Research Infrastructure for Food (and nutrition) Security

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Food security is important

925 MILLION
PEOPLE ARE STARVING THROUGHOUT THE WORLD
$1.00
IS THE DAILY INCOME MADE ON AVERAGE
515 MILLION
PEOPLE DIE EACH YEAR BECAUSE OF STARVATION

YOU CAN MAKE A
DIFFERENCE
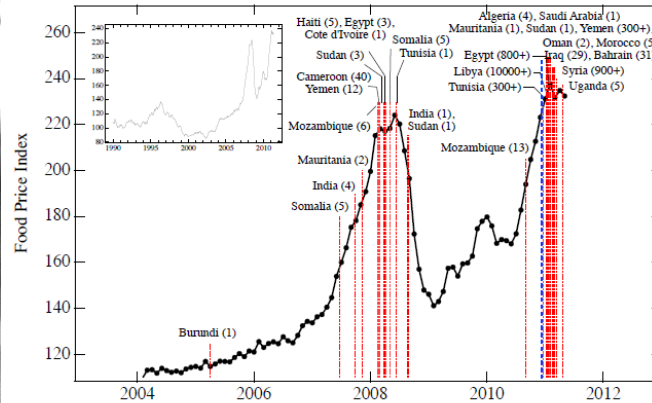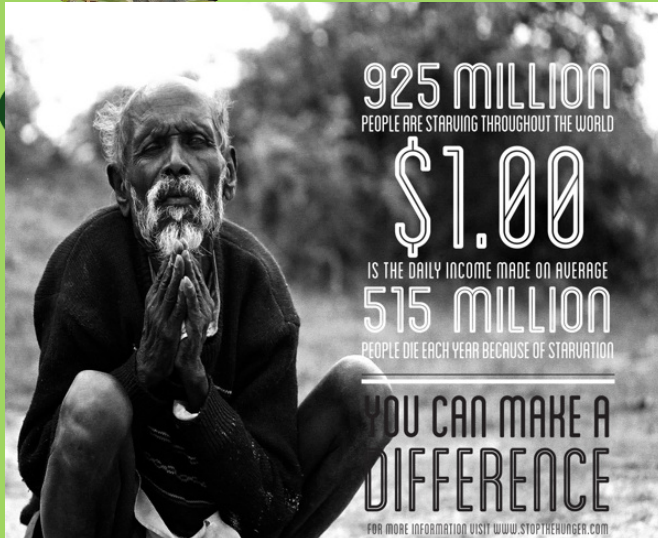FOR MORE INFORMATION VISIT WWW.STOPTHEHUNGER.COM

Fig. 1: Time dependence of FAO Food Price Index from January 2004 to May 2011. Red dashed vertical lines correspond to beginning dates of "food riots" and protests associated with the major recent unrest in North Africa and the Middle East. The overall death toll is reported in parentheses [55]. Blue vertical line indicates the date, December 13, 2010, on which we submitted a report to
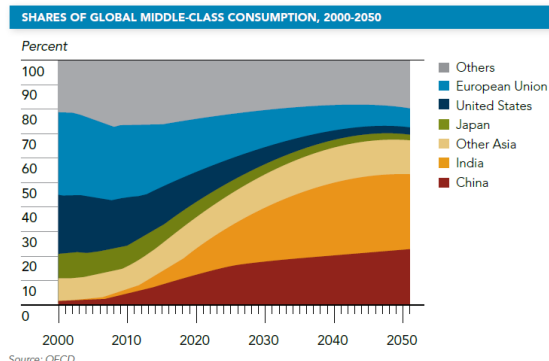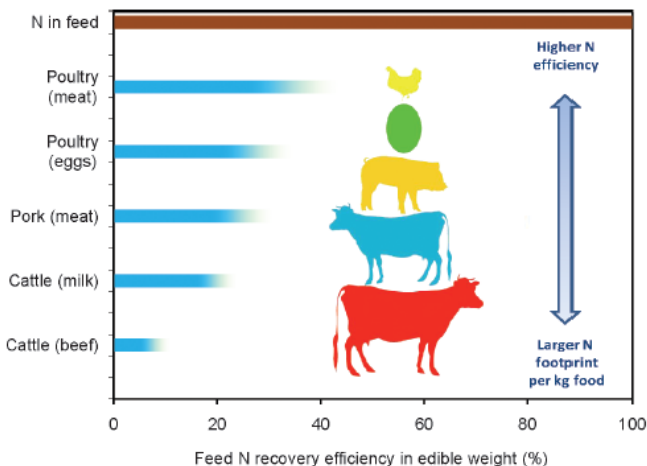
LIBYA
BAHRAIN
YEMEN
IRAN
ALGERIA
TUNISIA
EGYPT
LIBERATE

…and the food system is the world biggest land user, employer and, arguably, polluter

DRIVERS OF CHANGE

DRIVER 1: DEMAND IS GROWING

Growth in global food demand

SHARES OF GLOBAL MIDDLE-CLASS CONSUMPTION, 2000-2050

Source: OECD

2000: 60% middle class "western" vs 20% "eastern"
2050: 12% vs 68%

- 35% more mouths by 2050
  - Mainly in Asia, Africa and S. Am
- Richer people eat more and differently:
  - Global middle class will increase 3bn by 2050
- 70% urbanised
  - Understanding of food systems

