“The Food Equation”
Taking a long/term View on World Agriculture, Climate Change and Food Security

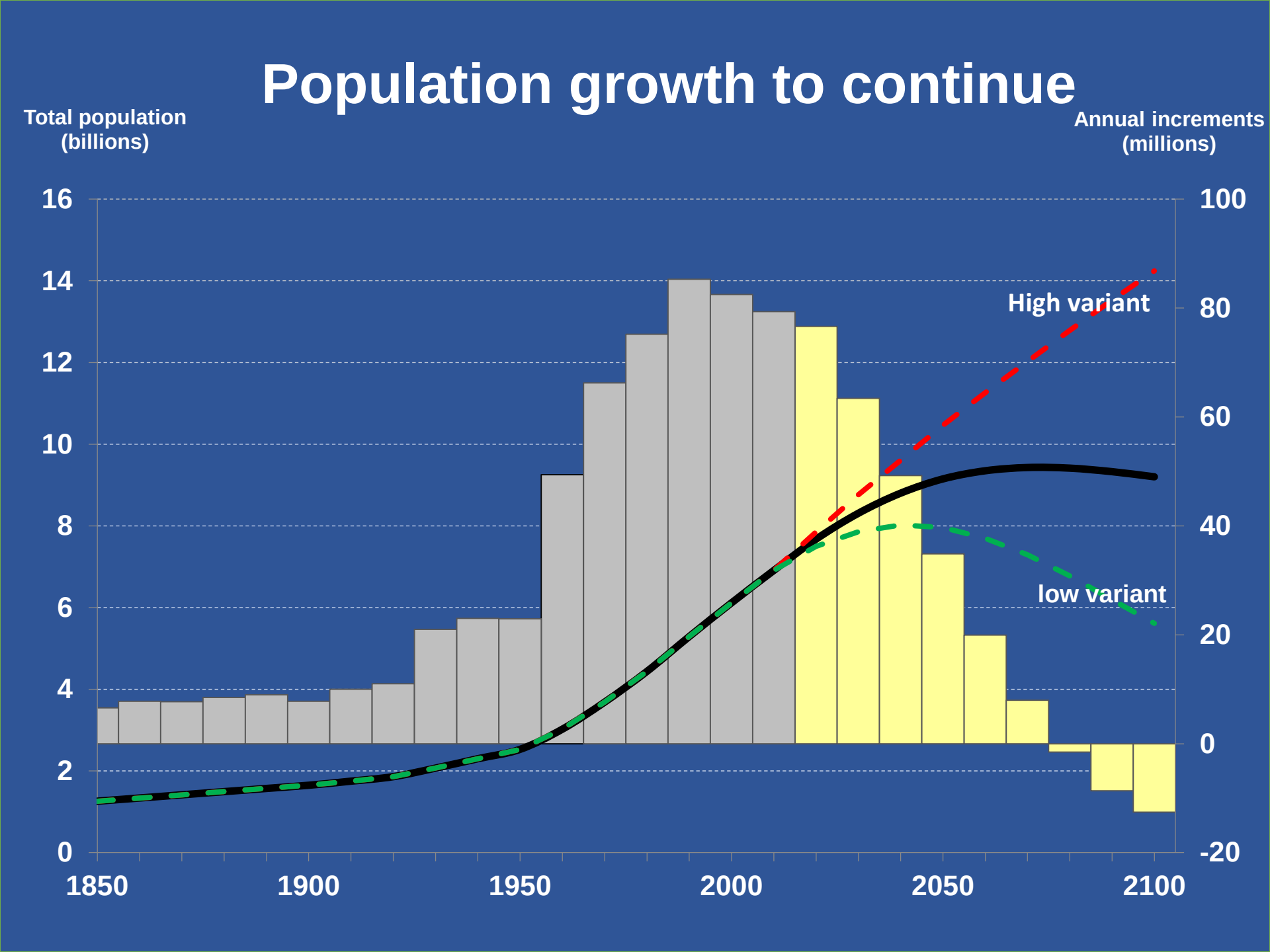
Josef Schmidhuber

Food and Agriculture Organization of the United Nations (FAO)

