

Addressing the joint challenges of climate change and food security

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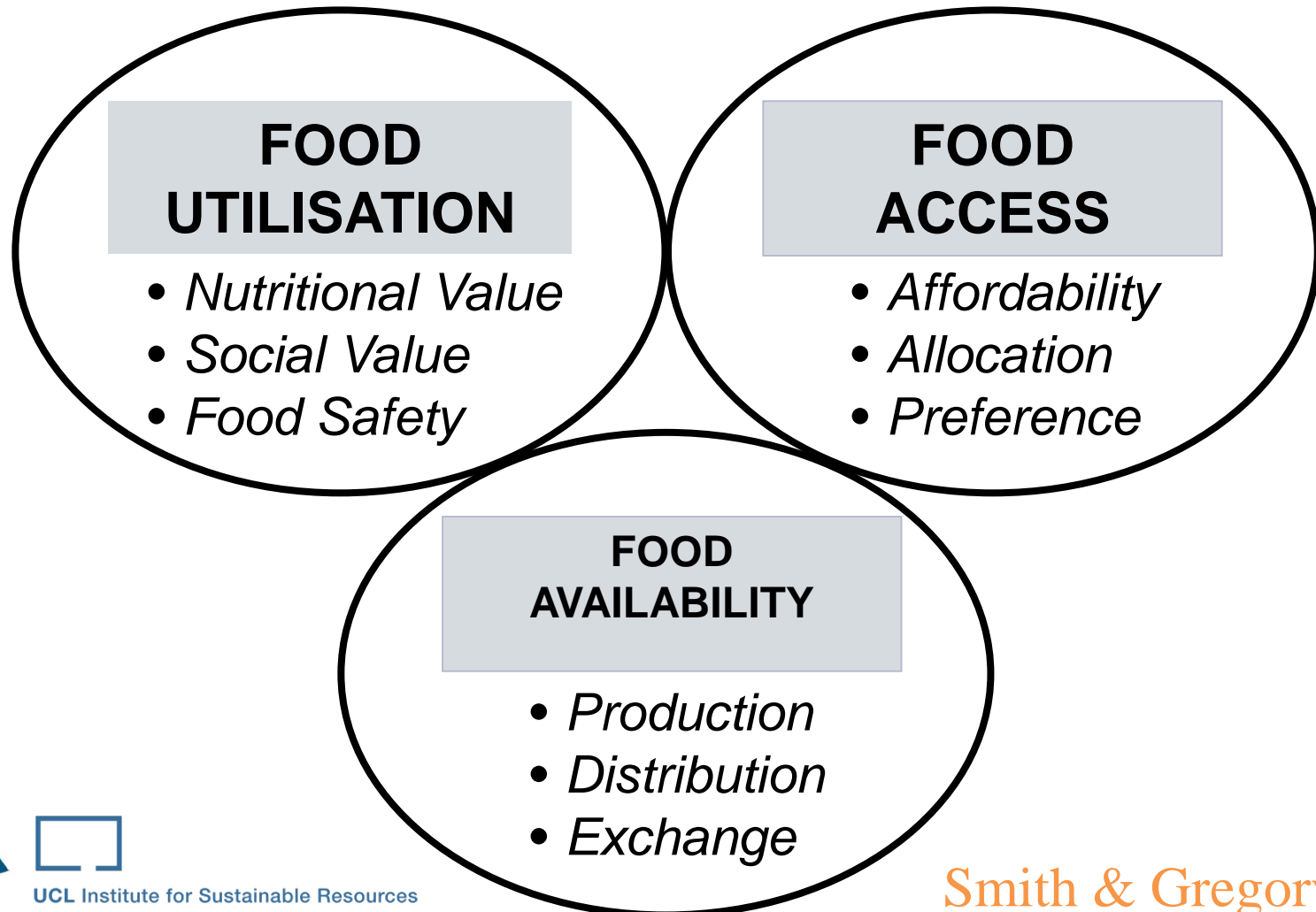
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Food Security

“... exists when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life”.