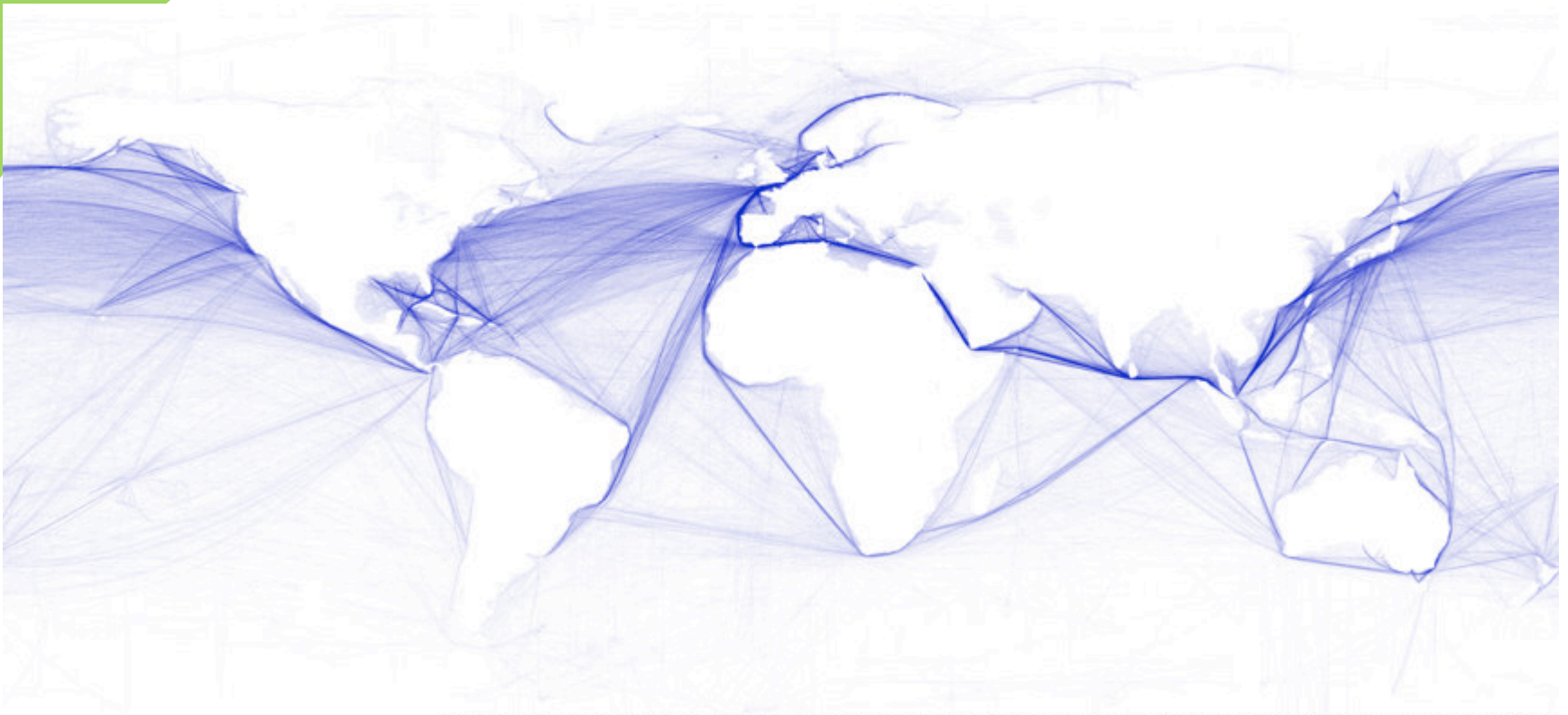- All add up to projected increased global food demand (FAO estimate 60% more)
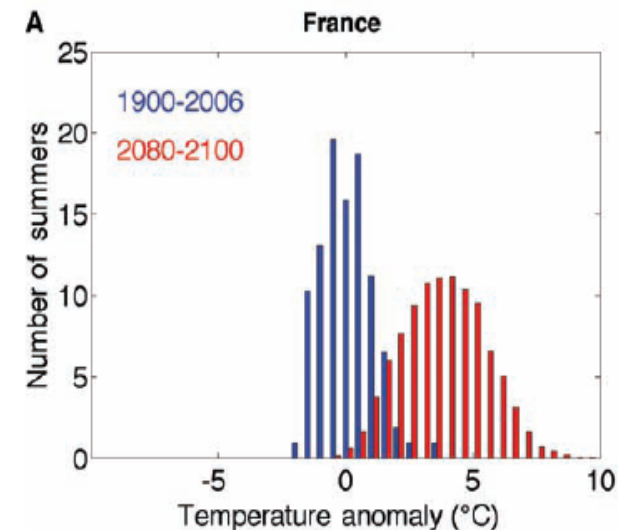
DRIVER 2: THE WORLD IS GLOBAL AND CHANGING