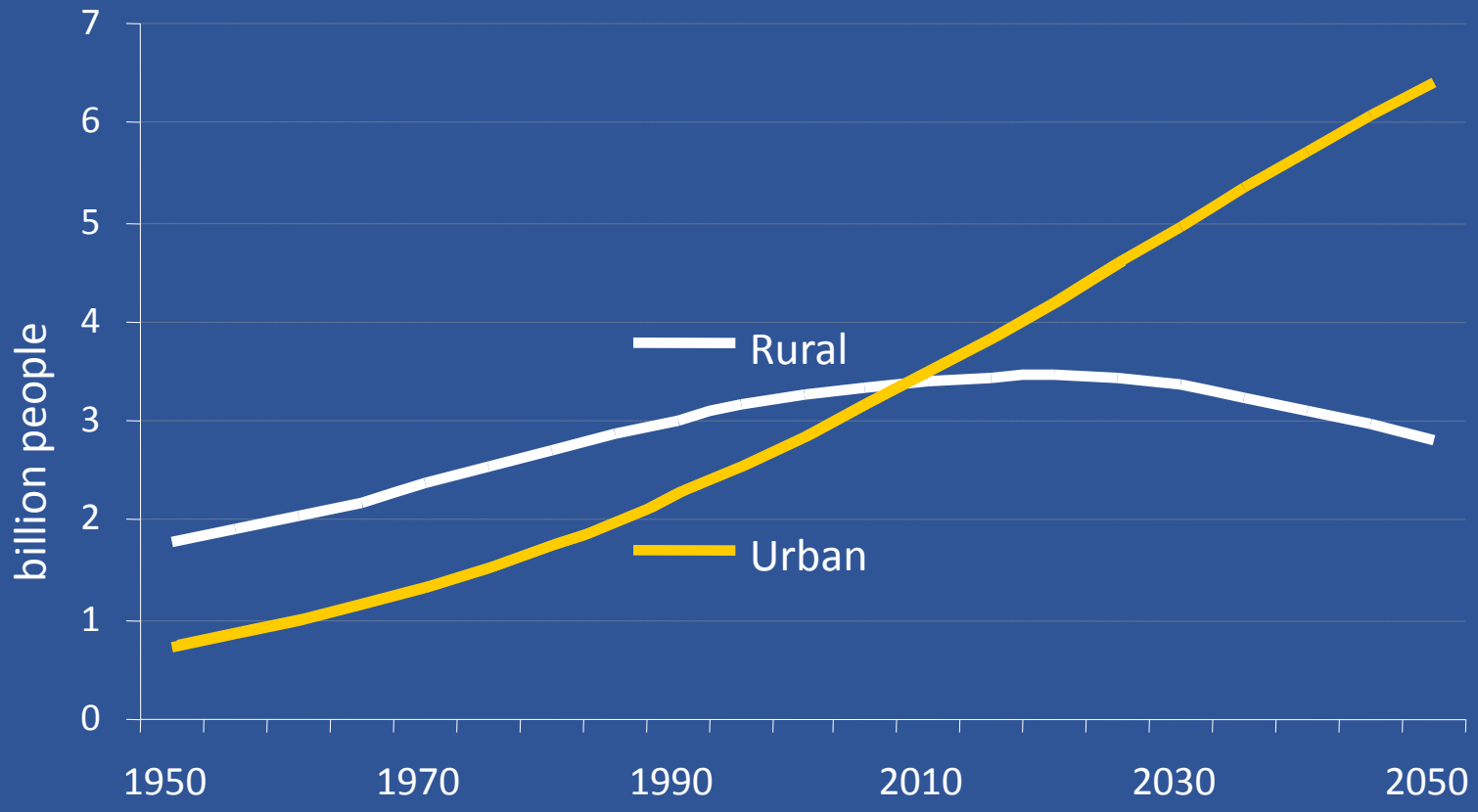
Drivers of change

POPULATION and INCOME

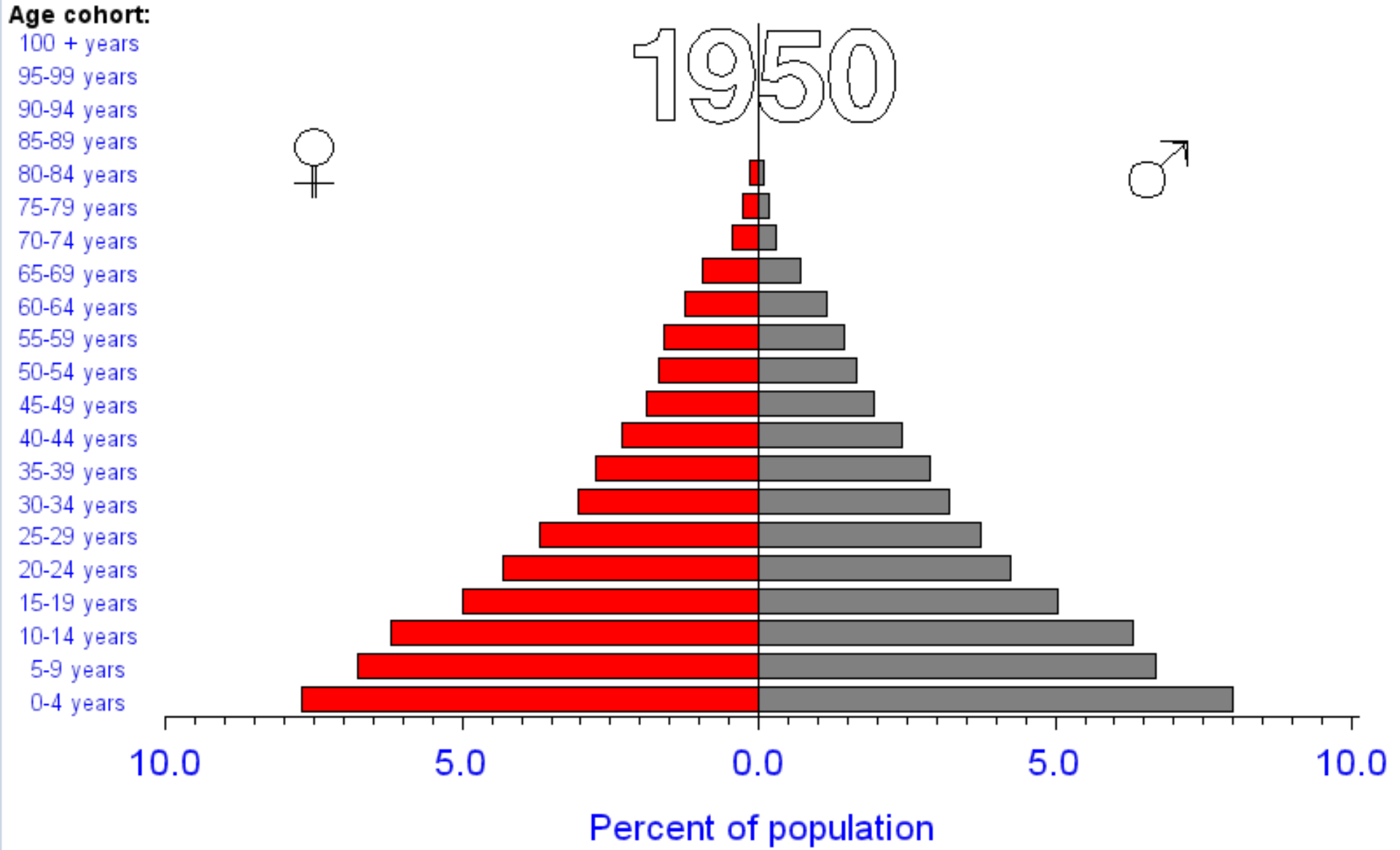
Population growth to continue



Urbanization to accelerate



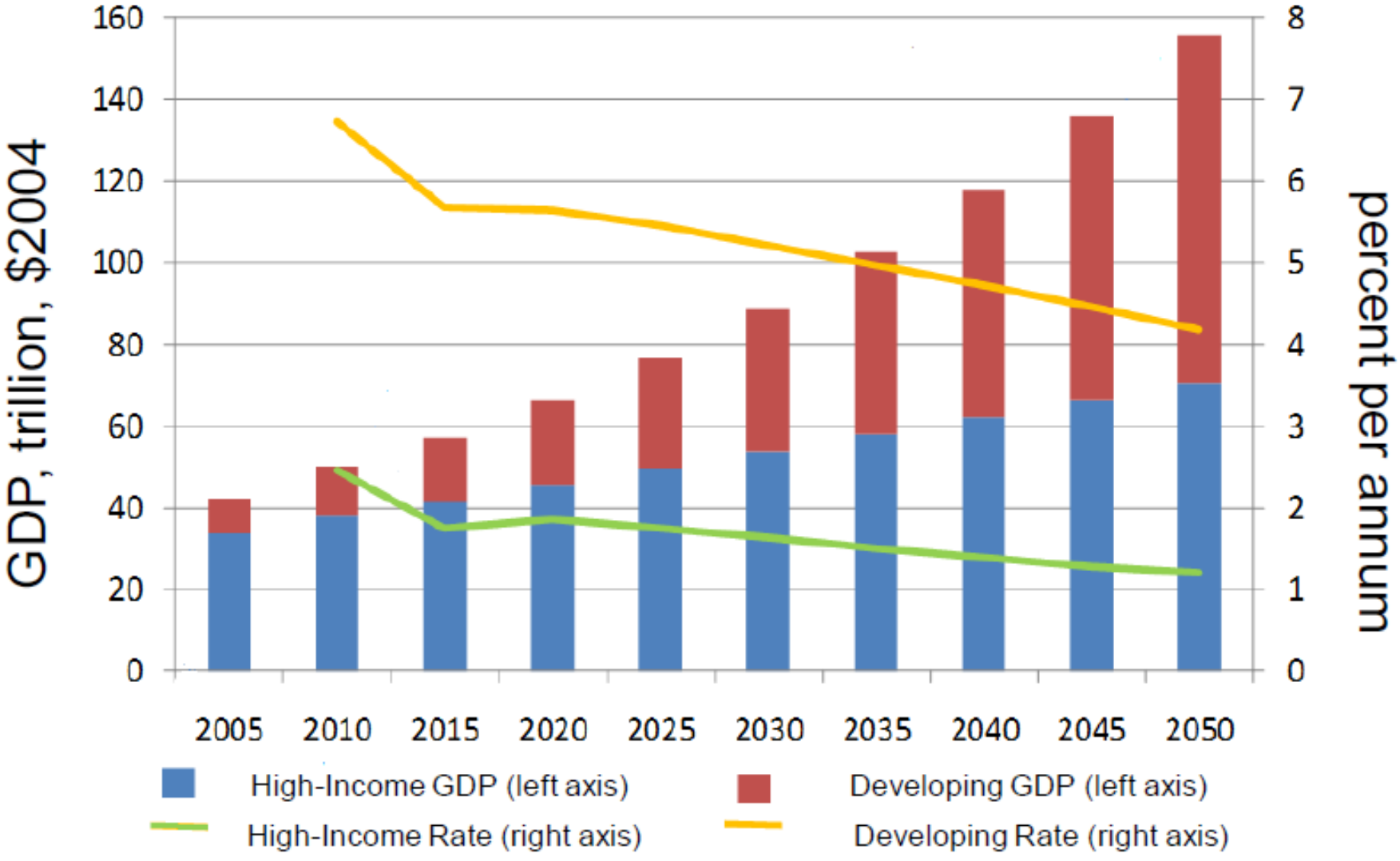
Republic of Korea: Population structure 1950 to 2050



Data: UN 2012 (http://www.un.org/esa/population/unpop.htm)

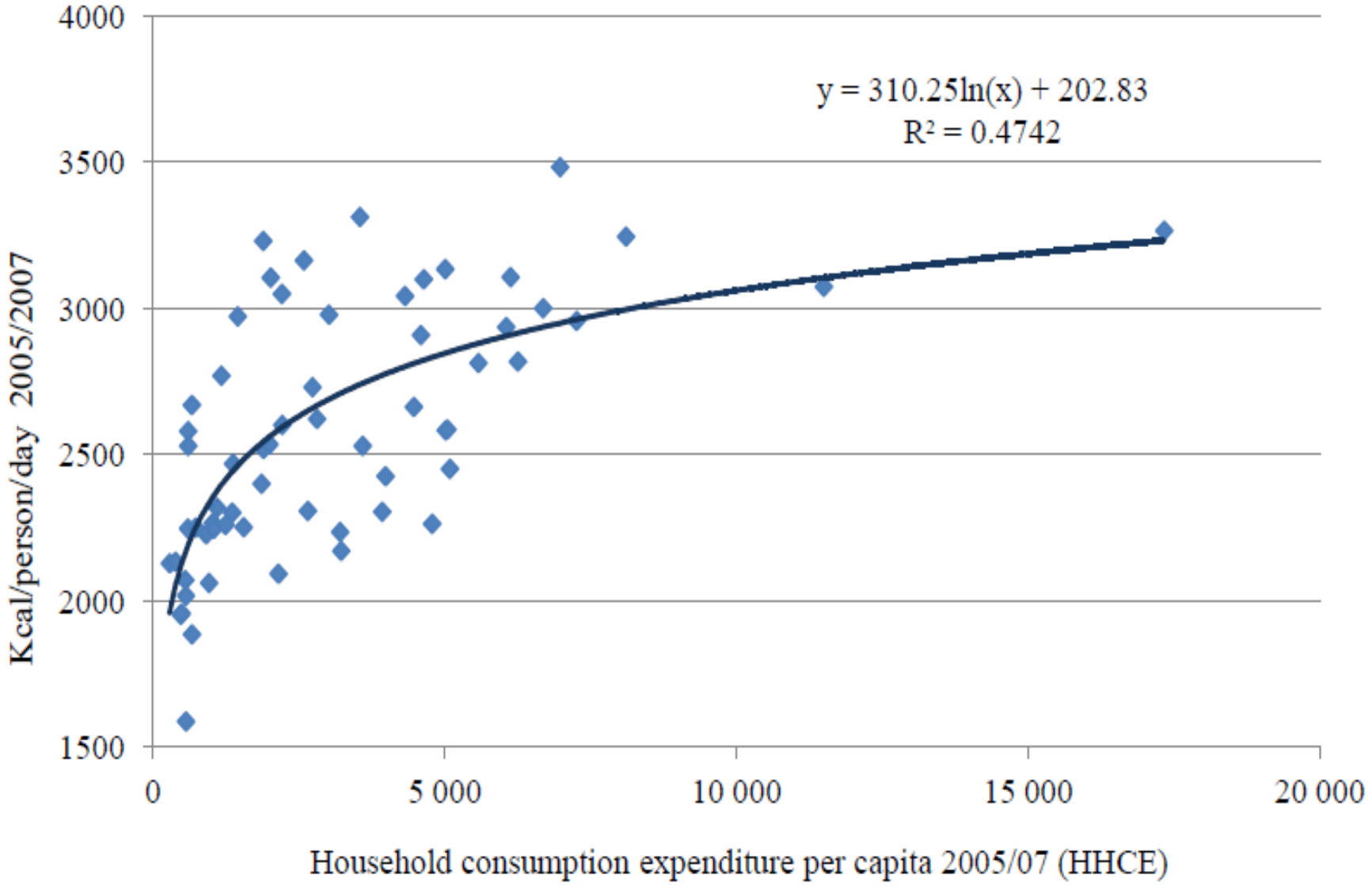
Josef Schmidhuber (2014)

GDP Growth to continue



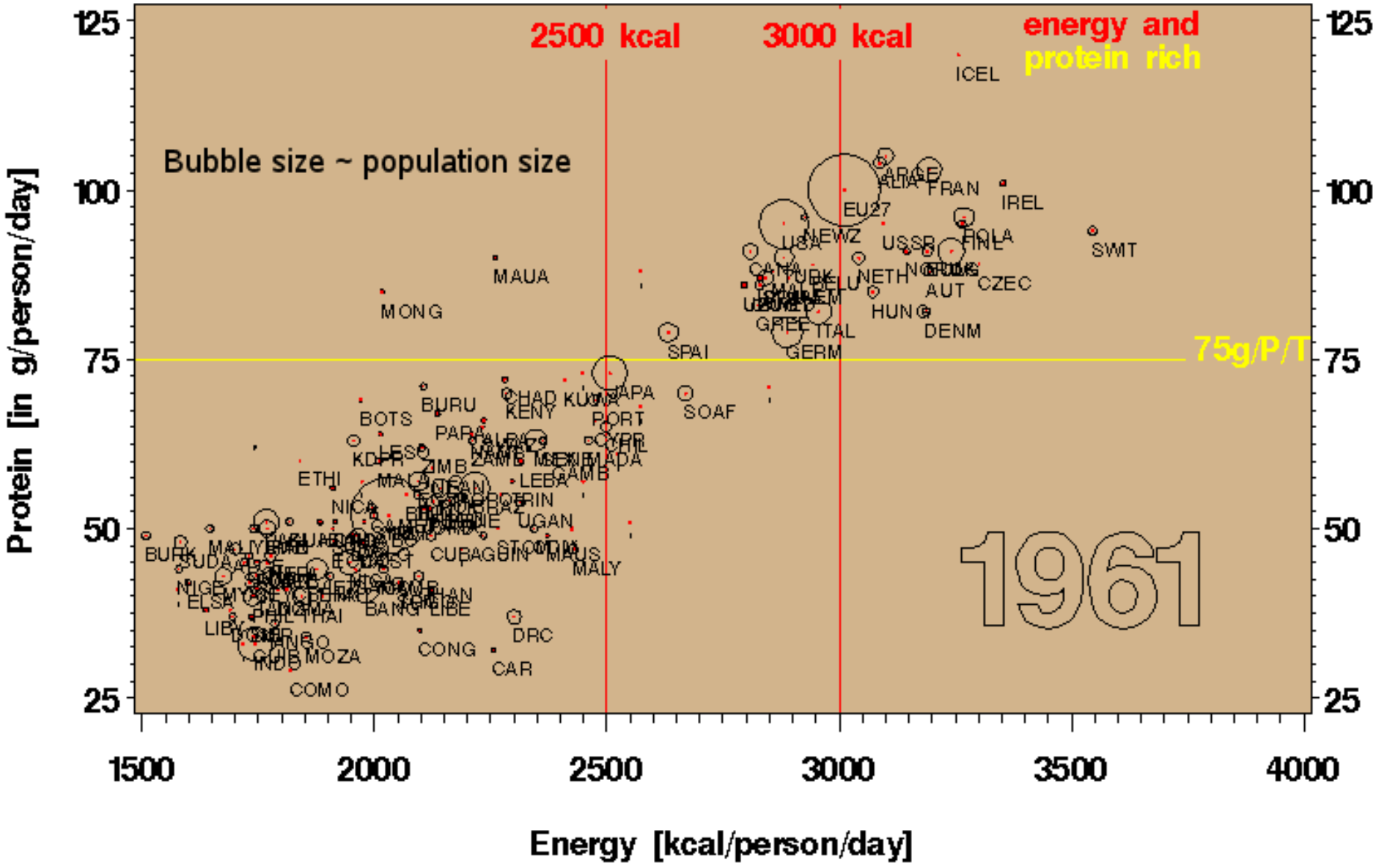
Source: World Bank

Consumption(kcal/pc) and GDP p.c. (62 Developing Countries)



