





The challenge of sustainable agriculture in a food-insecure world

Tim Benton

UK Champion for Global Food Security

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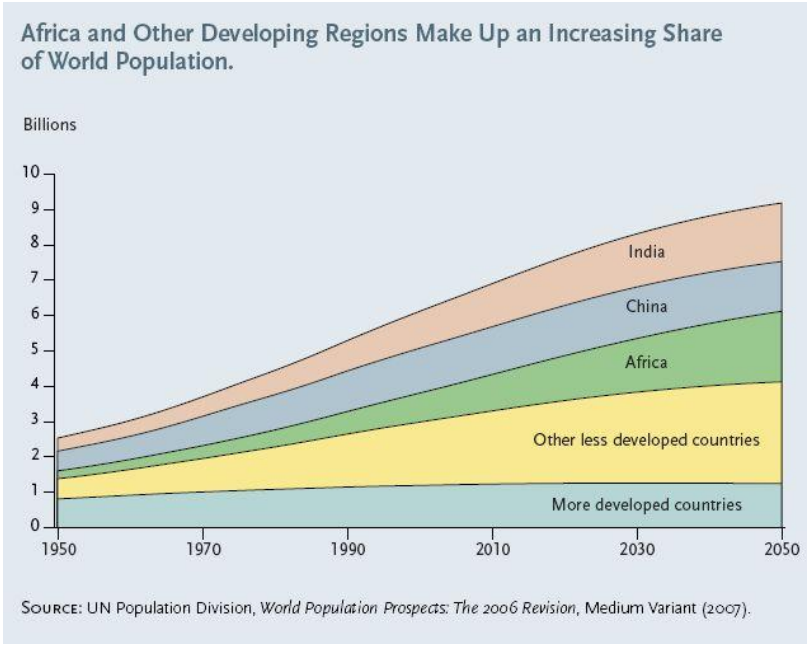
Growth in food demand



To 2050:

Population will increase **35%** (7.0-~9.2 bn)

Developing world: food demand increases >2x population growth

Therefore **70-100%** more food needed

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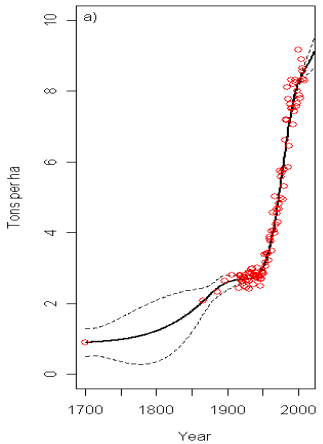
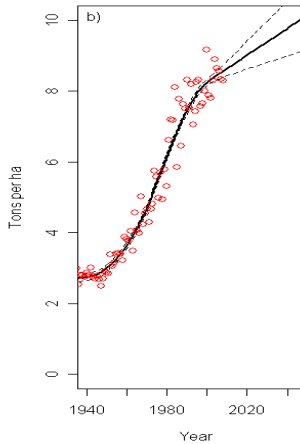
Barriers to production

- Biofuels taking land out of food production
- Movement to a low carbon economy will affect agriculture and food transport
- Yield increase slowing
- Global warming will on average reduce yields