Supply chain logistics
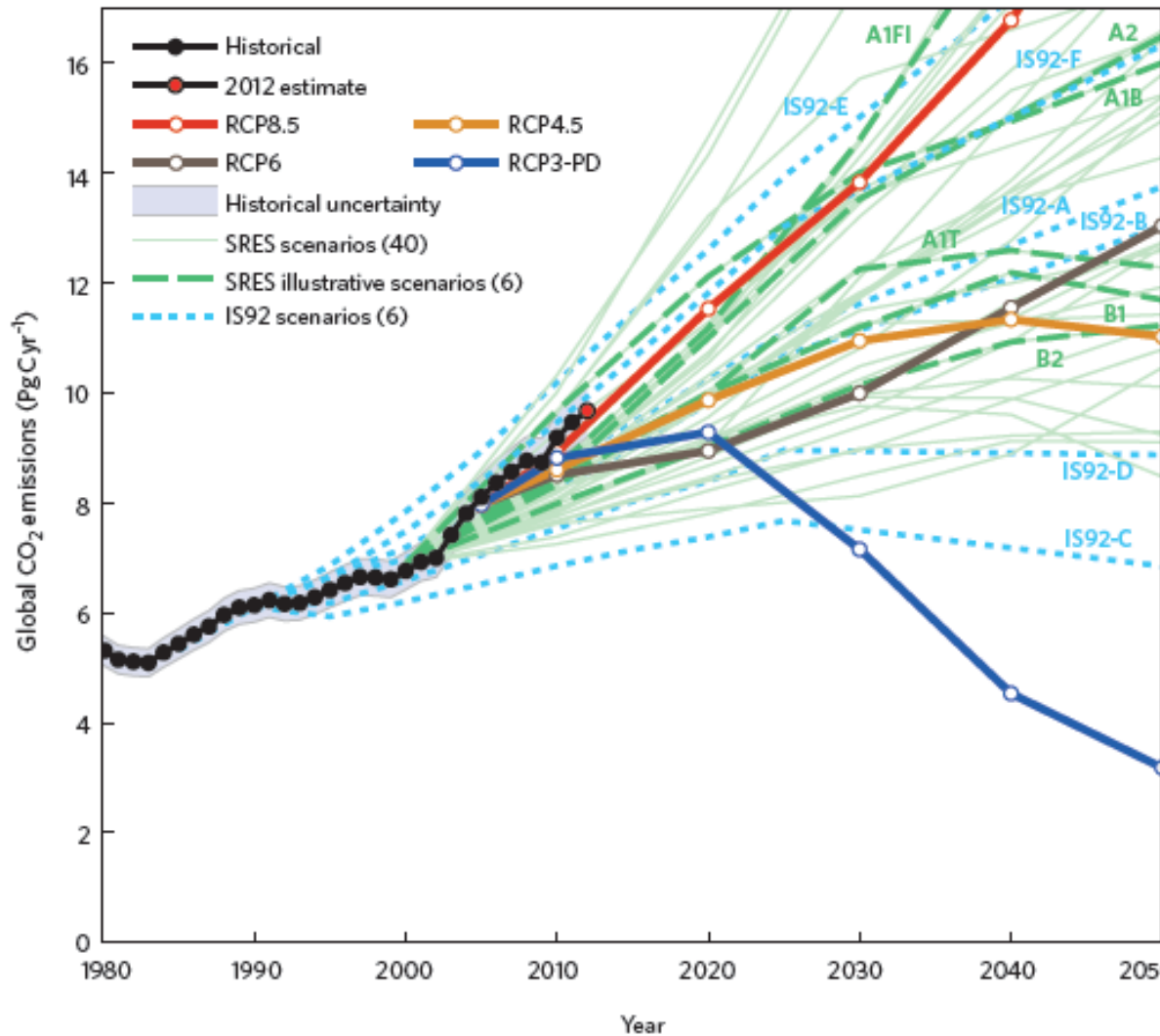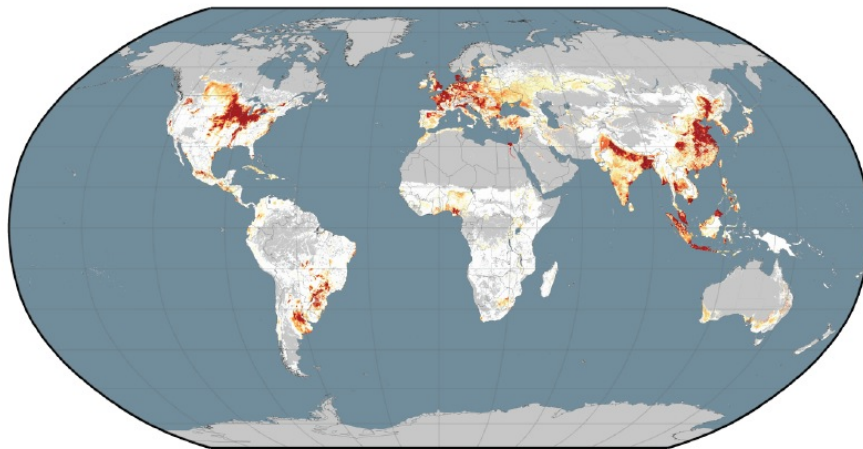
The challenge to keep global warming below 2°C