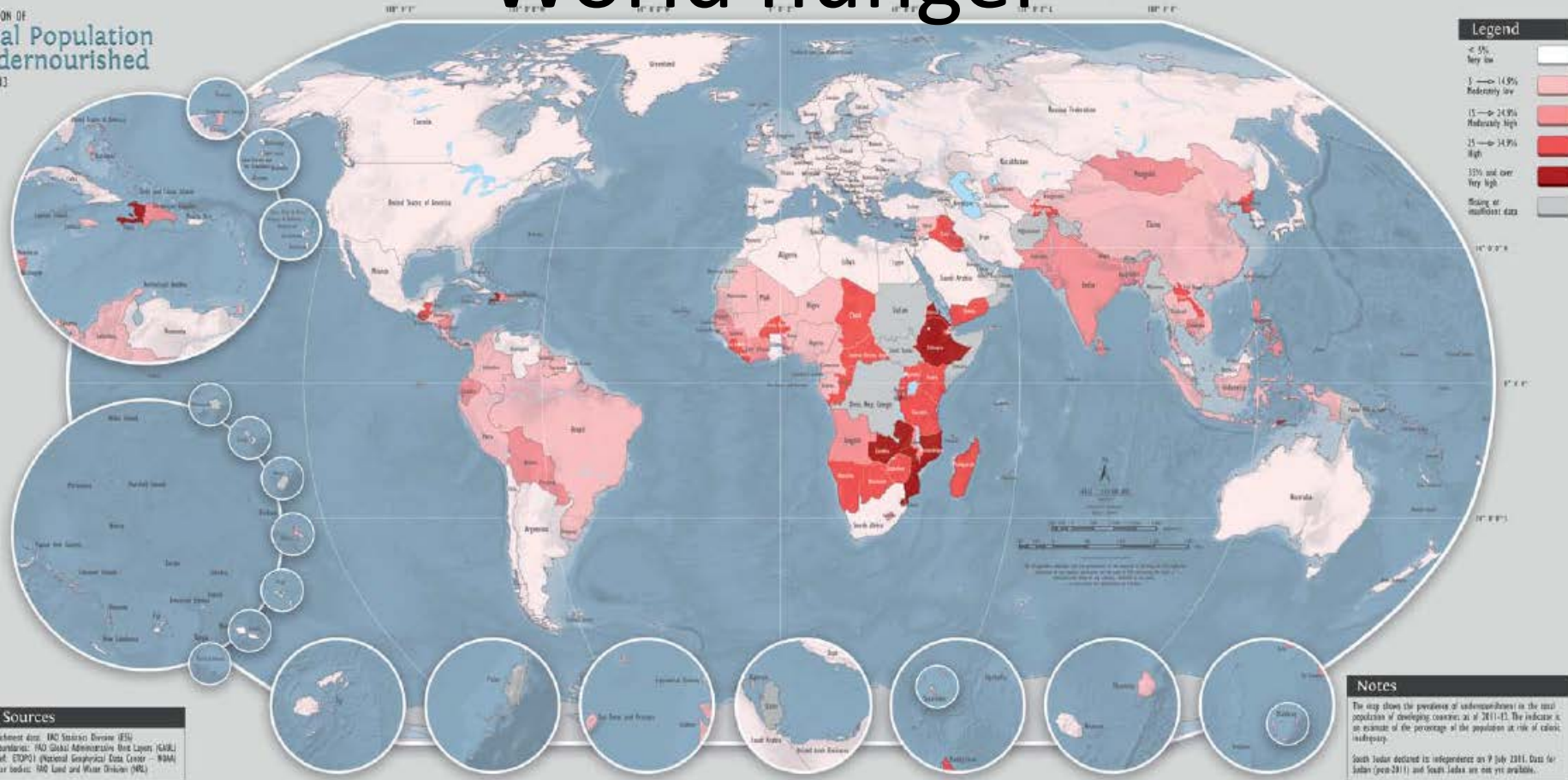
(definition from the 1996 World Food Summit)

3 Components of Food Security *each with Key Elements*



World hunger

PROPORTION OF
Total Population
Undernourished
IN 2011-13



842 million people will go to bed hungry and undernourished tonight





Pour ses cinq enfants, D'jamal a fui la milice du Nord-Est et a cherché refuge dans le camp de réfugiés de l'Onu. En attendant sa femme, il travaille dur pour survivre.

CHAD 230 000 réfugiés de guerre soudanais vivent dans les camps de l'Onu. Chacun a droit

Source: © 2005 PETER MENZEL PHOTOGRAPHY

3,75 € par semaine
pour manger:
des Moutons...
des Allemands...
gourmands...
Les plats favoris?
Nouilles, frites,
pizza, pudding.



ALLEMAGNE 1500 sortes de saucisses, 1200 restaurants McDonald's, 750 millions de kebabs