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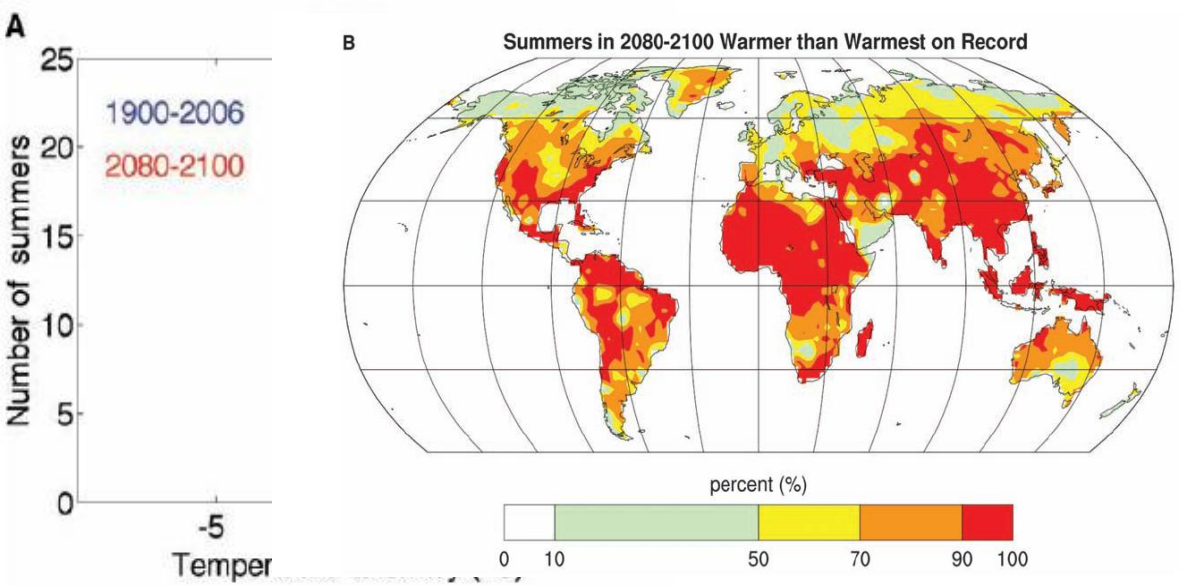
Climate change: localised crop failures will increase

"…in France and northern Italy, where over **30,000** people perished from heat-related causes….. Italy experienced a record drop in maize yields of **36%** from a year earlier, whereas in France maize and fodder production fell by **30**%, fruit harvests declined by **25**%, and wheat harvests (which had nearly reached maturity by the time the heat set in) declined by **21**%"



Battisti 2009 Science

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So…

- We probably need ~2x more food whilst our ability to supply food is reduced due to biofuels, climate change and low-input farming

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Where does global food come from?

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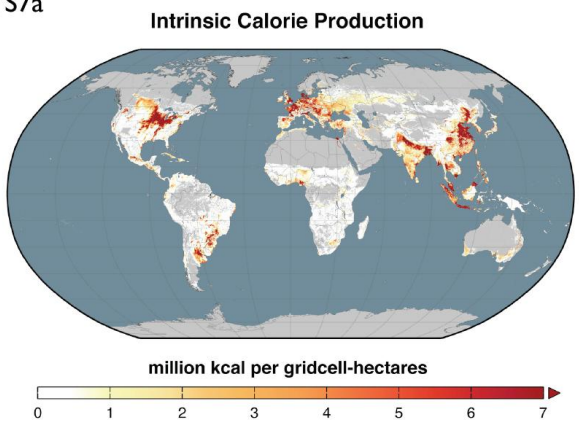
Fig S7a