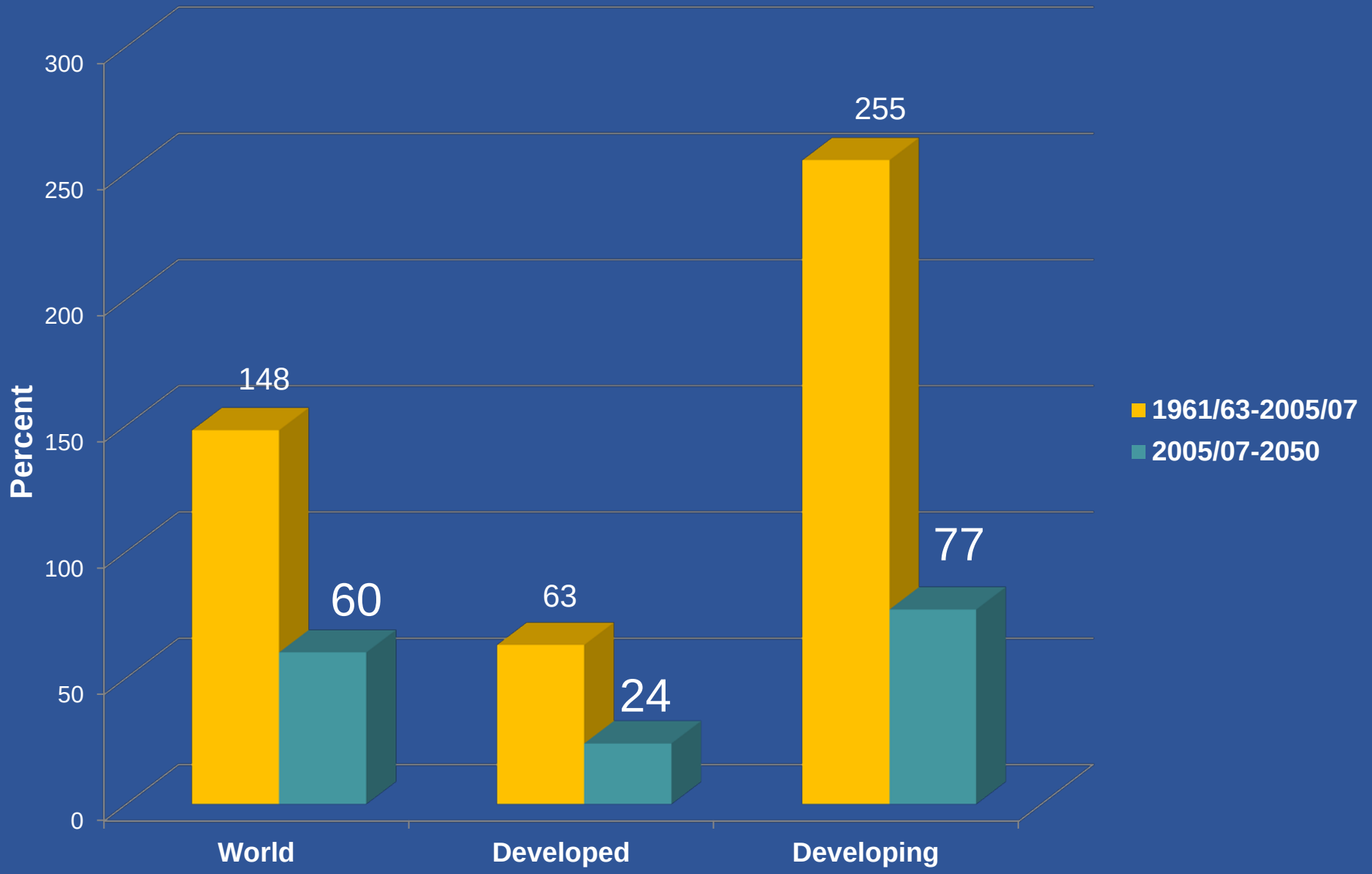
Impacts on
FOOD AVAILABILITY & PRODUCTION

Energy and Protein Content of the Diet, Total Availability (1961-2080)



Source: AT2050/80, Josef Schmidhuber, 2011

Past and projected increase in food production

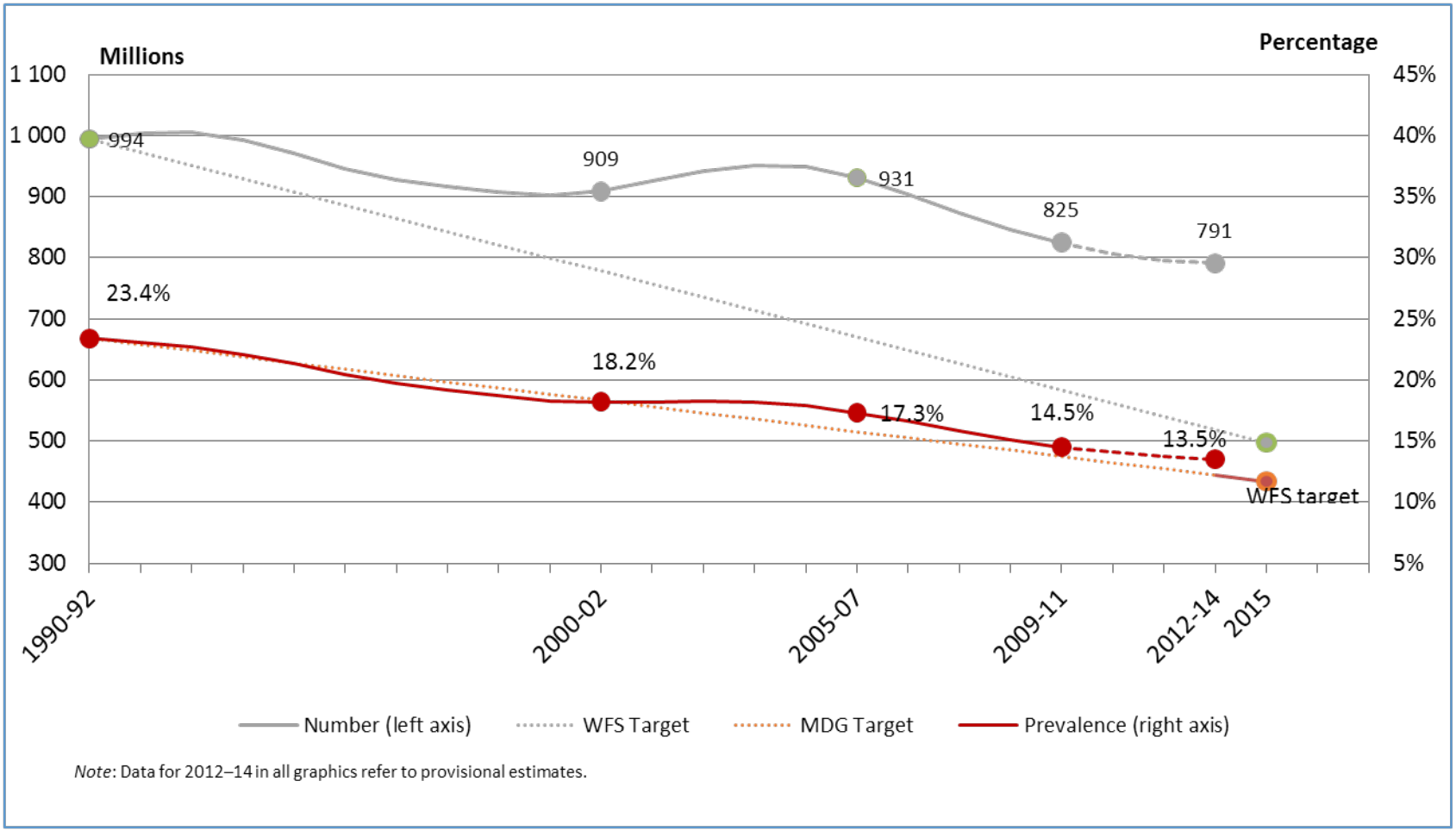


Impacts of change

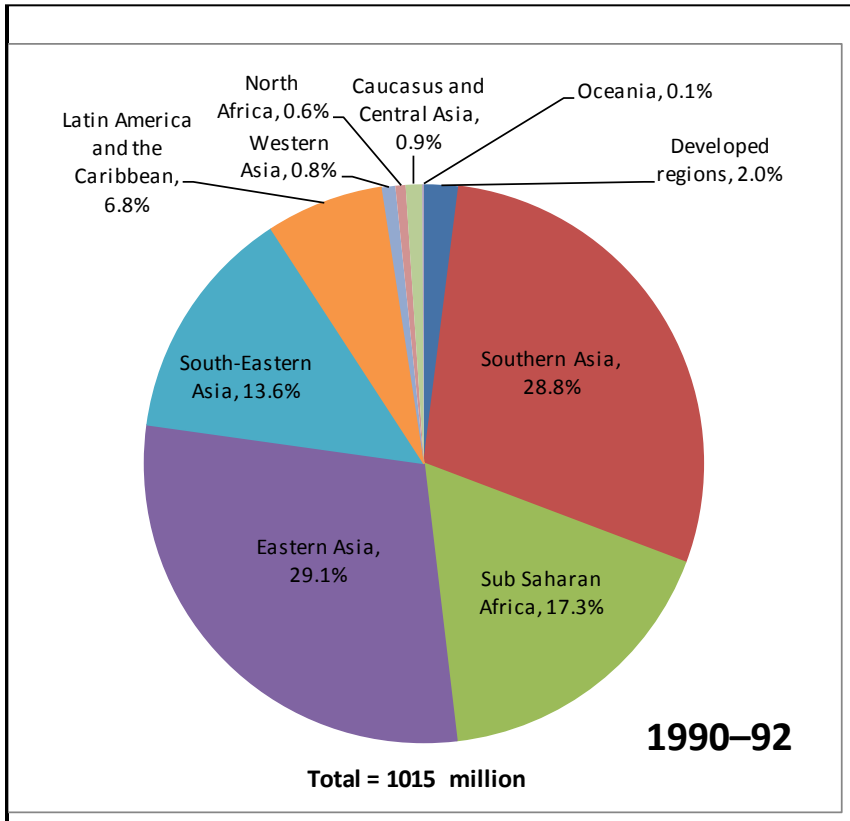
HUNGER & MALNUTRITION

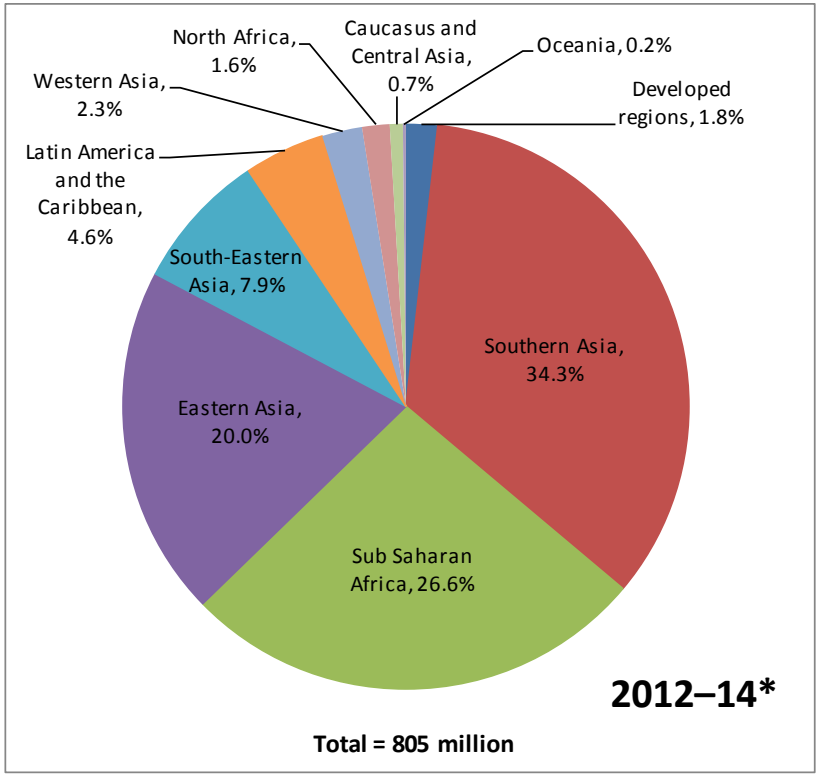
The Hunger targets

- The MDG one hunger target can be reached, with additional efforts
- The WFS goal is out of reach:

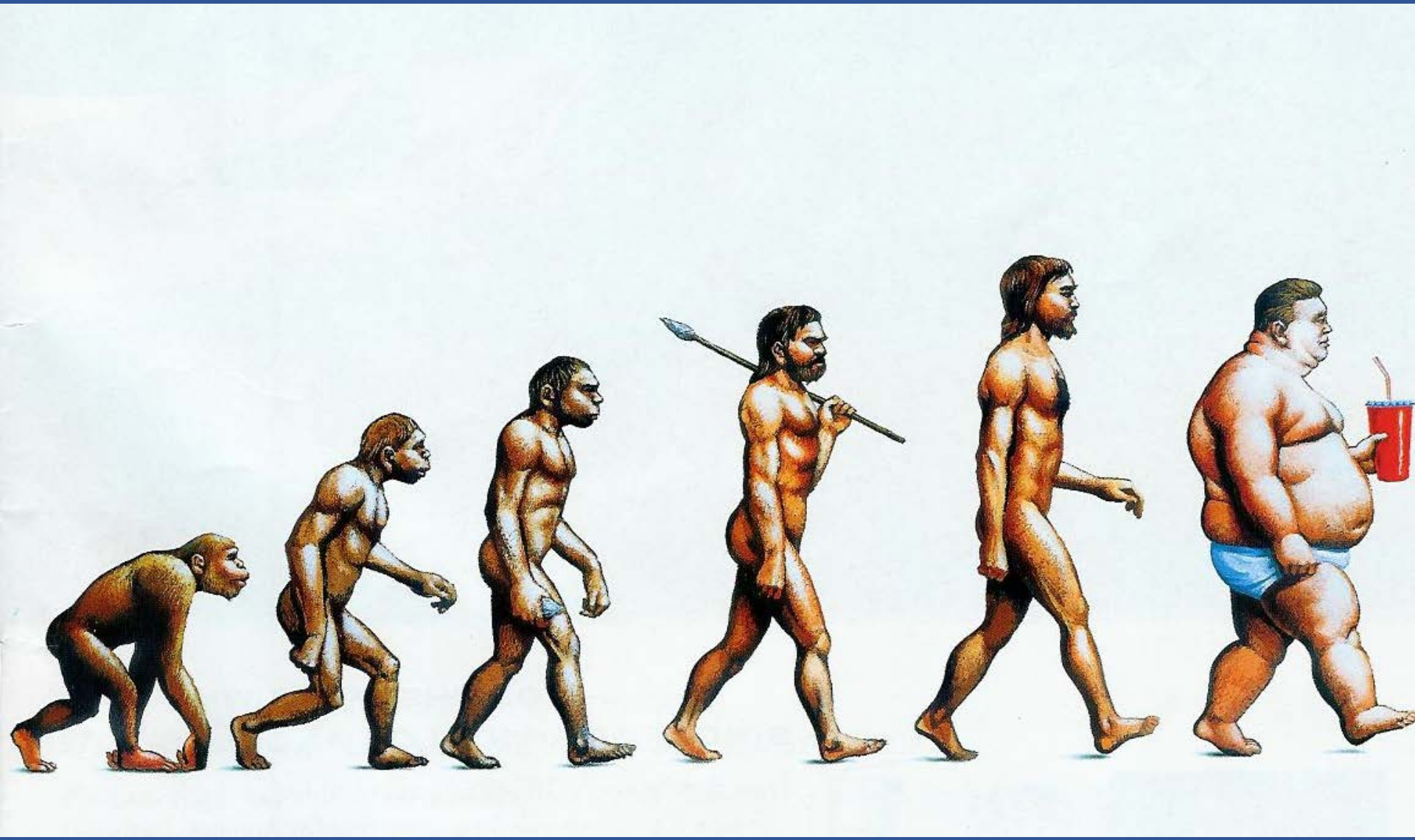


The changing distribution of hunger in the world, 1990–2014





The shape of things to come?



The Economist, December 2003

Provisional nutritional outcomes (global averages/aggregates)

	undernourished		% of population with kcal/person/day		obese	
	%	million	>2700	>3000	%	million
2012/14	11	805	57	28	8	570
2050	4	330	91	52	15	1400
2080	2	150	98	66	21	2000

Impacts of

Bioenergy and new Demands

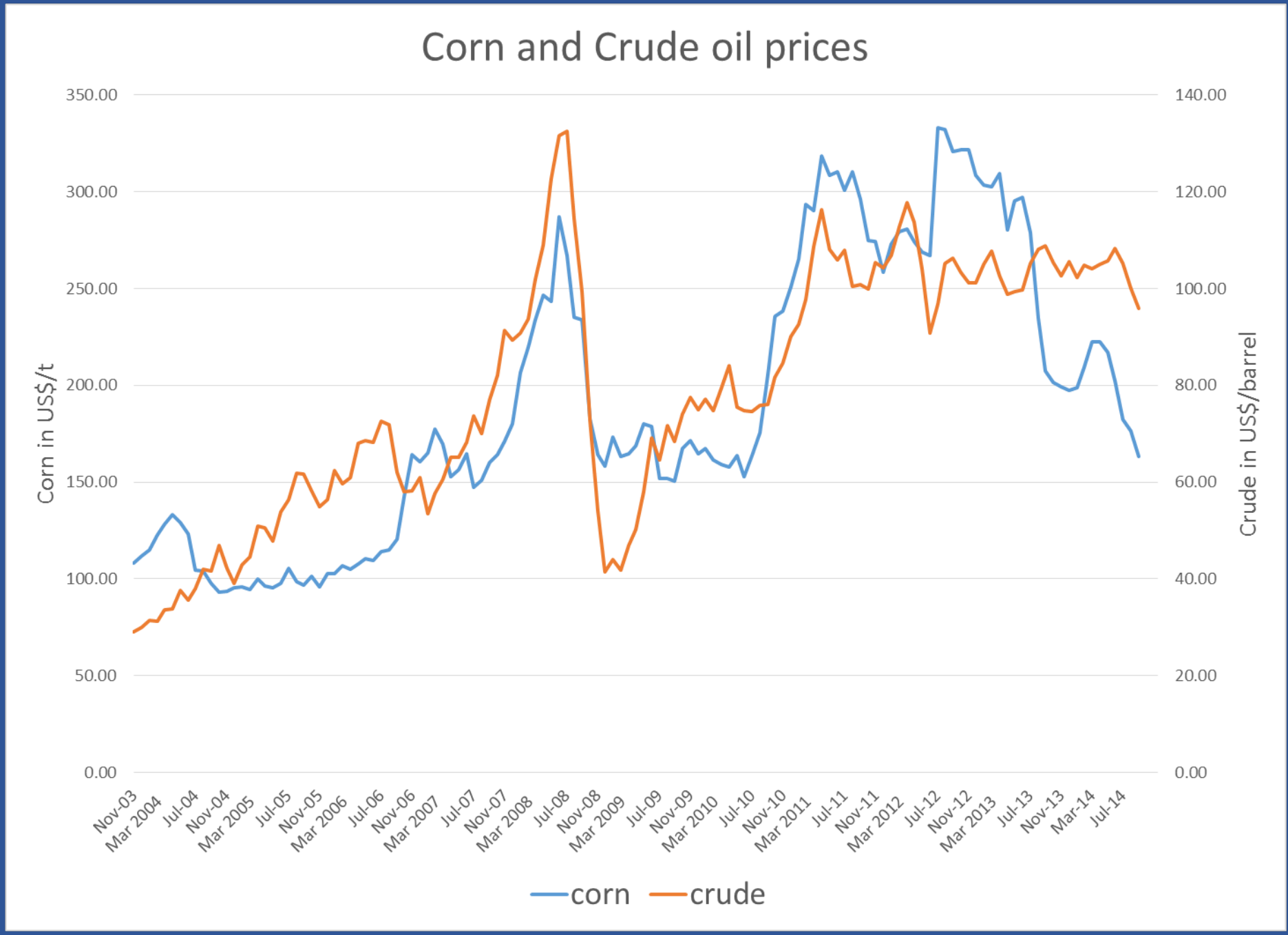
How big is the energy market?

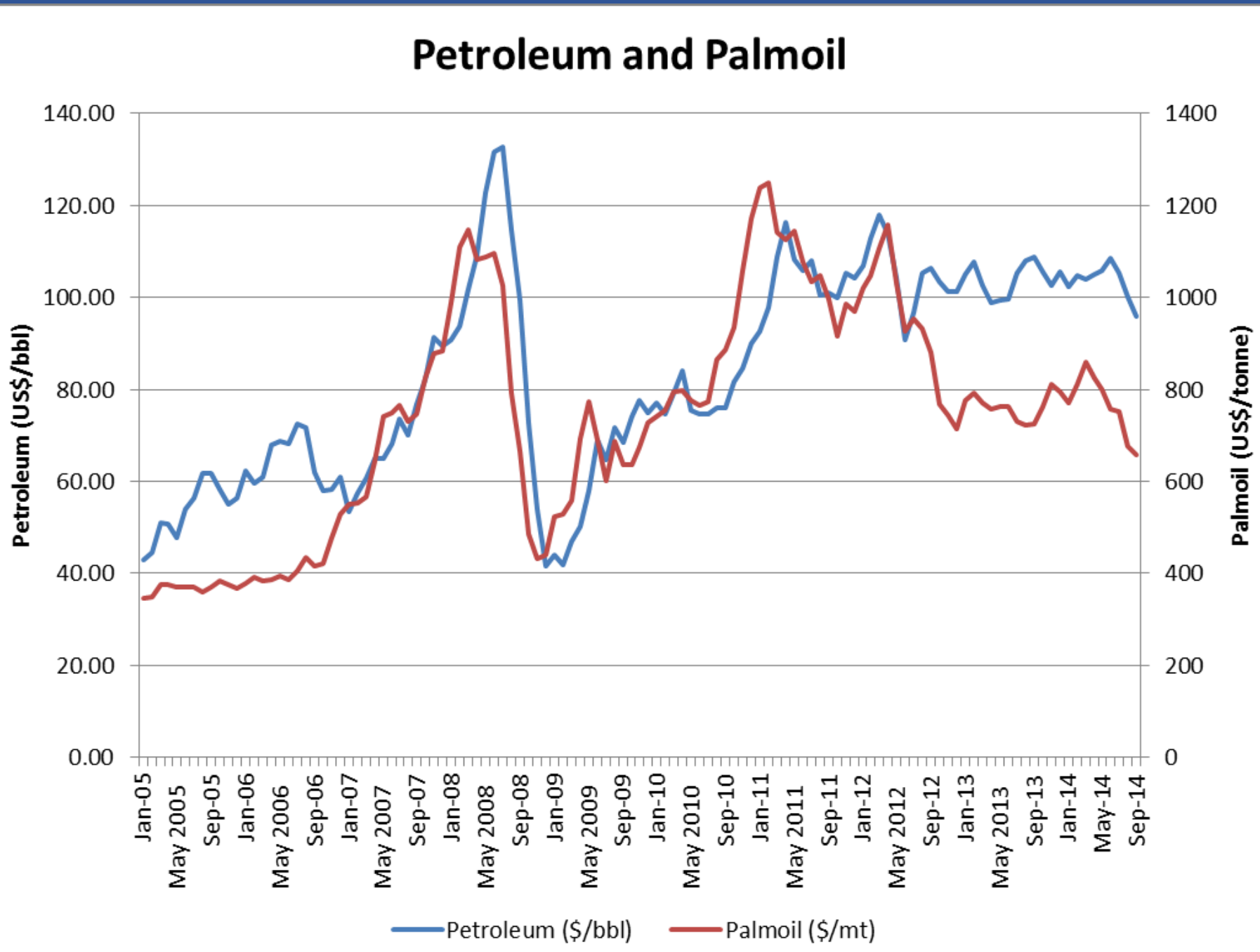
1. Energy market (TPES): nearly 500 EJ
2. Biomass: 50 EJ (80% in developing countries)
3. Biofuels: 3.3 EJ, on ca. 33 million ha
4. Transport energy needs: ca. 95 EJ
5. Crop area to cover transport energy needs: >1000 million ha, i.e. 2/3 of global crop area.