Glen P. Peters, Robbie M. Andrew, Tom Boden, Josep G. Canadell,
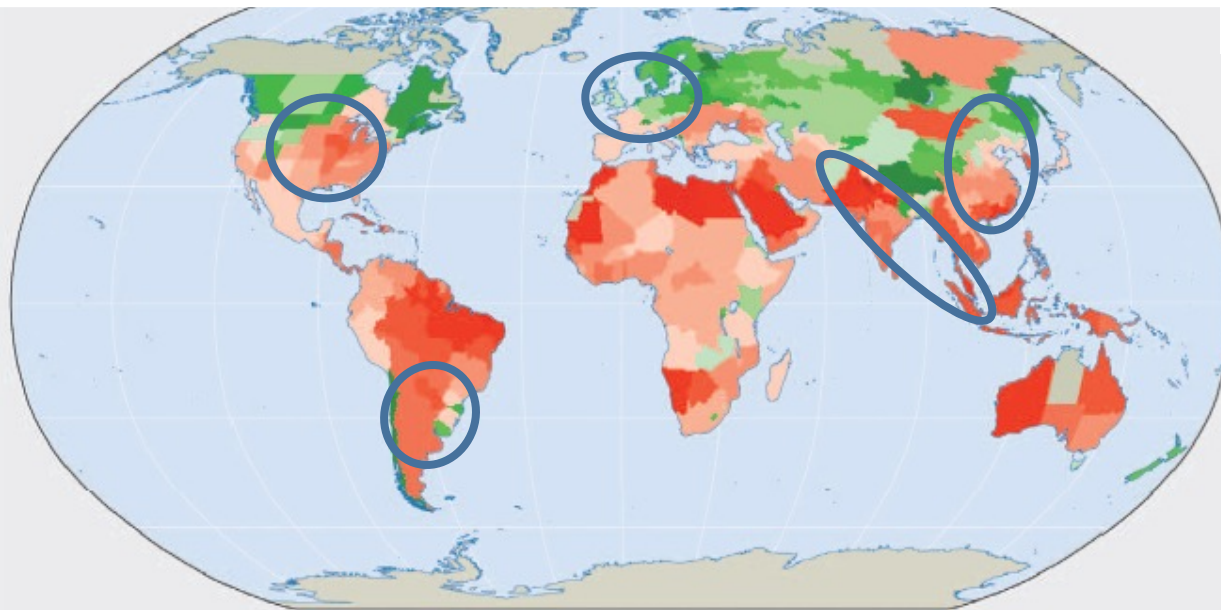Philippe Ciais, Corinne Le Quéré, Gregg Marland, Michael R. Raupach and Charlie Wilson

We're on course for a 4 degree world

Fig S7a

Intrinsic Calorie Production

Foley et al 2011

million kcal per gridcell-hectares

tion. (A) (Log-linear scale). The world's food production (thin red line),
nt of food transported on the IFTN (linearly fitted small squares, blue)
s flow at an increasing rate from countries to countries, as shown by the
rom the above data (small squares fitted by an exponential curve). Note
JN databases [6,23].

**Complexity of the International Agro-Food Trade
Network and Its Impact on Food Safety**

Mária Ercsey-Ravasz[1,2], Zoltán Toroczkai[1], Zoltán Lakner[3], József Baranyi[4]*

Percentage change in yields between present and 2050

From Wheeler & Von
Braun (2013) after
World Bank (2010)

INFRASTRUCTURE NEEDS

1. Genes to phenotypes

- Traits to understand:
  - Yield
  - Nutritional quality
  - Resource use efficiency
  - Resistance to biotic and abiotic stresses
  - Growth rate and phenology

- Infrastructure needs
  - Genomics
  - Proteomics
  - Metabolomics
  - Bioinformatics
  - phenotyping
  - Open and big data
  - Multilevel models

INFRASTRUCTURE NEEDS

2. Genes to phenotypes in the field

Yield-defining factors

Varietal characteristics

Development rates (plastochrone, phyllochrone, thermal times)

Growth rate (photosynthesis, specific leaf area, leaf weight ratio, net assimilation rate, relative growth rate, respiration coefficient)

Morphology and plant architecture (growth habit, partitioning, shoot:root ratio, leaf area ratio, harvest index)