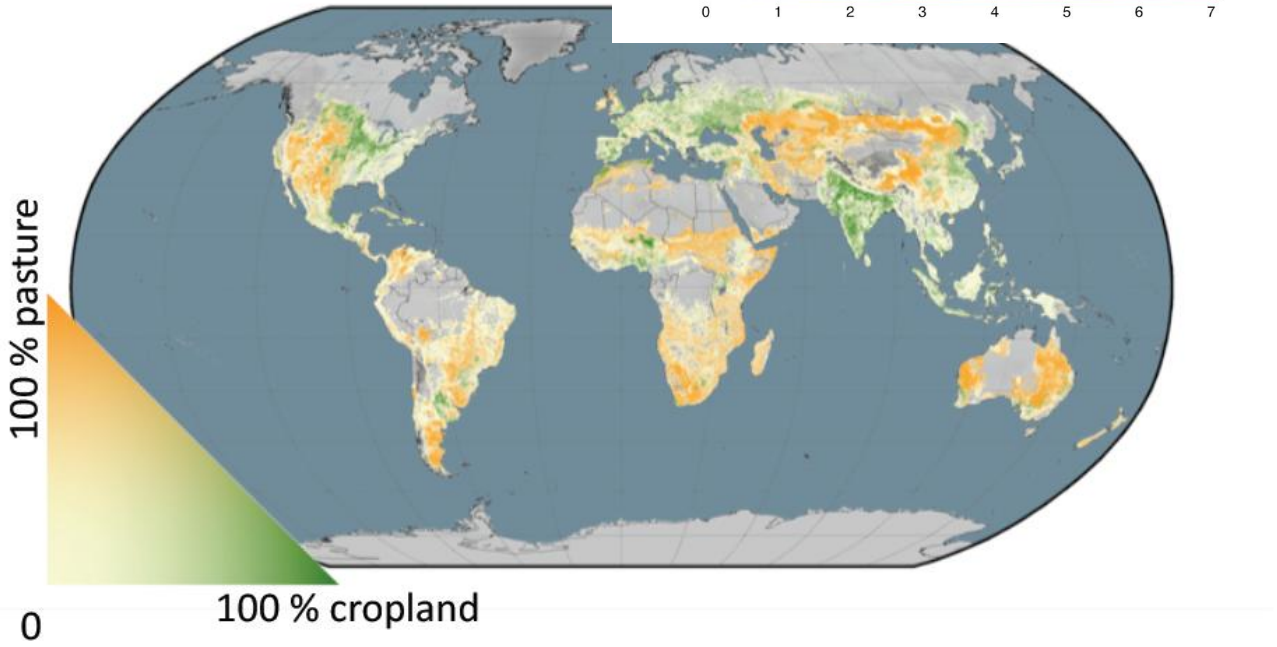


Figure S1. Extent of Global Agricultural Lands. This map illustrates the global extent of croplands (green) and pastures (brown), as estimated from satellite- and census-based data by Ramankutty *et al.*[1]. According to U.N. FAO statistics, croplands currently extend over 1.53 billion hectares (~12% of the Earth's land surface, not counting Greenland and Antarctica), while pastures cover another 3.38 billion hectares (~26% of global land). Altogether, agriculture occupies ~38% of the Earth's terrestrial surface, emerging as the largest use, by far, of land on the planet[1,2].

- Foley et al (2011)

Is Europe immune from global food insecurity?

2005

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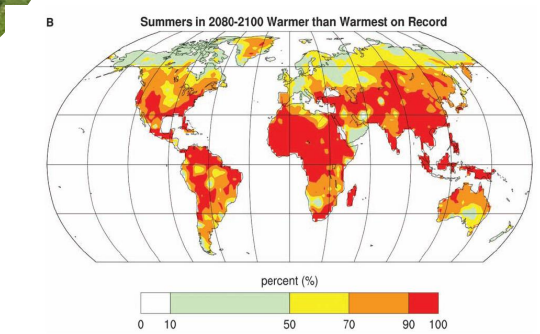
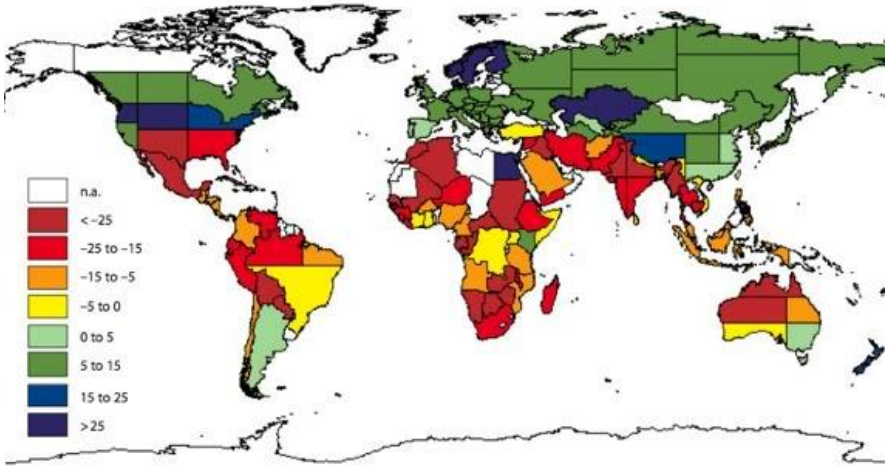
Germany: The Melander family – 4 mouths $500.07 per week