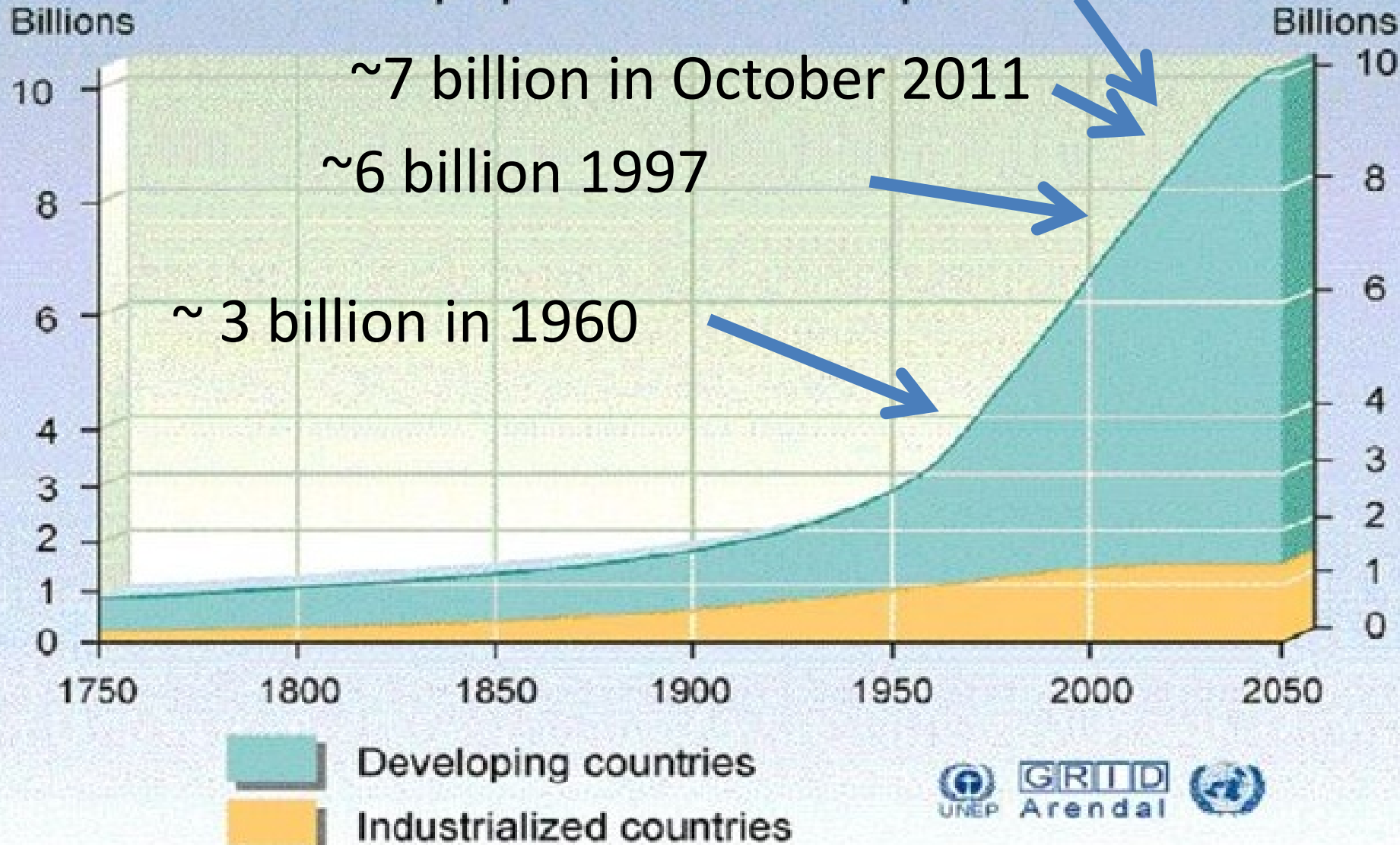
Source: © 2005 PETER MENZEL PHOTOGRAPHY



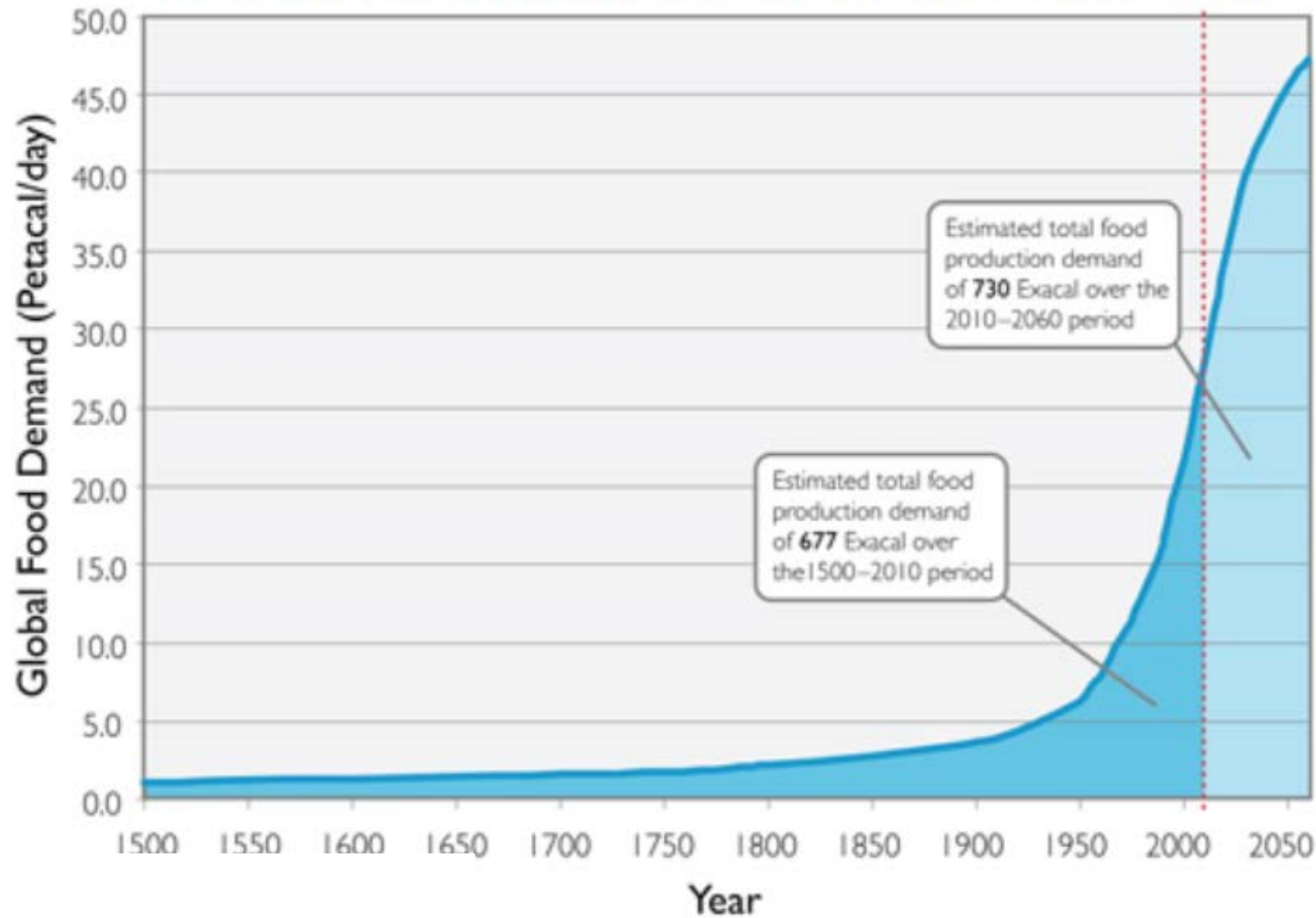
Population growth and dietary change



World population development

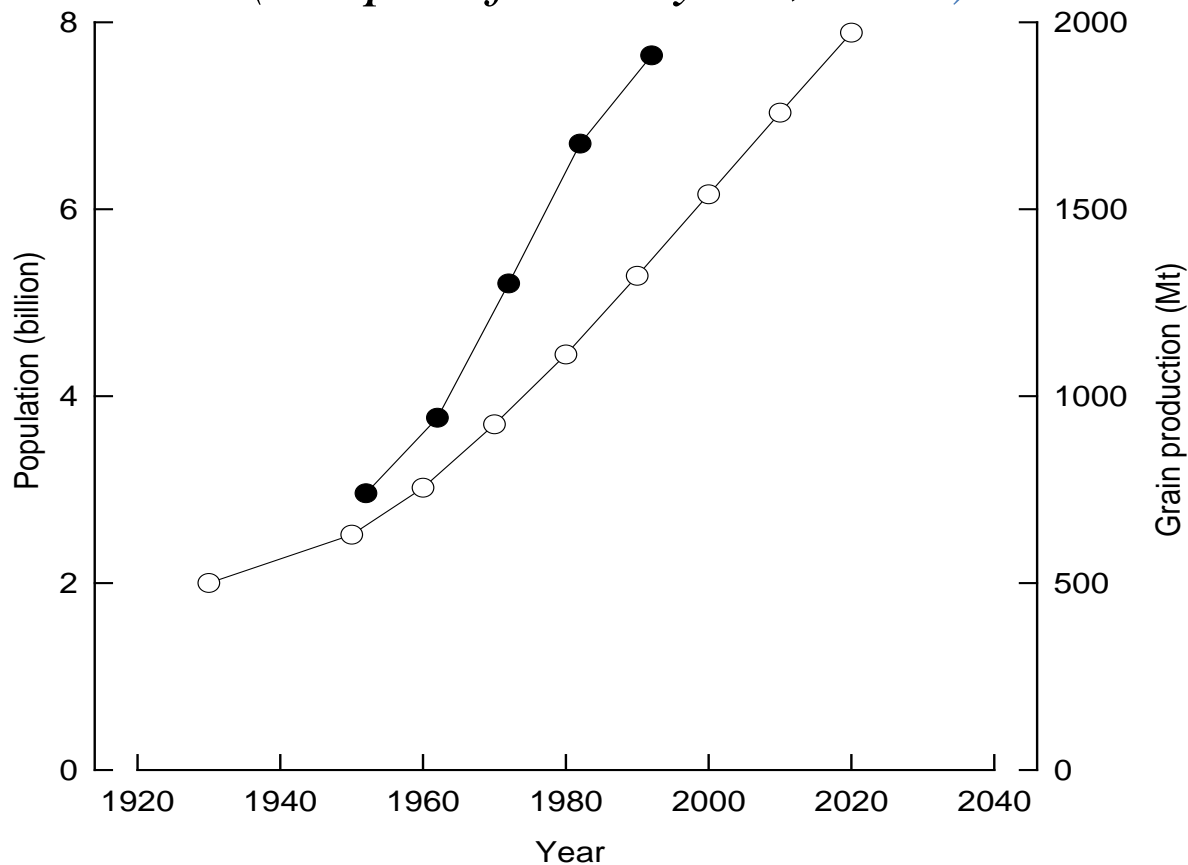