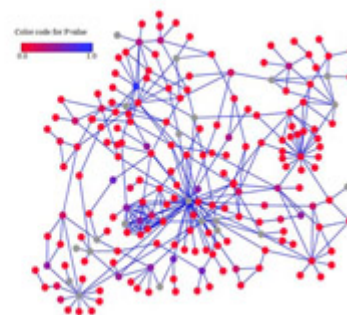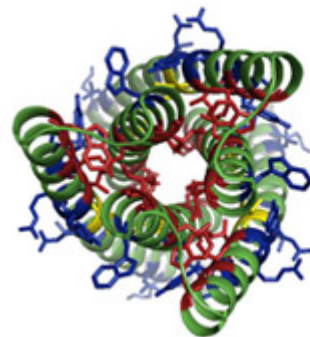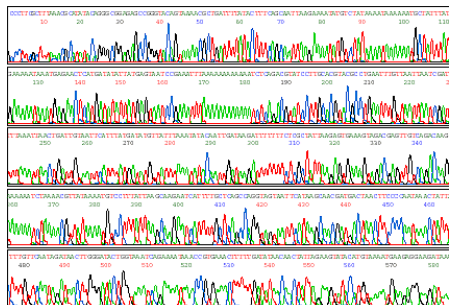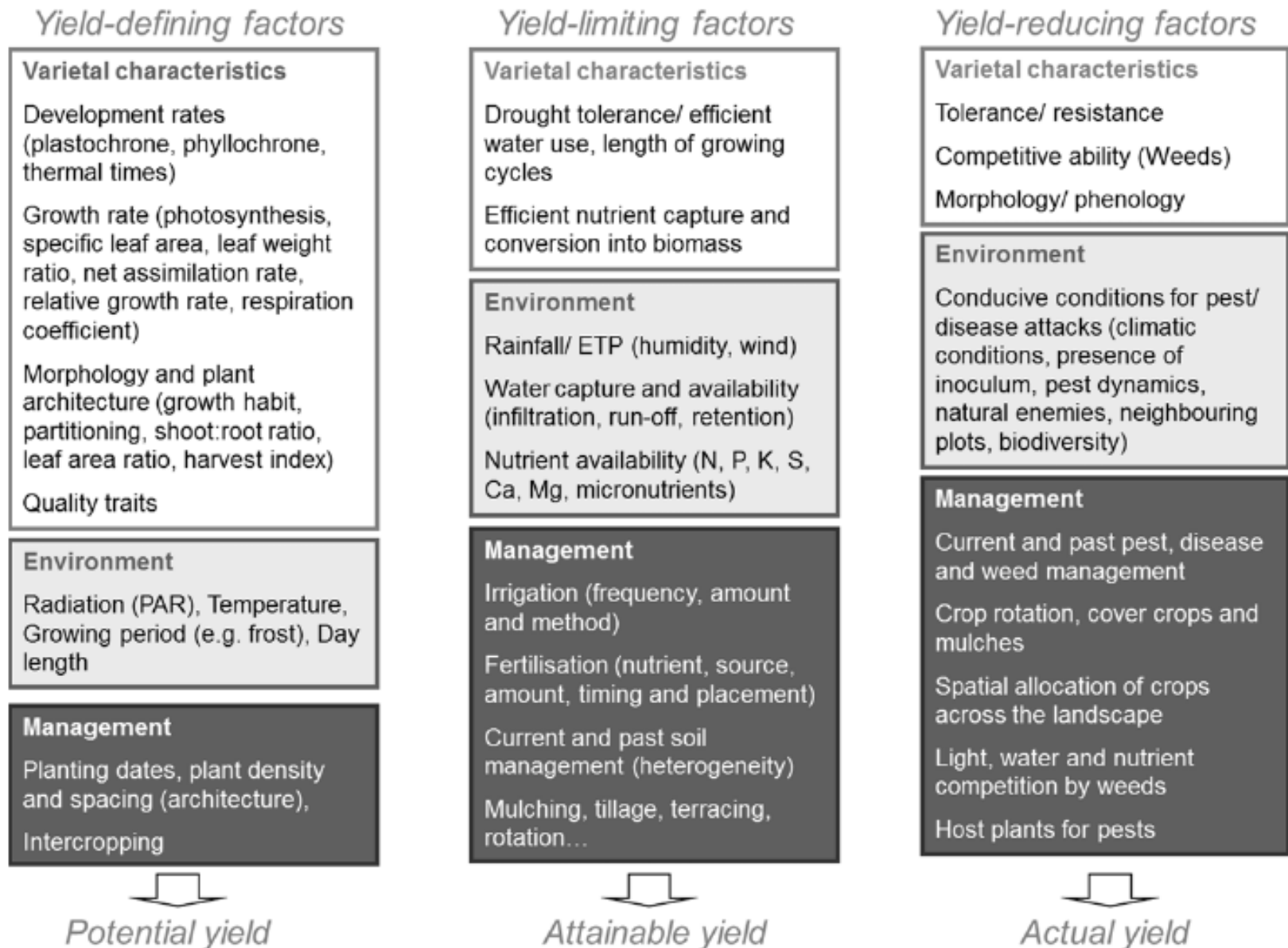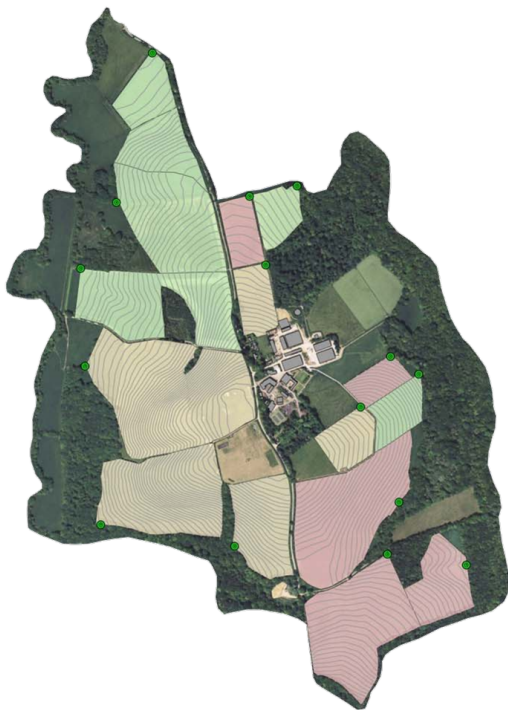Quality traits

Environment

Radiation (PAR), Temperature, Growing period (e.g. frost), Day length

Management

Planting dates, plant density and spacing (architecture),

Intercropping

⬇

Potential yield

Yield-limiting factors

Varietal characteristics

Drought tolerance/ efficient water use, length of growing cycles

Efficient nutrient capture and conversion into biomass

Environment

Rainfall/ ETP (humidity, wind)

Water capture and availability (infiltration, run-off, retention)

Nutrient availability (N, P, K, S, Ca, Mg, micronutrients)

Management

Irrigation (frequency, amount and method)

Fertilisation (nutrient, source, amount, timing and placement)

Current and past soil management (heterogeneity)

Mulching, tillage, terracing, rotation…

⬇

Attainable yield

Yield-reducing factors

Varietal characteristics

Tolerance/ resistance

Competitive ability (Weeds)

Morphology/ phenology

Environment

Conducive conditions for pest/ disease attacks (climatic conditions, presence of inoculum, pest dynamics, natural enemies, neighbouring plots, biodiversity)