=> Energy market ispotentially large, creates perfectly elastic demand for agricultural produce up to break-even points (parity prices).

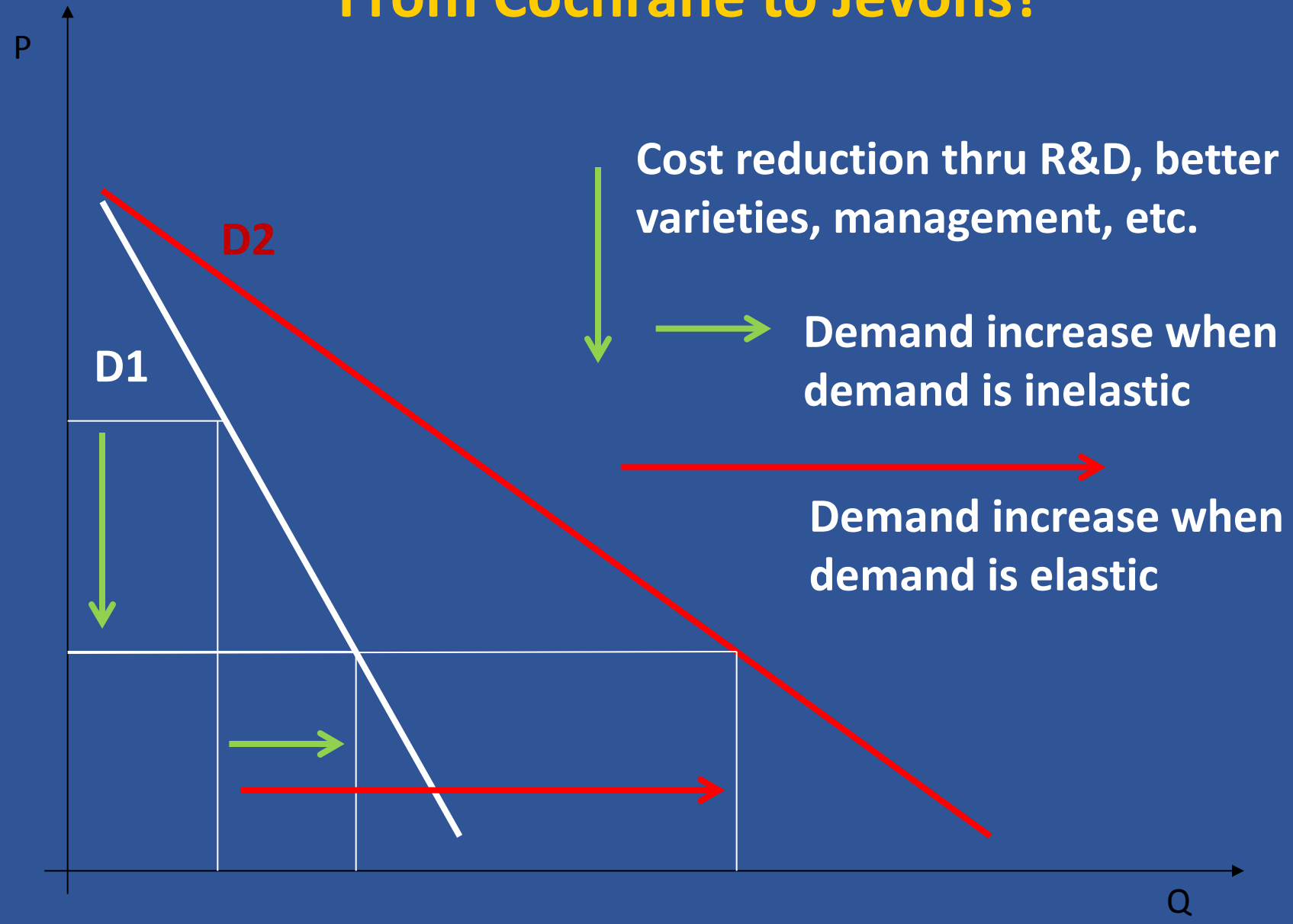
=> Blendwalls reached for ethanol in the US and approached for biodiesel in the EU. Saturation without further subsidies or lifting blendwalls

=> Bio-energy subsidies have a price supporting impact, not price depressing as the traditional coupled agricultural subsidies. No WTO pressure to reduce/eliminate them


Corn and Crude oil prices
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
Corn in US$/t
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Crude in US$/barrel
Nov-03
Mar 2004
Jul-04
Nov-04
Mar 2005
Jul-05
Nov-05
Mar 2006
Jul-06
Nov-06
Mar 2007
Jul-07
Nov-07
Mar 2008
Jul-08
Nov-08
Mar 2009
Jul-09
Nov-09
Mar 2010
Jul-10
Nov-10
Mar 2011
Jul-11
Nov-11
Mar 2012
Jul-12
Nov-12
Mar 2013
Jul-13
Nov-13
Mar-14
Jul-14
corn
crude


Petroleum and Palmoil
Petroleum (US$/bbl)
Palmoil (US$/tonne)
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
1400
1200
1000
800
600
400
200
0
Jan-05
May 2005
Sep-05
Jan-06
May 2006
Sep-06
Jan-07
May 2007
Sep-07
Jan-08
May 2008
Sep-08
Jan-09
May 2009
Sep-09
Jan-10
May 2010
Sep-10
Jan-11
May 2011
Sep-11
Jan-12
May 2012
Sep-12
Jan-13
May 2013
Sep-13
Jan-14
May-14
Sep-14
Petroleum ($/bbl)
Palmoil ($/mt)

From Cochrane to Jevons?