The challenge to produce enough food will be greater over the next 50 years than in all human history



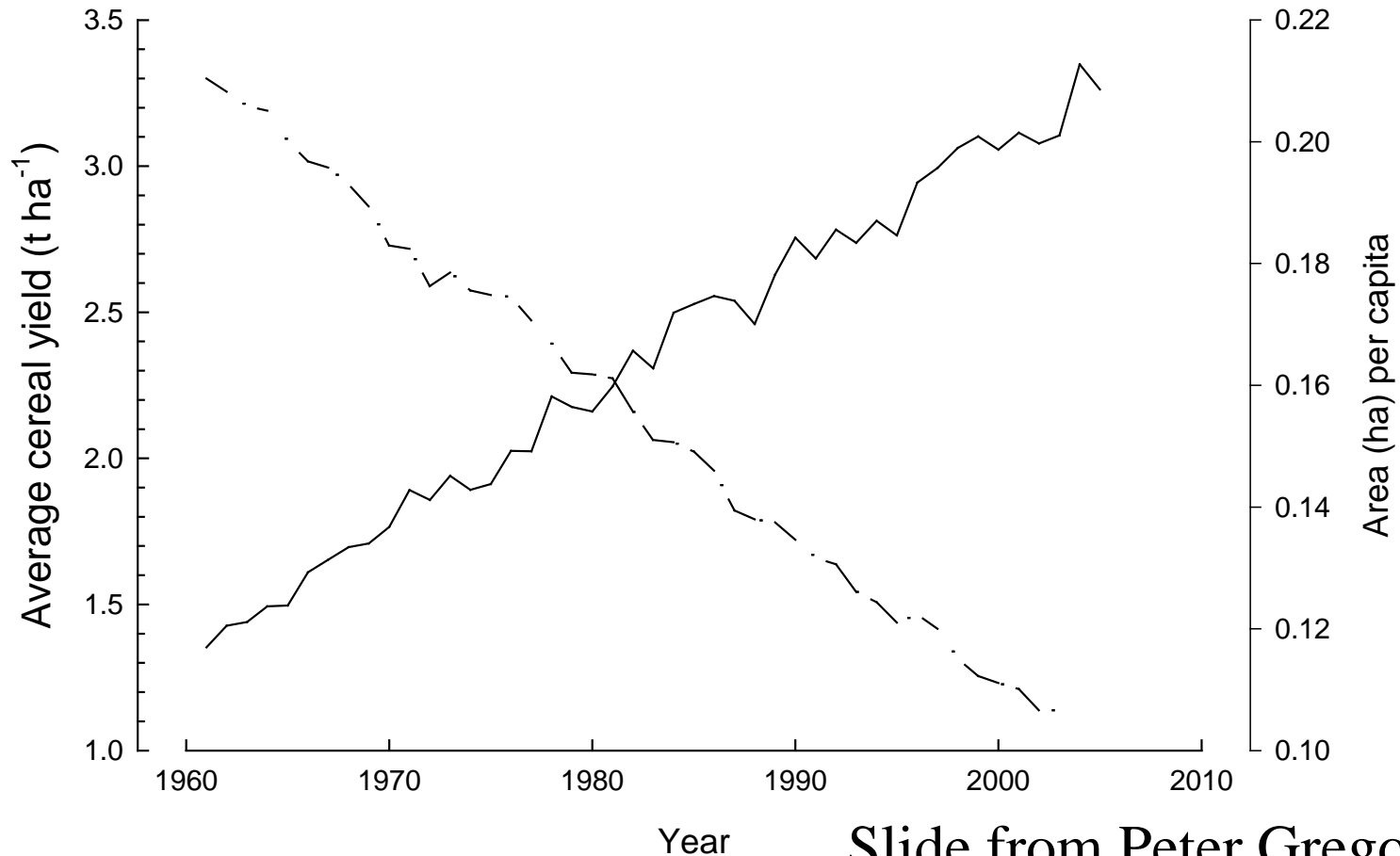
Recorded and projected population (o) and grain production (●)