Management

Current and past pest, disease and weed management

Crop rotation, cover crops and mulches

Spatial allocation of crops across the landscape

Light, water and nutrient competition by weeds

Host plants for pests

⬇

Actual yield

- Exploiting GxExM

Understanding GxExM

The North Wyke Farm Platform

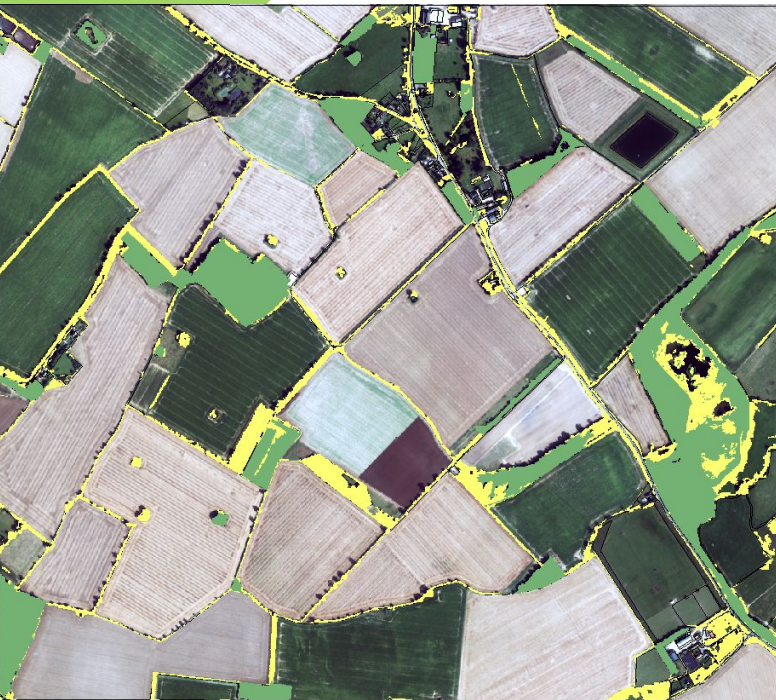Farming for food security and ecosystem services

- Farm-scale instrumented platforms
  - Sensors
  - Networks
  - Big data
- Distributed across many replicates to sample many Envts
- Functioning networks of existing platforms?

INFRASTRUCTURE NEEDS

3. Managing landscapes

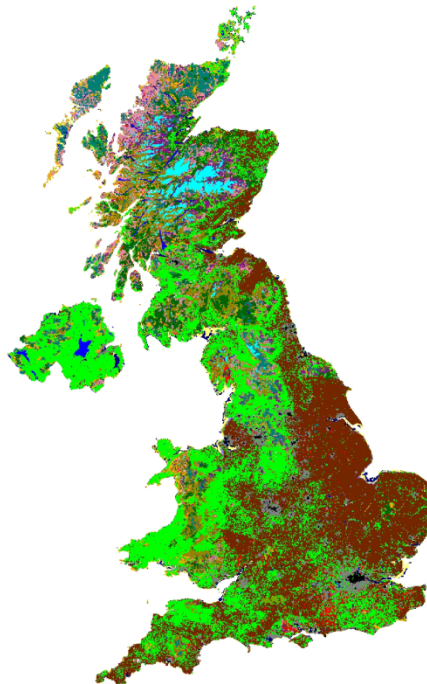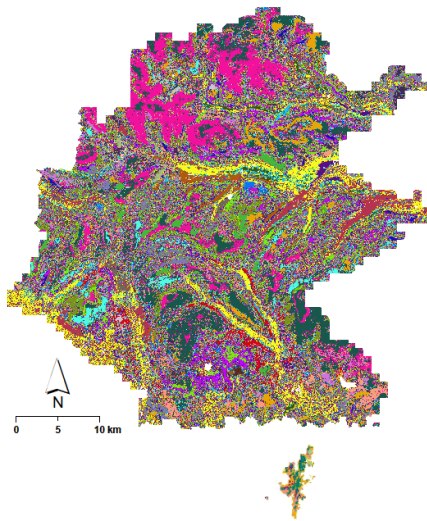# What does land do?

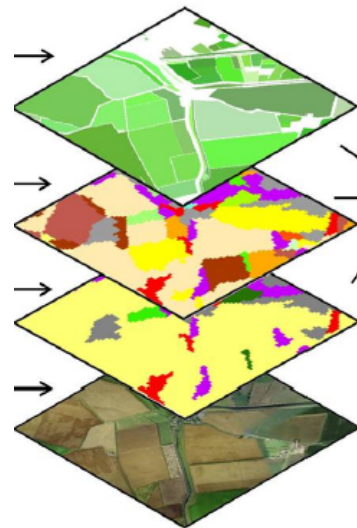# Creating smart landscapes

- New algorithms for remote sensing

- Detailed ecosystem service mapping

- Big data and scalable models

Richard German thesis 2012

INFRASTRUCTURE NEEDS

4. Resilience and risk-management

Resilience and risks
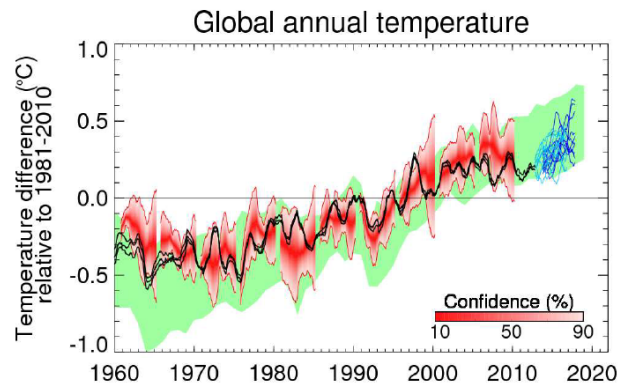

Global annual temperature

Figure 1: Global annual temperature record since 1960 and the latest ensemble of forecasts from the Met Office decadal prediction system produced in January 2014. The dark blue lines show the evolution of the 10 individual forecasts from this year's forecast starting from November 2013 and the pale blue lines the equivalent for last year's