Chad: The Aboubakar family - 6 mouths $1.23 per week

Europe and the rest of the world

- The current “virtual land area” farmed by Europe in SSA and SE Asia is equivalent to the size of Germany (~50m ha) and has increased by the size of Portugal in the last decade (~10m ha) *(von Witzke & Noleppa 2010)*





Climate’s impact on food by 2080 (W Cline)

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World food prices enter 'danger territory' to reach record high | Business | guardian.co.uk - Windows Internet Explorer

http://www.guardian.co.uk/business/2011/jan/05/world-food-prices-danger-record-high-un

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World food prices enter 'danger territory' to reach record high

UN food price index rises for sixth month in a row to highest since records began in 1990

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Jill Treanor
guardian.co.uk, Wednesday 5 January 2011 15.04 GMT
Article history

A larger | smaller

An El Salvadorean farmer harvests sugar cane. Sugar and meat prices are at record levels. Photograph: Victor Ruiz Caballero/AP

Soaring prices of sugar, grain and oilseed drove world food prices to a record in December, surpassing the levels of 2008 when the cost of food sparked riots around the world, and prompting warnings of prices being in "danger territory".

An index compiled monthly by the United Nations surpassed its previous monthly high – June 2008 – in December to reach the highest level since records began in 1990. Published by the Rome-based Food and

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Sept 11th 2011

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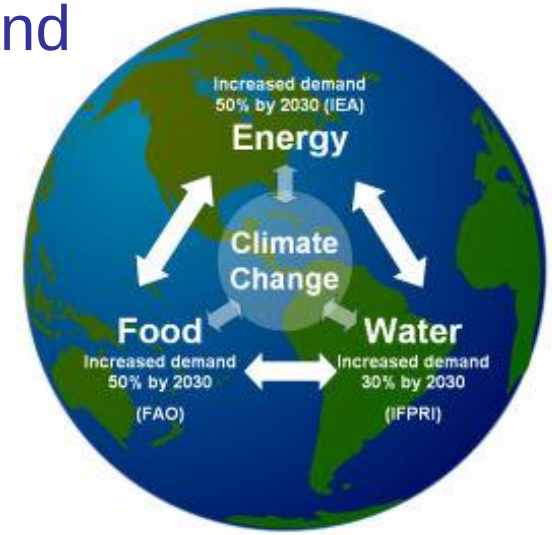
The food security challenge

John Beddington's *Perfect Storm*

- **Increase** food production
  - in the face of climate change
  - whilst reducing the carbon cost of farming
  - Without taking more land
- **Therefore:**
  - *Farm same area and produce more per unit area*



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technology
production
Poverty and livelihoods
Human health
Food security
Sustainability

The sustainability challenge: to produce more food AND minimise impact on ecology

- Biodiversity is valuable but value often hidden
  - Direct values to production
  - Direct values to society
- Sustainability requires protecting biodiversity

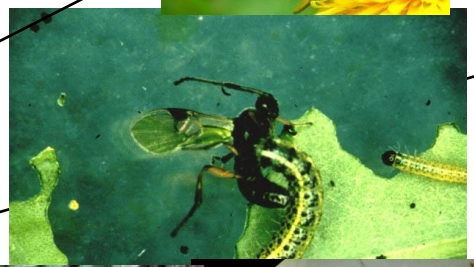
Ecology is important: e.g. 15-20% of global food production comes from insect pollinated crops (Klein et al 2008)