(adapted from Dyson, 1996)



World cereal yield and area harvested per capita

(extended from Dyson, 1996)

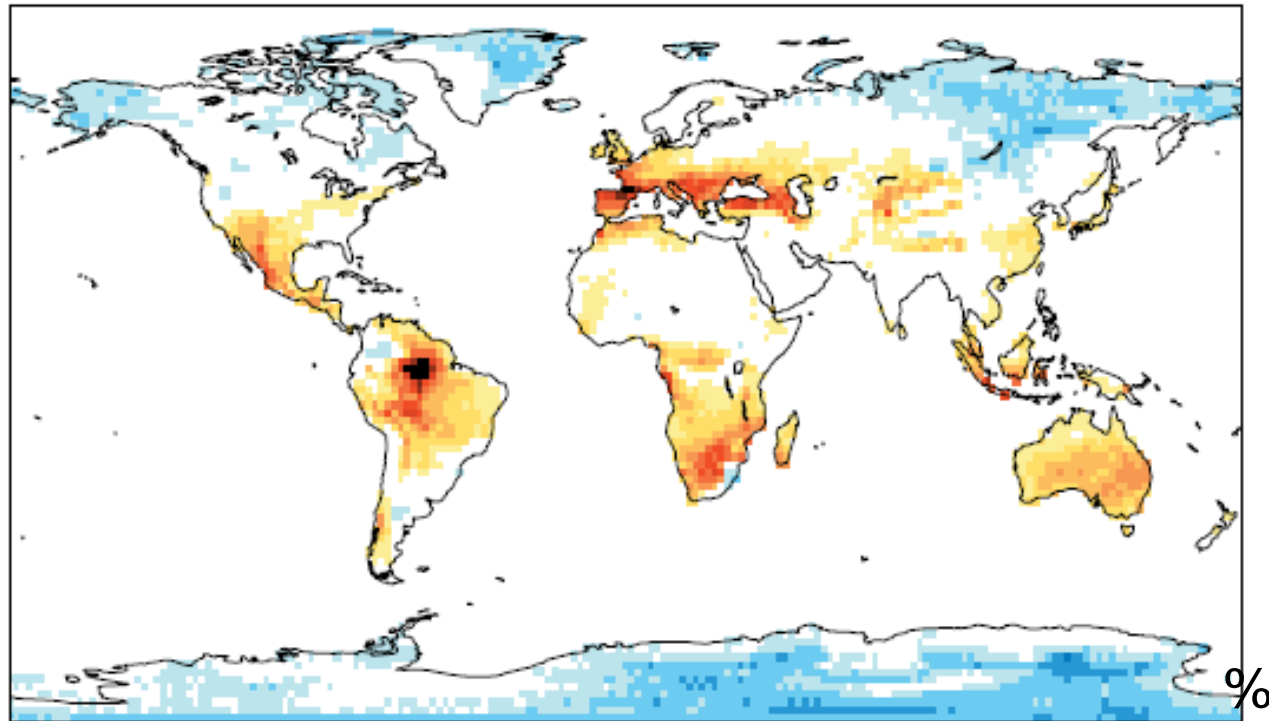




Climate change impacts on food production