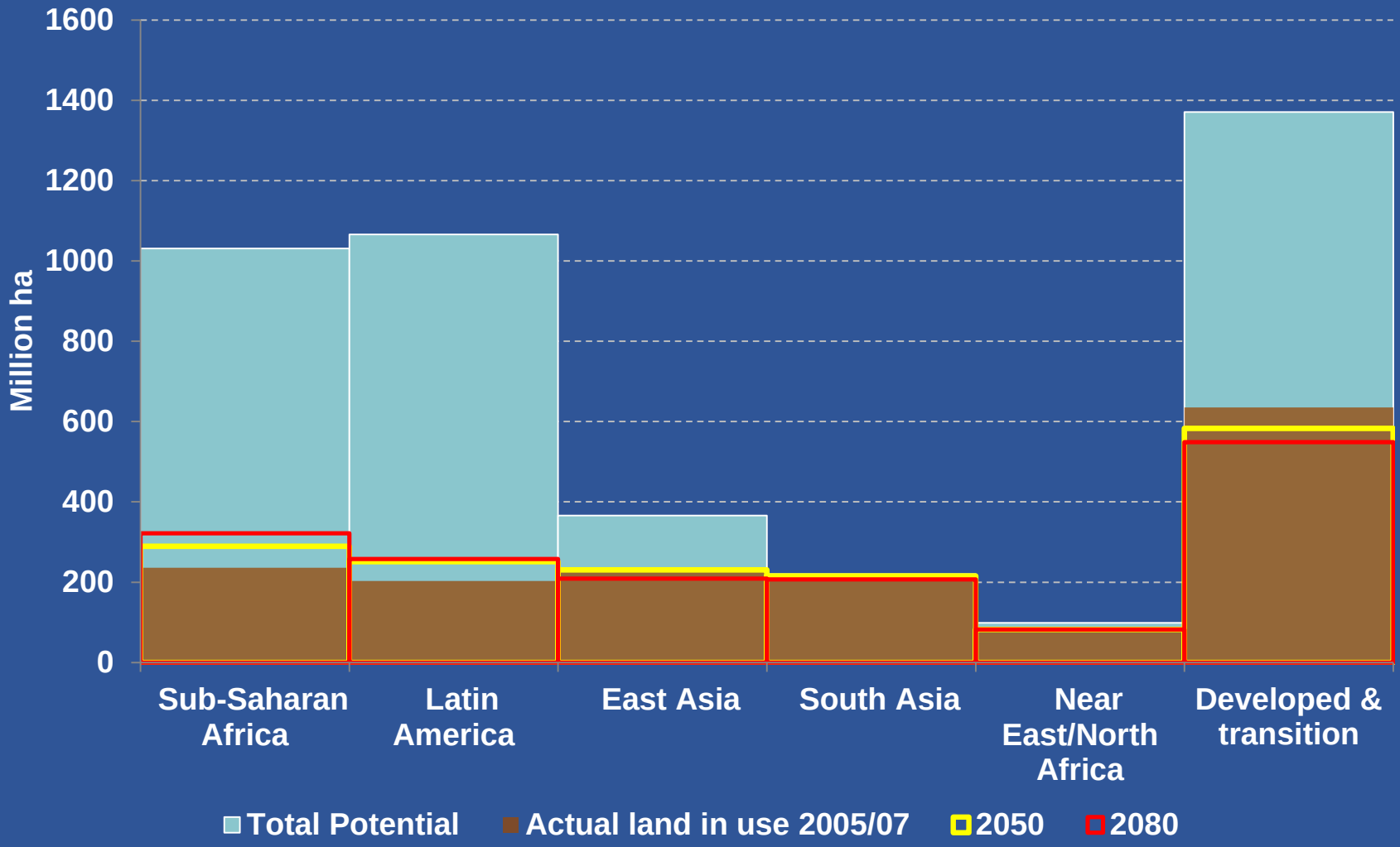


Impacts of change

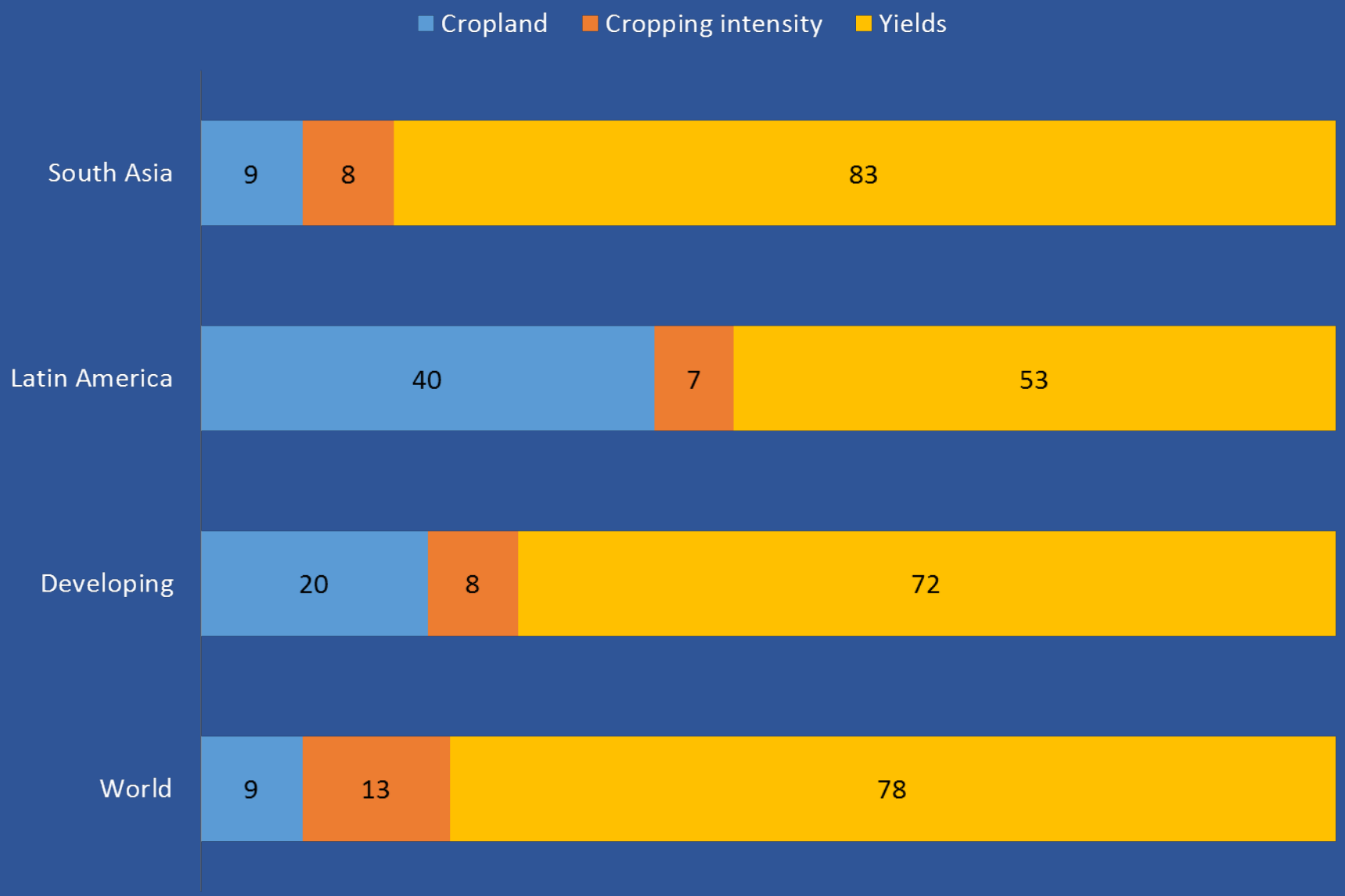
RESOURCES & ENVIRONMENT


there enough cropland
nd enough yield potential?

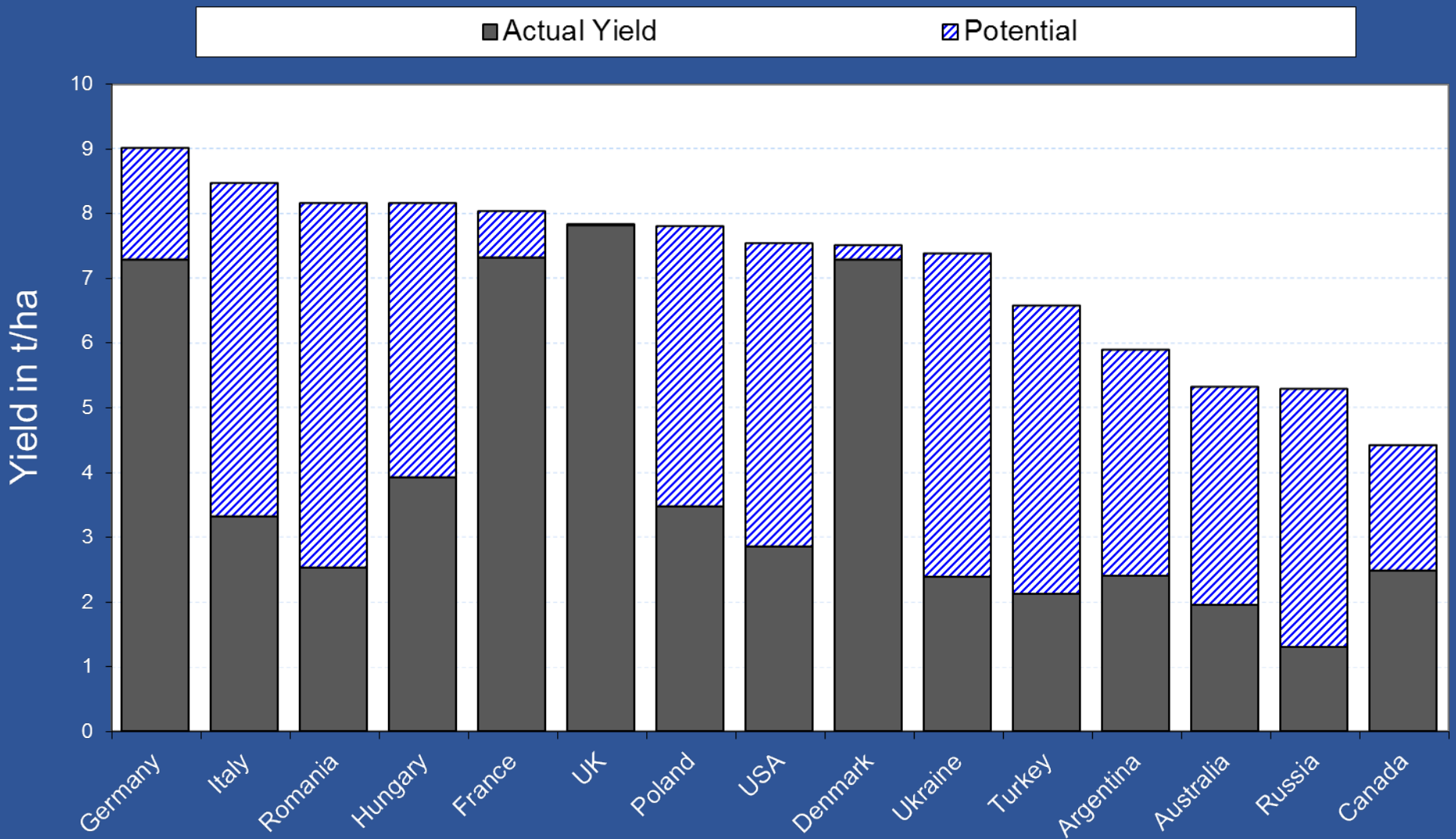
Cropland potential and actual use 2005/07, 2050 and 2080



Sources of growth (%): 2005/07-2050



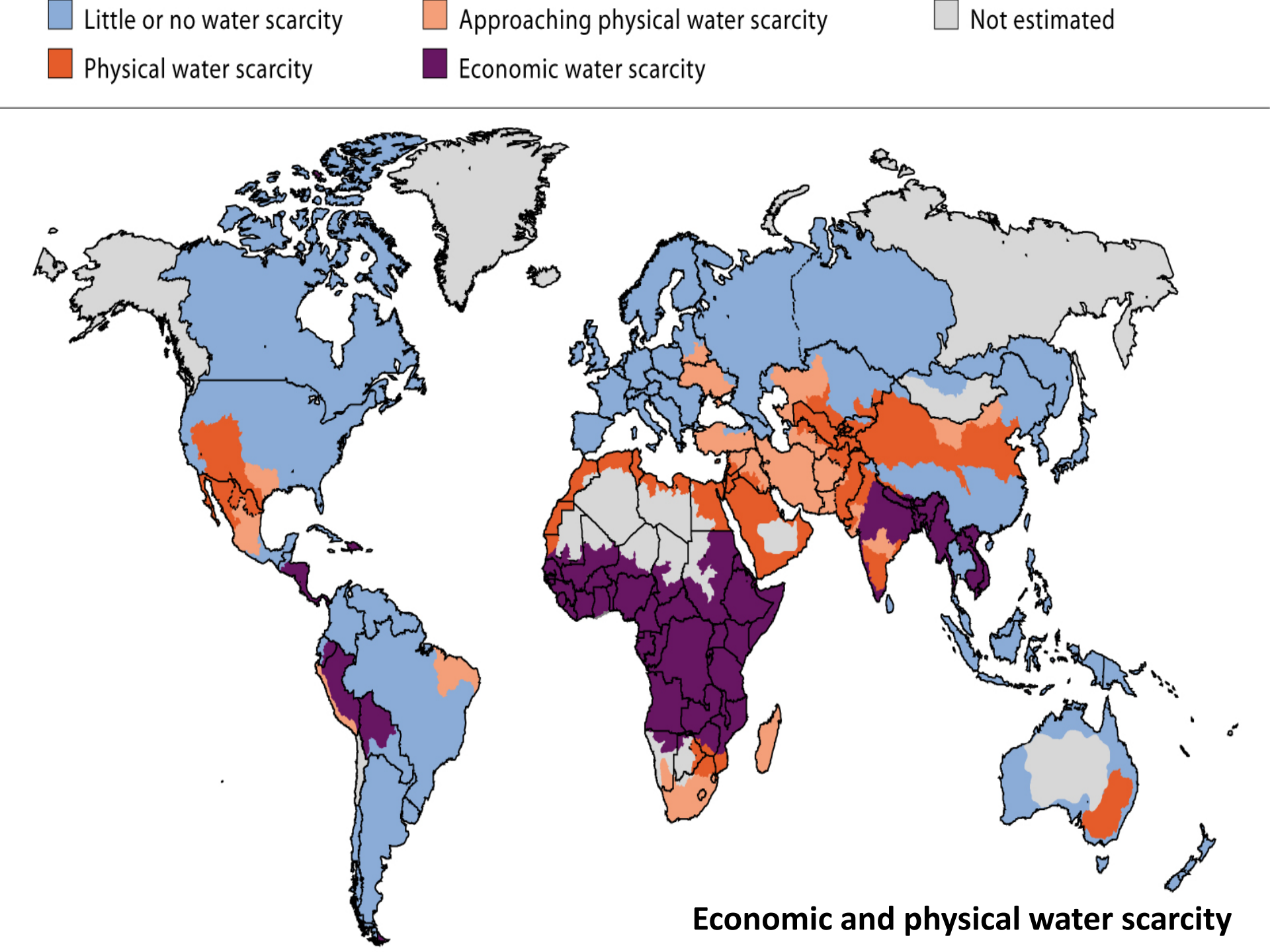
Actual (1996/2000) and potential wheat yields for intensive production systems