Schmallenberg disease

- Weather
  - High resolution forecasts
  - Seasonal-to-decadal
- Trade/production/impact models
  - How does a shock in one place influence food security in another?
- Pests and diseases
  - Surveillance, monitoring and forecasting
- Crop diversity
  - Developing new crops to reduce reliance on rice, wheat, maize

INFRASTRUCTURE NEEDS

5. Food into health

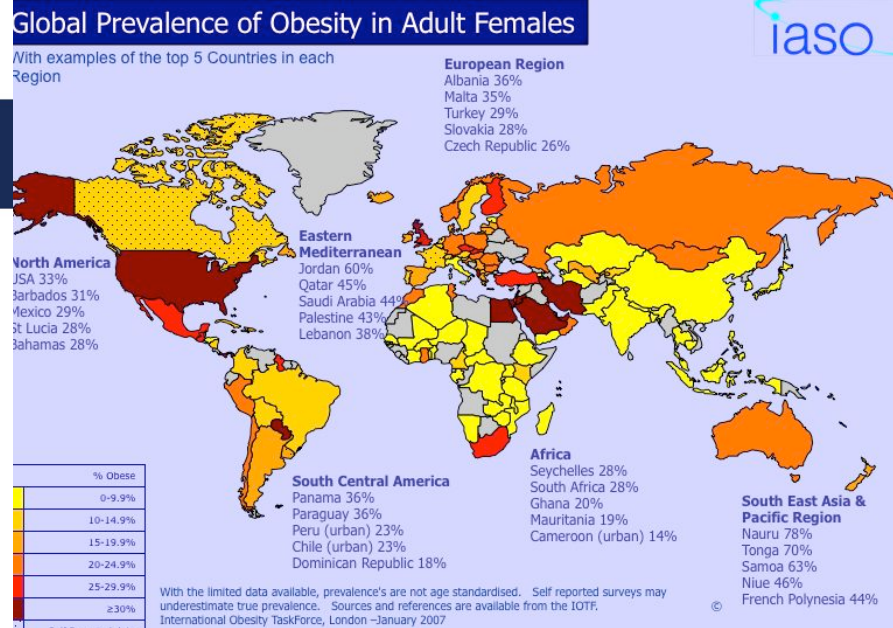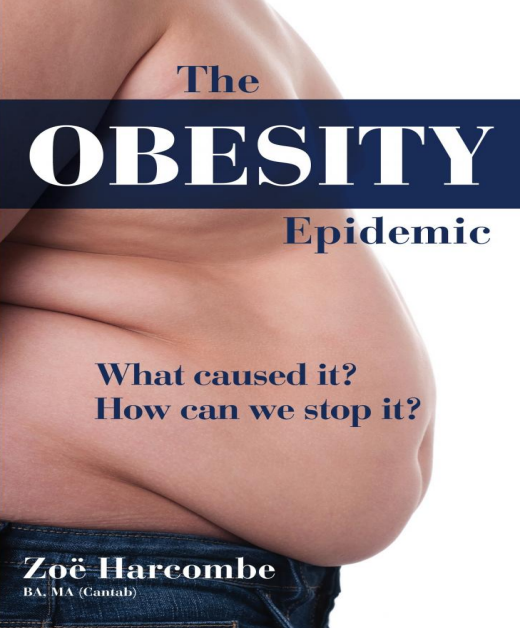The OBESITY Epidemic

What caused it? How can we stop it?

Zoë Harcombe
BA, MA (Cantab)

Global Prevalence of Obesity in Adult Females

With examples of the top 5 Countries in each Region

European Region
Albania 36%
Malta 35%
Turkey 29%
Slovakia 28%
Czech Republic 26%

Eastern Mediterranean
Jordan 60%
Qatar 45%
Saudi Arabia 44%
Palestine 43%
Lebanon 38%

North America
USA 33%
Barbados 31%
Mexico 29%
St Lucia 28%
Bahamas 28%

South Central America
Panama 36%
Paraguay 36%
Peru (urban) 23%
Chile (urban) 23%
Dominican Republic 18%

Africa
Seychelles 28%
South Africa 28%
Ghana 20%
Mauritania 19%
Cameroon (urban) 14%

South East Asia & Pacific Region
Nauru 78%
Tonga 70%
Samoa 63%
Niue 46%
French Polynesia 44%

% Obese
0-9.9%
10-14.9%
15-19.9%
20-24.9%
25-29.9%
≥30%

With the limited data available, prevalence's are not age standardised. Self reported surveys may underestimate true prevalence. Sources and references are available from the IOTF. International Obesity TaskForce, London –January 2007

iaso

Diet and health:

- Diabetes UK cost ~£30bn
- >50% of adult Chinese are pre-diabetic *JAMA*. 2013;310(9):948-958. doi:10.1001/jama. 2013.168118
- over-consumption associated with >20% of deaths globally;
- Malnutrition & micronutrients

Need for greater understanding of

- Attitudes to food choice and consumption
- Impacts of food
  - At population and demographically structured levels (e.g. elderly)

- Infrastructural needs
  - Cohort & population studies
    - Link to European Social Survey (ERIC)?
  - Basic biology underpinning health
    - Personalised nutrition
    - Holistic nutrition
  - Big and open data
    - Health data?