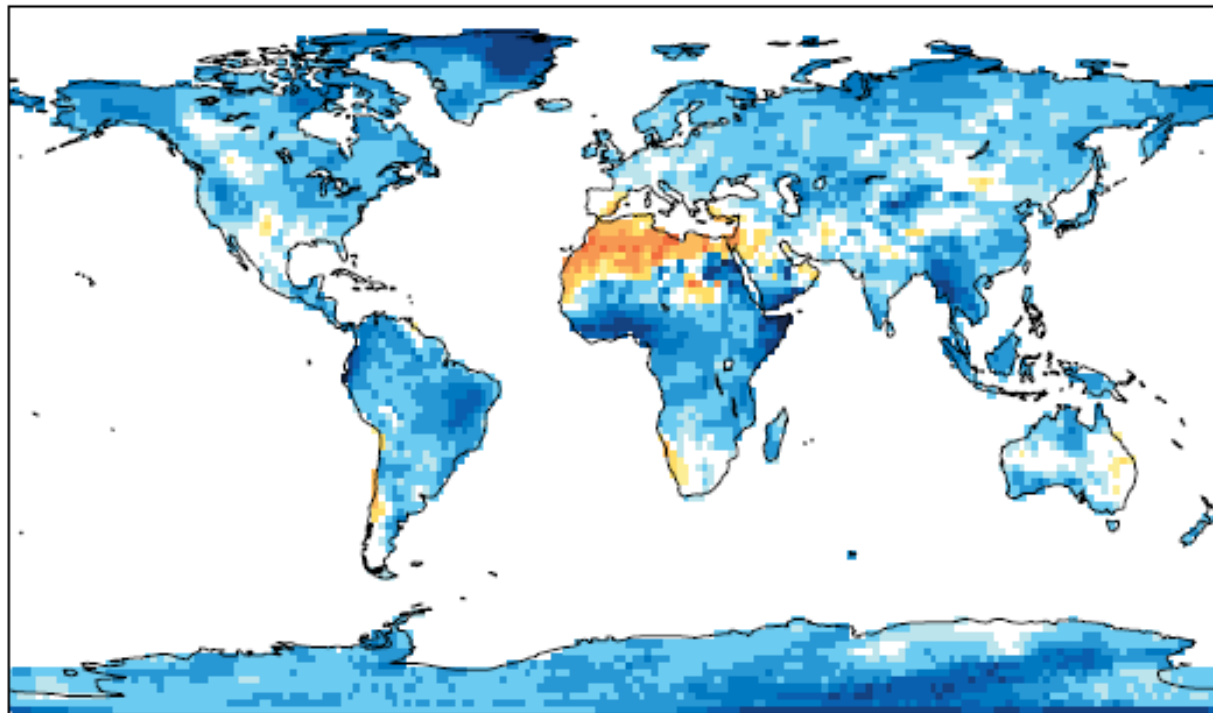


Drought worldwide (IPCC A1B)



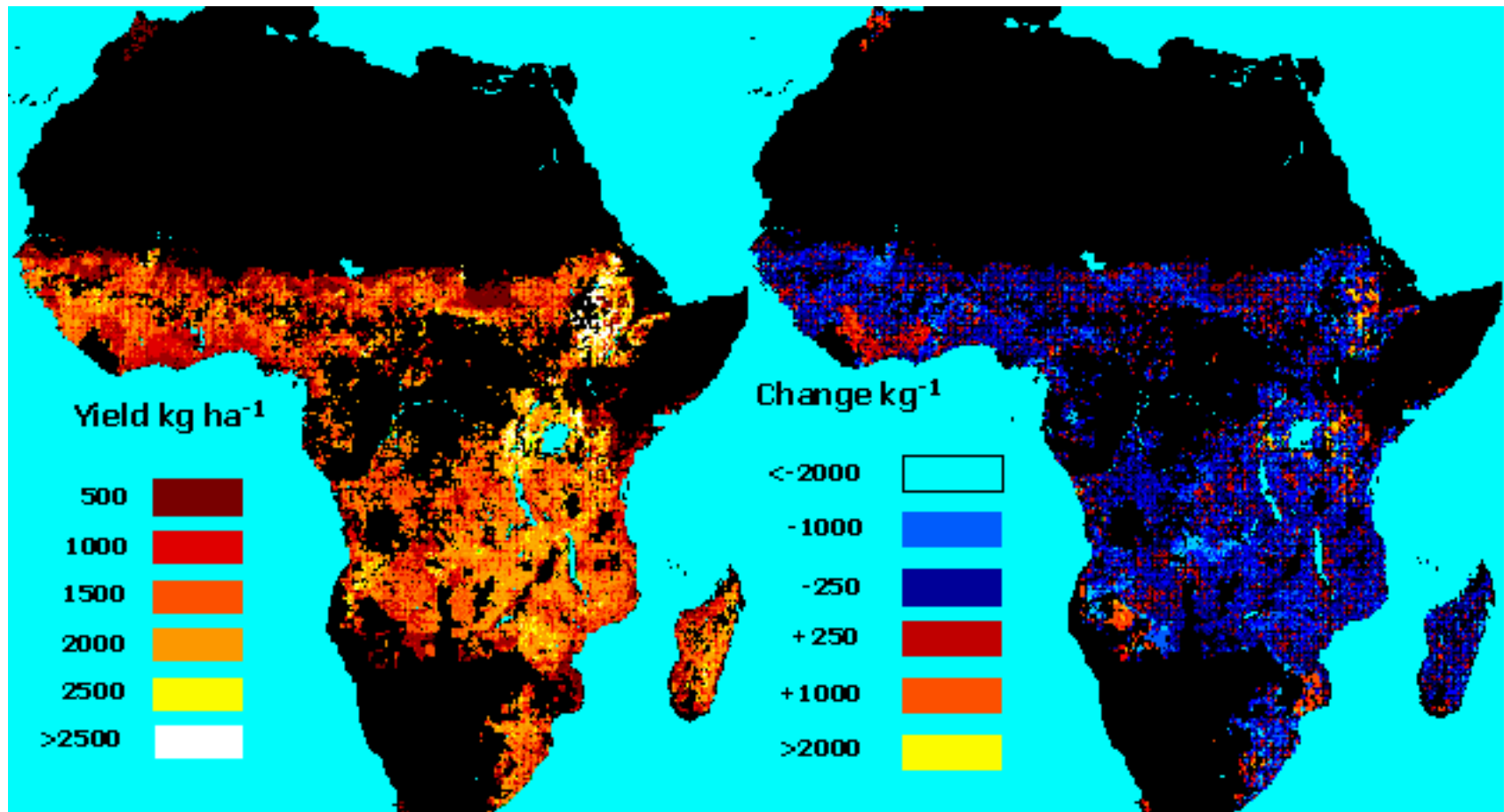
Change in 30-yr mean of maximum drought periods (length) in 2071-2100 relative to mean in 1961-1990 (MPI Hamburg, 2006)