Impacts of change

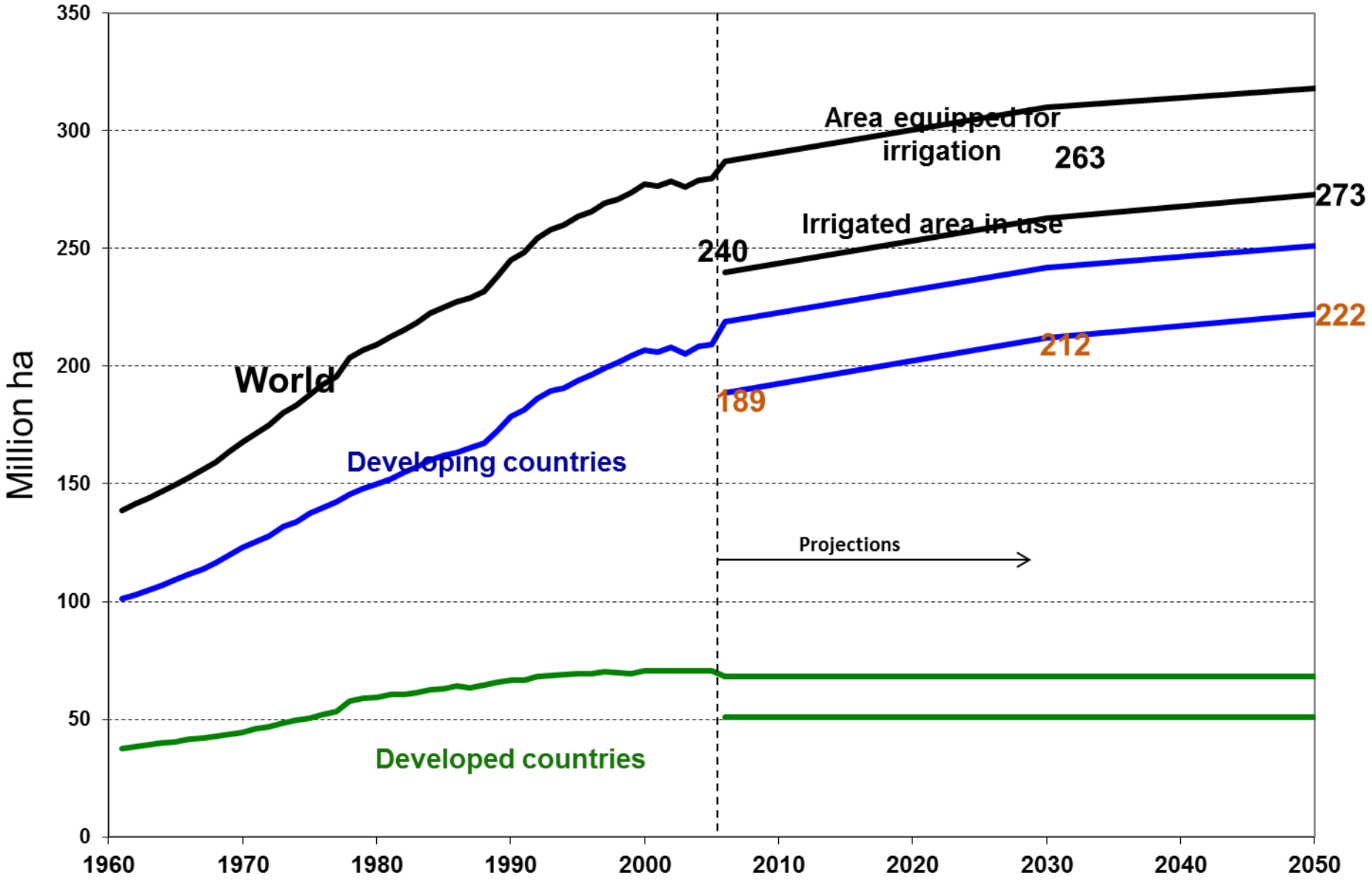
RESOURCES & ENVIRONMENT

Is there enough water?



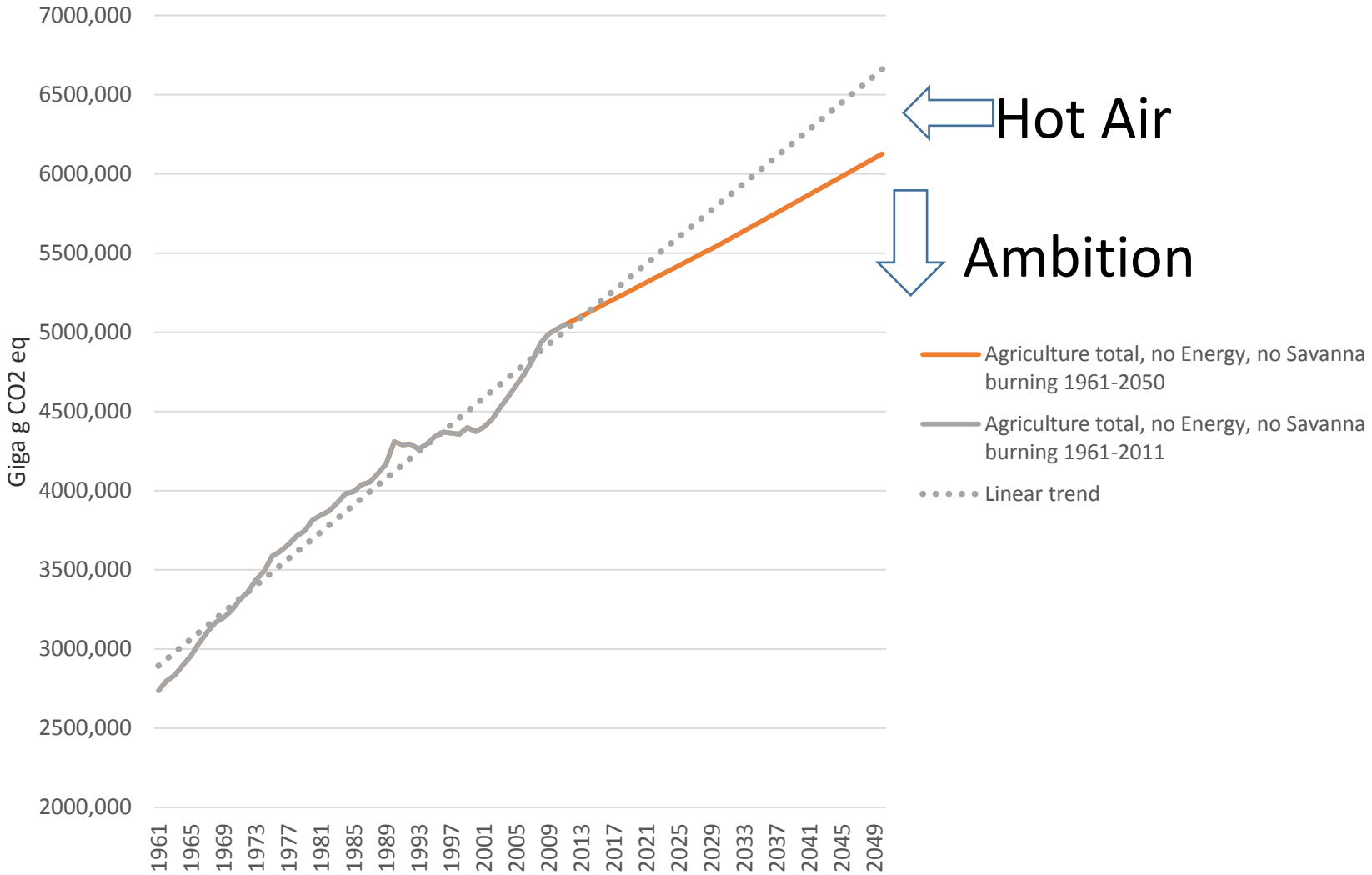
Economic and physical water scarcity

Area equipped for irrigation and irrigated area in use

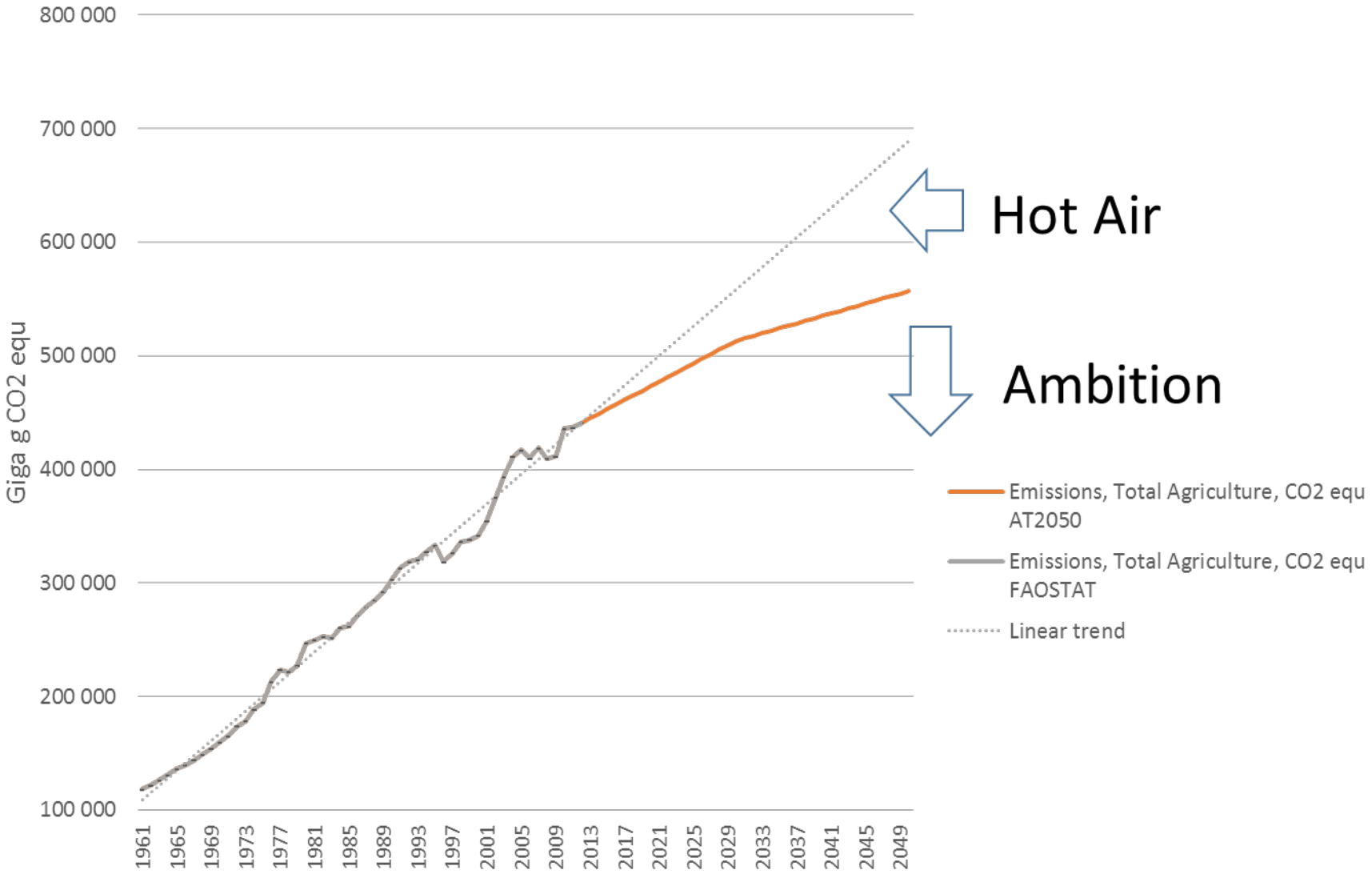



What does agriculture contribute to GHG emissions?

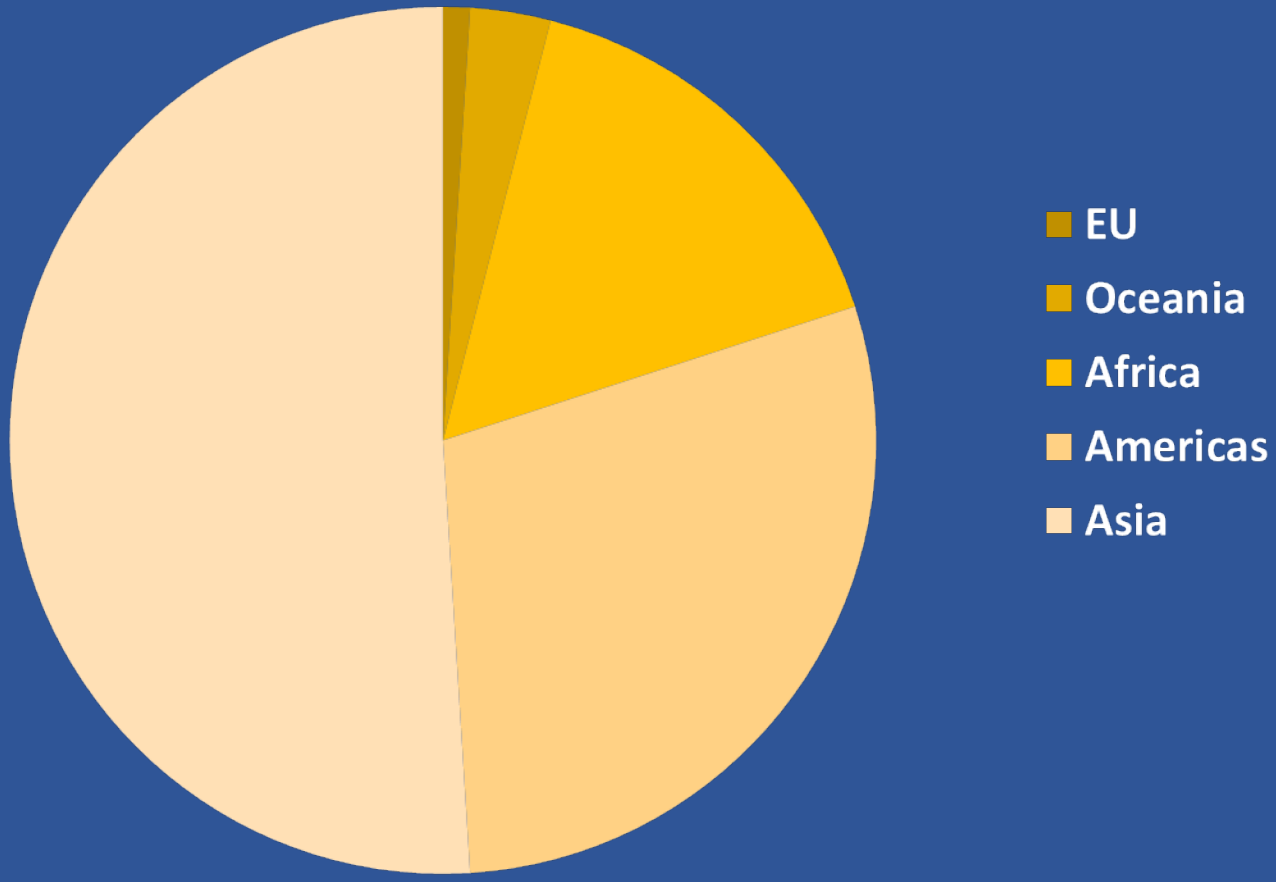
GHG baseline, World: continuing a past trend vs actual projections to 2050