Ecosystem Services (ES): biodiversity is important

- Provisioning
  - Food, fibre, fuel
- Regulating
  - Flood, water purity etc

Cultural

Pollination



Pest control

Soil fertility and C storage

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Millennium Ecosystem Assessment, 2005. *Ecosystems and Human Well-being: Synthesis.* Island Press, Washington, DC.

Sustainable agricultural landscapes need not be organic

If an area (“landscape”) has to produce both food and “biodiversity”, do you get **more of both** if (a) you farm extensively throughout **or** (b) you separate some land to specialise in food and some to specialise in biodiversity?

Is specialising the key to sustainable production?

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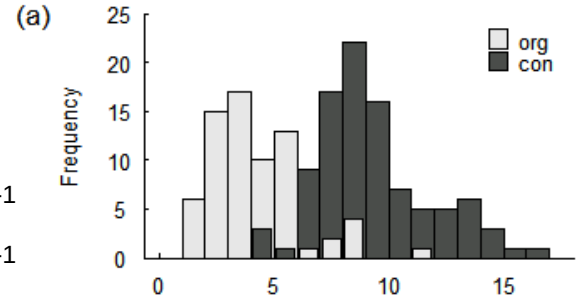
High production landscapes

Comparing organic farming and land sparing: maintaining yield and wildlife at a landscape scale.
J A. Hodgson*, W E. Kunin, C D. Thomas, T G. Benton & D Gabriel. (2010) Ecology letters

- Gain in biodiversity converting from intensive to organic ~12%
- Loss of yield 46%
- *Land sparing* (intensive plus land properly managed for wildlife) would produce more food and wildlife than *land sharing*
  - when O yields are <~90% C

Conventional yield = 9.35 t ha^{-1}

Organic yield = 4.25 t ha^{-1}



Where do pesticides fit in?

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Not using pesticides has an environmental cost

- Total worldwide pre-harvest crop losses estimated to be in excess of 40%

(Yudelman et al 1998)

Table 3 Actual global production of eight major crops and estimated losses, 1988 90

Crop	Actual production	Losses due to					Total attainable production
		Pathogens	Insects	Weeds	Total		
		(US$ billions)					
Rice	106.4	33.0	45.4	34.2	112.5	51%	218.9
Wheat	64.6	14.0	10.5	14.0	38.5	37%	103.1
Barley	13.7	1.9	1.7	2.0	5.7	29%	19.4
Maize	44.0	7.8	10.4	9.3	27.4	41%	71.4
Potatoes	35.1	9.8	9.6	5.3	24.8	32%	59.9
Soybeans	24.2	3.2	3.7	4.7	11.6	38%	35.8
Cotton	25.7	4.3	6.3	4.9	15.5	40%	41.2
Coffee	11.4	2.8	2.8	2.0	7.6		19.0

Pesticides are important and can be part of “sustainability agenda”

- Better chemical targeting
  - Specificity of action
  - minimise indirect and persistent effects
  - Best practice
- Work with the environment
  - Enhance natural pest control
  - Ensure proper use: keep PPPs away from non-cropped areas and ground water
- “sustainable landscapes”

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Conclusions

- We face a severe challenge: producing more food, not using more land, whilst reducing the environmental footprint
- Great need for innovation in agronomy, agri-chemicals, agri-ecology, crop biotech, waste, consumption etc
- Each area can play a part, but all need to work in concert to ensure sustainable food security

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"*Food security, nutrition and sustainable agriculture must remain a priority on the political agenda, to be addressed through a cross-cutting and inclusive approach, relevant to all stakeholders at global, regional and national level* ."

[G8 statement July 2009]

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