Heavy precipitation (IPCC A1B)



Change in 30-yr mean number of heavy precipitation events in 2071-2100 relative to means in 1961-1990 (MPI Hamburg, 2006)

Simulated maize yields: baseline and changes by 2055



present

2055



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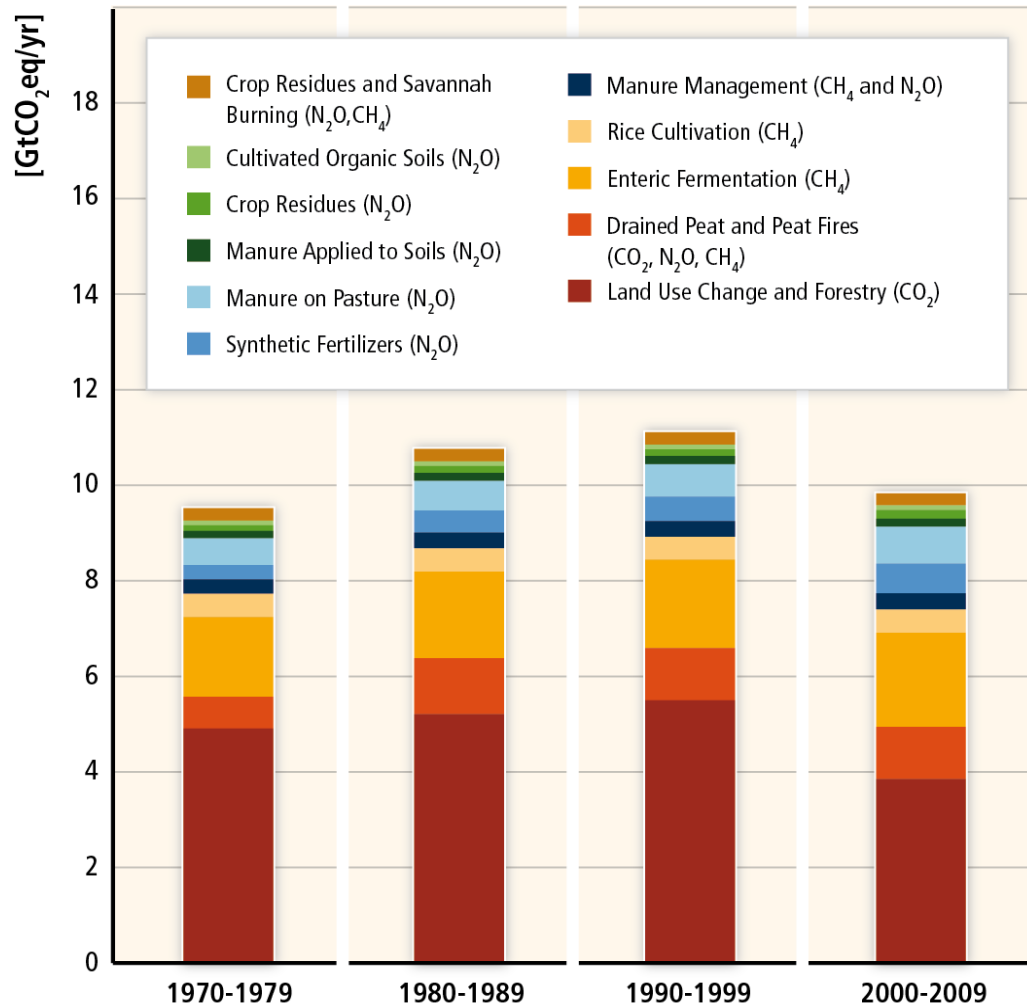
(from Jones & Thornton, 2001)



