmental performance, soil health, and improved animal health and welfare.”

43,356 responses

Farmers prepare for overhaul of subsidy system after Brexit

High-stakes plan rewards projects that bring environmental benefits such as clean water

The new system – laid out in a Bill that received its second reading on Wednesday – justifies using subsidies for projects that provide so-called ‘public goods’, such as clean water, flood prevention and wildlife preservation.

It is a good one, the farmer makes around £12,000 profit, and sees that the money could be repaid with one government subsidy worth about £44,000 that is repaid under the EU’s Common Agricultural Policy.

“If I were the Minister, I certainly wouldn’t invest the money in this sort of thing,” he added. “But the minister is actually just a wronged husband. If we see it this, then there are broken world view, and it would all disappear.”

Farmers like Mr. Taylor who work in national parks or other places of particular environmental importance, are likely to be the big winners under a new government plan to overhaul how the UK supports its agriculture sector after Brexit.

The plan, announced by Michael Gove, the environment secretary, is to scrap the much-criticised EU system that pays an annual subsidy to farmers based on how much land they cultivate, and instead plan to reward those who deliver environmental benefits.

The government argues that the current system gives too much help to big farms that do not need it, while also leaving up insufficient ones. Subsidies are also keeping the market by inflating everything from food to fertilizer costs, according to officials.

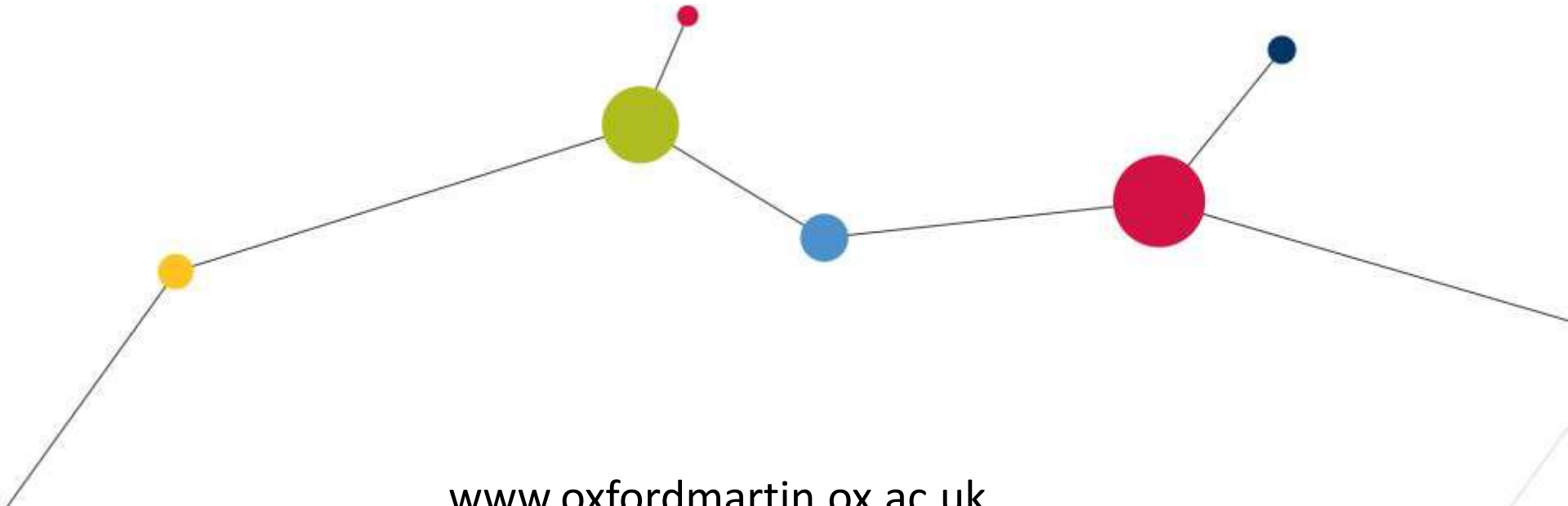
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The policy is also a high-stakes gamble given that it could severely reduce the output of UK farms which provide the staple of food to the nation, at a time when trade talks with the rest of the world are being initiated.

Derrick Williams, a consultant and former chair of the National Farmers’ Union, predicted a shake-out that could result in fewer, larger farms as smaller ones fail.

“The proposal for public goods model will be widely seen,” he said. “There will be a lot of farms that will fail and there will be redistribution of subsidies. If farmers want to stay on the farms they will have to change.”

Farmers in the UK are very dependent on the so-called basic payment scheme that is the cornerstone of the CAP. It accounted for 61 per cent of the average annual farm profit of £12,000 from 2014 to 2017, according to estimates from the Department for Environment, Food and Rural Affairs, although that level varies widely by type of farm. Creating livestock farms rely on subsidies.



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