Global Food Security
Sustainable, healthy food for all

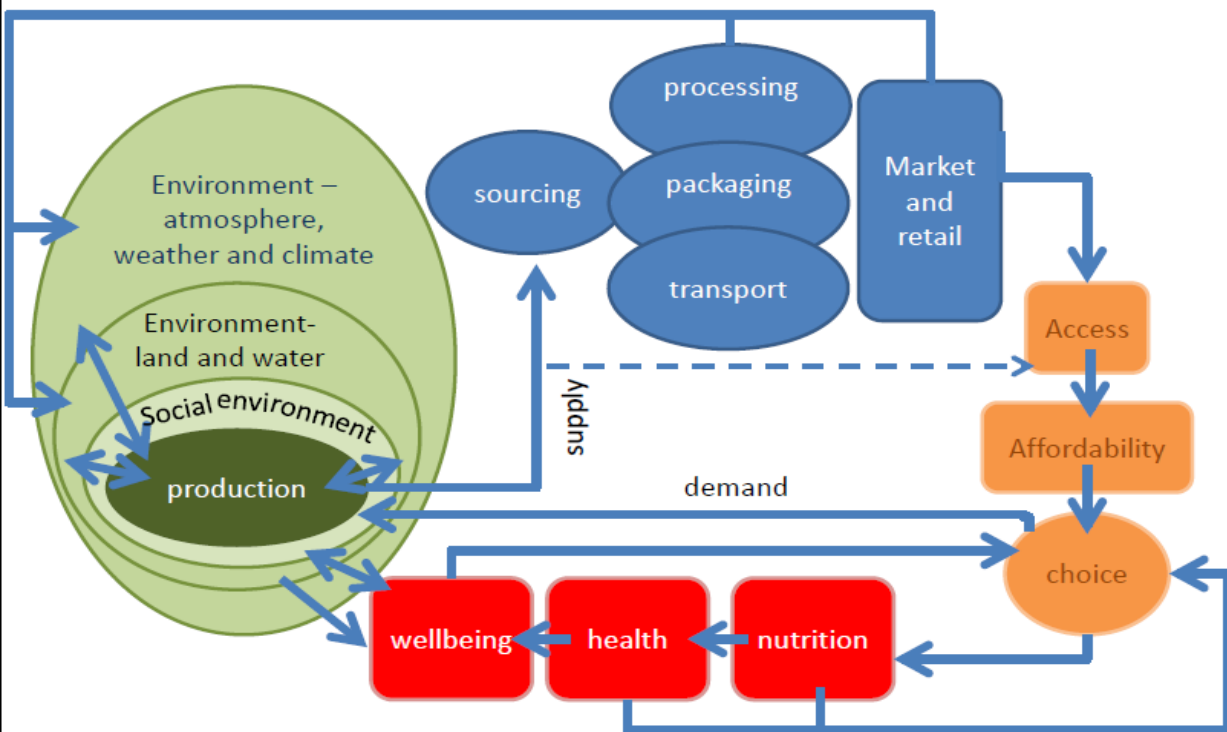"Let's see…number of cheeseburgers eaten in a typical month? three…no, I'll put down four."

Systems approaches

Needs:
- Systems' view
- trans-disciplinarity
- Prioritisation of "key questions"
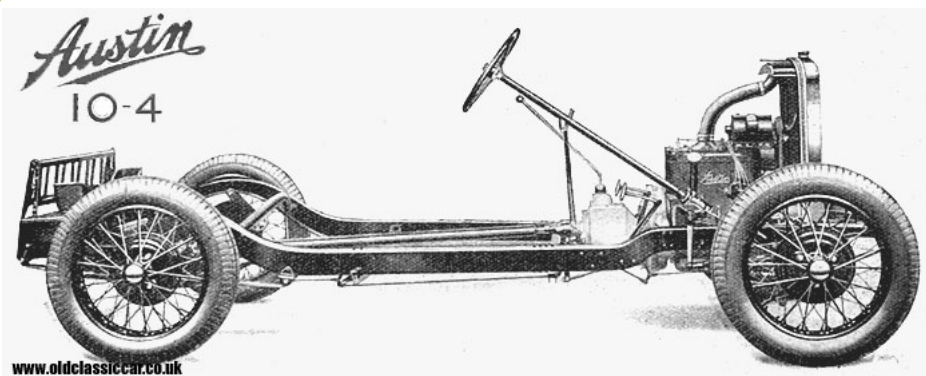 - Is complex & needs stakeholder input

Final thoughts

Connected infrastructure already exists:
e.g. global observatories (e.g. NEON) or LTER sites

- Much existing infrastructure already exists
  - Perhaps less need for "big kit" than other sectors/disciplines
- The key is to connect it rather than re-invent the wheel
  - As with JPIs
- Need integrated knowledge systems and networks

Don't reinvent the wheel multiple times: connect them with a chassis

Thank you!

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