GHG baseline, "B-country": continuing a past trend vs actual projections to 2050

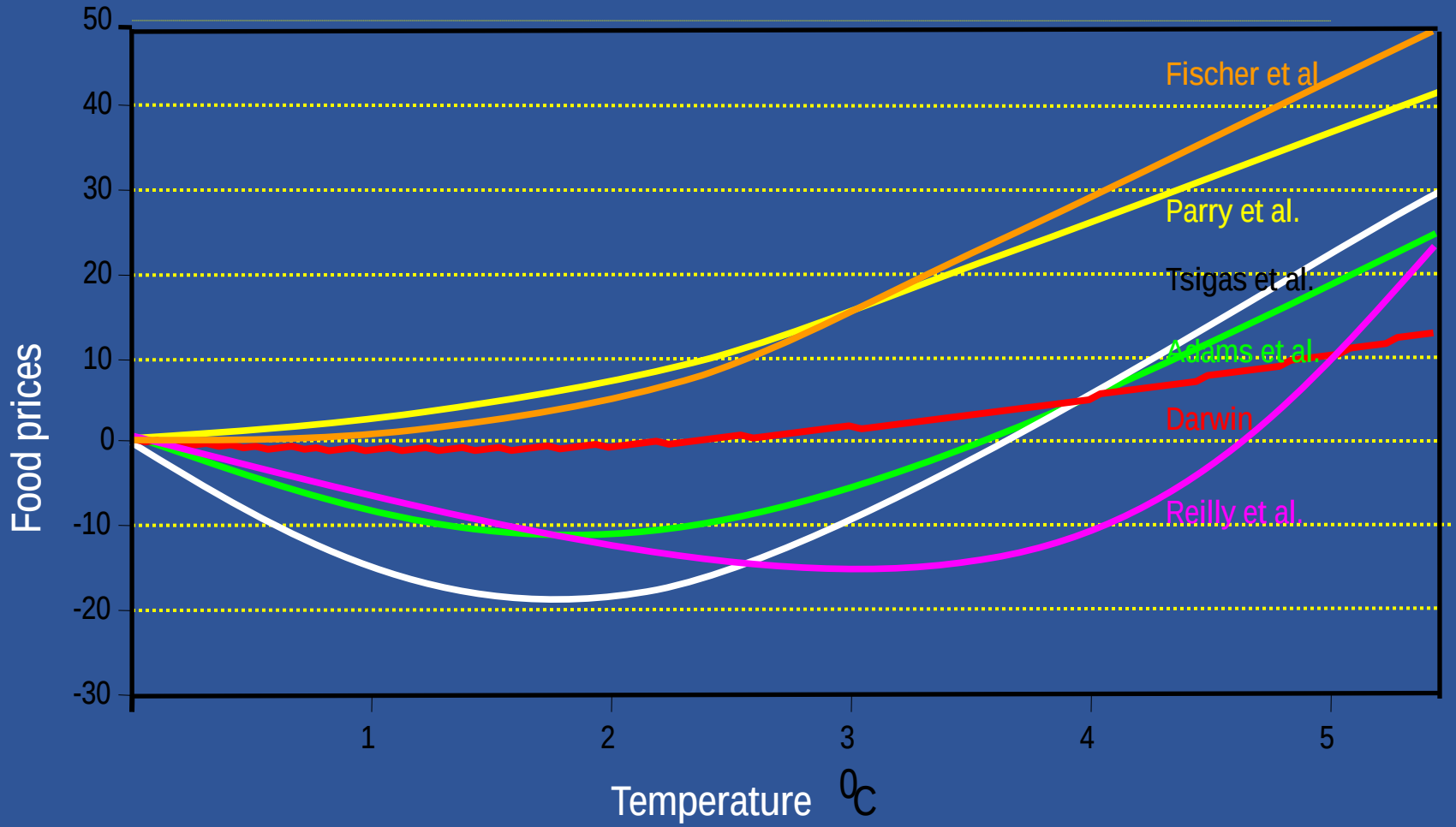


Share of additional CO2 Emissions from Agriculture, 2010-2050




How does Climate Change affect agriculture and food security?

Percentage change in world food (cereal) prices in relation to changes in temperatures



Source: IPCC, AR4

Table 1. The impacts of climate change and socio-economic development paths on the number of people at risk of hunger in developing countries

	No. of people at risk of hunger in developing countries, in millions					
	Year 2020		Year 2050		Year 2080	
Scenario	AEZ-BLS	DSSAT-BLS	AEZ-BLS	DSSAT-BLS	AEZ-BLS	DSSAT-BLS
Reference						
A1	663	663	208	208	108	108
A2	782	782	721	721	768	769
B1	749	749	239	240	91	90
B2	630	630	348	348	233	233
CC						
A1	666	687	219	210	136	136
A2	777	805	730	722	885	742
B1	739	771	242	242	99	102
B2	640	660	336	358	244	221
CC, no CO_2						
A1	NA	726	NA	308	NA	370
A2	794	845	788	933	950	1,320
B1	NA	792	NA	275	NA	125
B2	652	685	356	415	257	384

1. Improvements over time
2. CC is bad for FS
3. SRES>>CC
4. CO2 fertilization is important


How do we model the impacts of Climate Change on agriculture and food security?

What we are modelling:

20 agro-meteorological to agro-ecological combinations

Representative Concentration Pathways

Climate models	RCP2.6	RCP4.5	RCP6.0	RCP8.5
GFDL	✓	✓	✓	✓
HadGEM2	✓	✓	✓	✓
IPSL	✓	✓	✓	✓
MIROC	✓	✓	✓	✓
NorESM	✓	✓	✓	✓

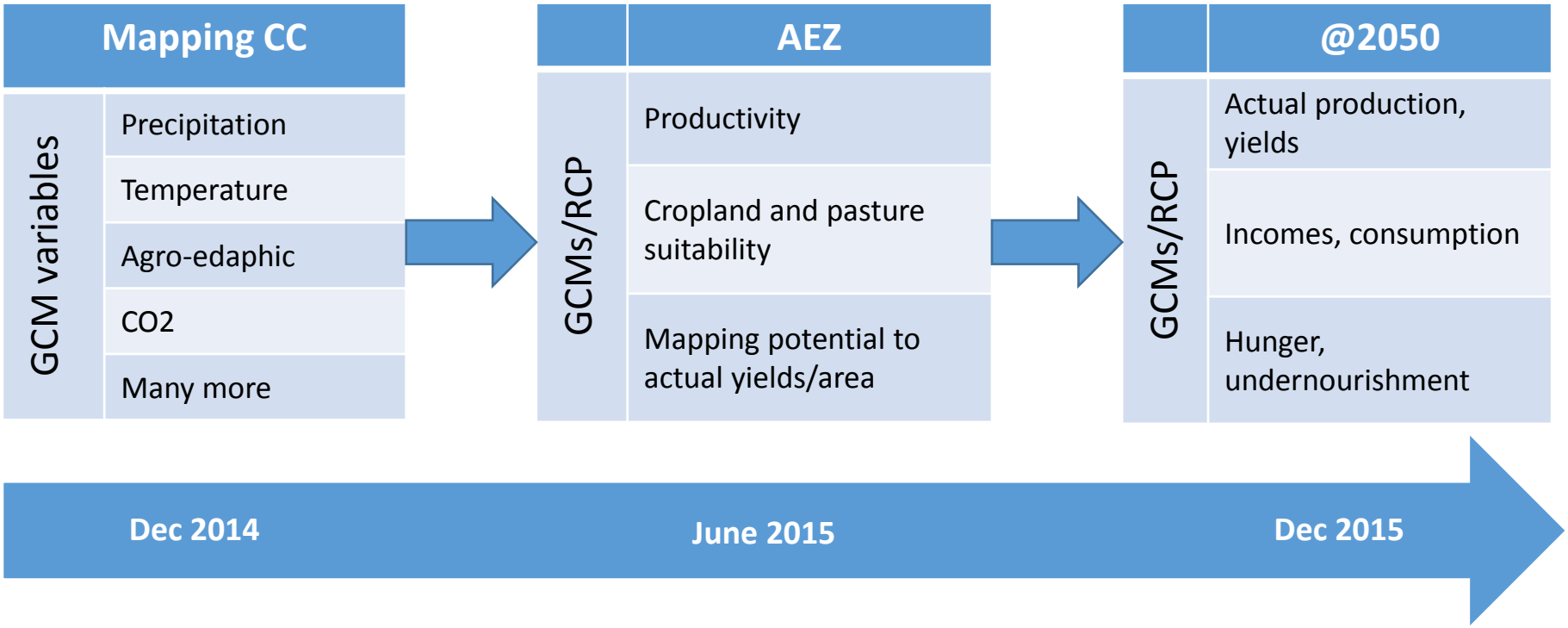
GCMs

How we are going to estimate impacts of Climate Change

1. Changing Climate

2. Changing agro-ecology

3. Changing agro-economy



CC and Food Security: The Stability Dimension
How we are going to estimate impacts of extreme weather events?

1. Changing Climate

2. Changing agro-ecology

3. Changing agro-economy

Mapping CC	
GCM variables	Extreme weather events
	Droughts, Floods
	Hurricanes, Typhoons, Tornados
	Frequency, duration, severity

	AEZ
GCMs/RCP	Productivity, short and long-term
	Marginal land, short and long term
	Suitability, short term and long-term

	Competitive storage model
GCMs/RCP	Price volatility Volatility and production level effects
	Stocks, buffer needs
	Hunger, famine undernourishment

June 2015 — June 2016 — Dec 2016

Overview and Summary

1. Global food demand will continue to rise, albeit at a slower pace (+60% by 2050)
2. In a BAU world, food security will continue to improve, the number of hungry will decline. Ditto for other forms of malnutrition (bar obesity).
3. Higher energy prices or massive climate change could worsen the outlook significantly, particularly for the poor and hungry.
4. The natural resources for such an increase are sufficient globally, but they are already now compromised locally.
5. The growth of GHG emissions from agriculture to decline with growing saturation, important for the definition of GHG targets
6. Climate change affects all dimensions of food security:
   - **Access and utilization:** access to improve with poverty reduction, ditto for utilization, but later and with higher incomes only
   - **Availability:** no global, but **local** challenges
   - **Stability**: the most severe challenge of CC on FS, coping with extreme weather events needs early policy action and decisions, not only for FS

THANKS