Agricultural GHG mitigation – supply-side measures

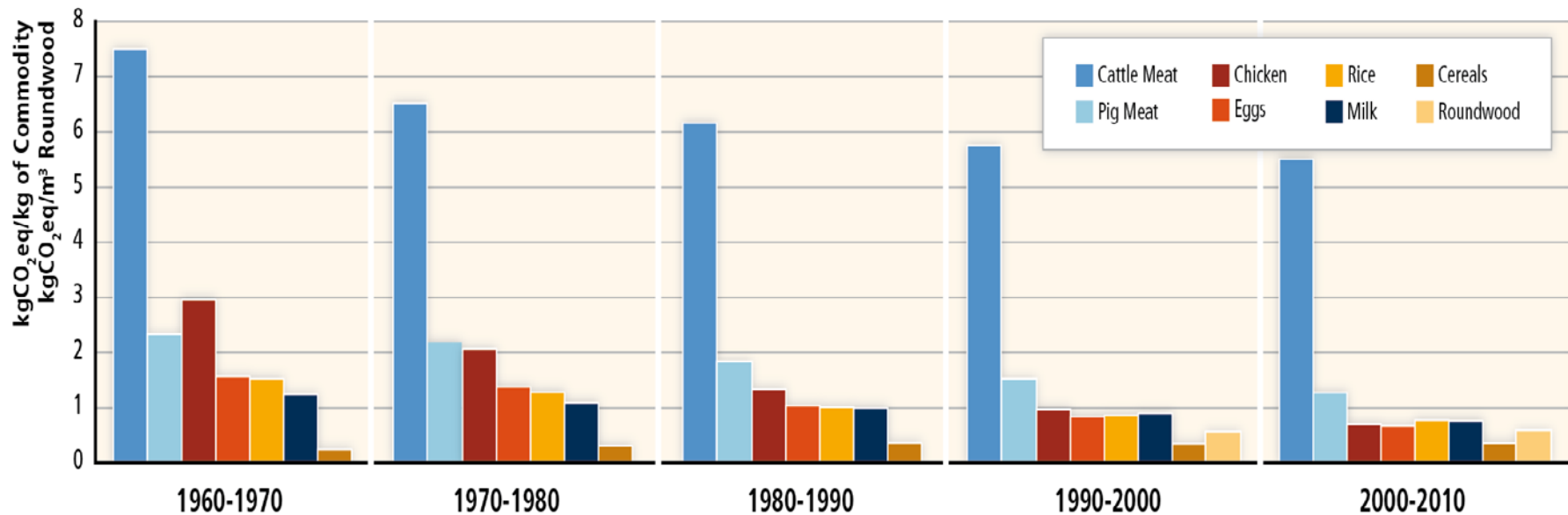


Agricultural emissions are increasing, but *net* forestry CO₂ emissions have fallen recently



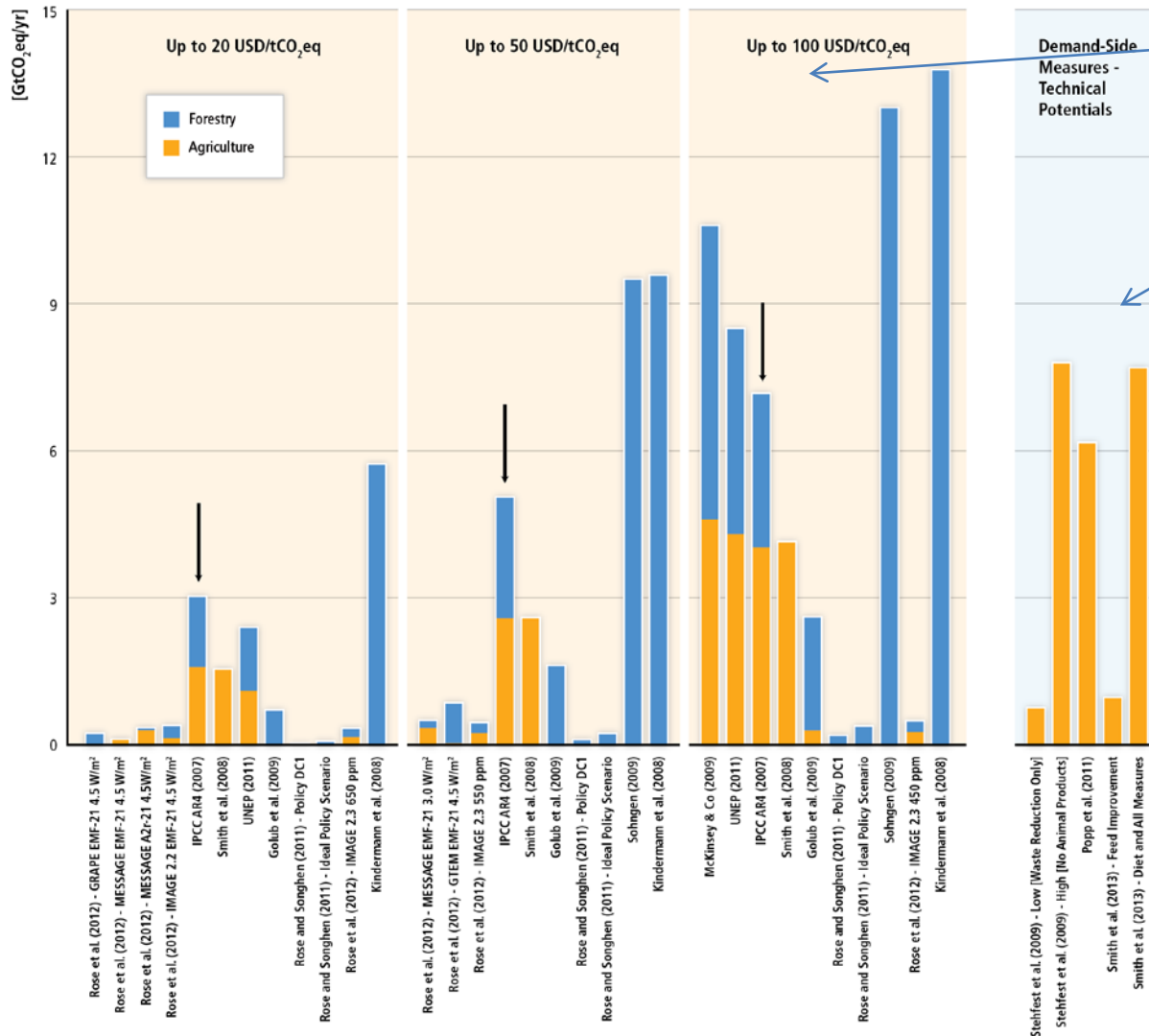
- AFOLU accounts for 24% of total anthropogenic GHG emissions
- AFOLU is the only sector where net emissions fell in the most recent decade
- Whilst agricultural non-CO₂ GHG emissions increased, *net* CO₂ emissions fell, mainly due to decreasing deforestation, and increased afforestation rates

Emissions intensity of AFOLU products is falling as agriculture and forestry become more efficient



- Note that ruminant meat has a GHG intensity much higher than other agricultural products
- But also note that these are direct emissions only. If we include the emissions from the human-edible feed for mono-gastric animal products, they move closer to ruminant meat

Demand- and supply-side measures need to be considered



- Supply-side measures in the AFOLU sector are large & cost-competitive
- Demand-side measures such as dietary change and waste reduction also have large, but uncertain, mitigation
- Demand-side measures may be difficult to implement, but are worthy of further research
- Other options in the AFOLU sector include bioenergy

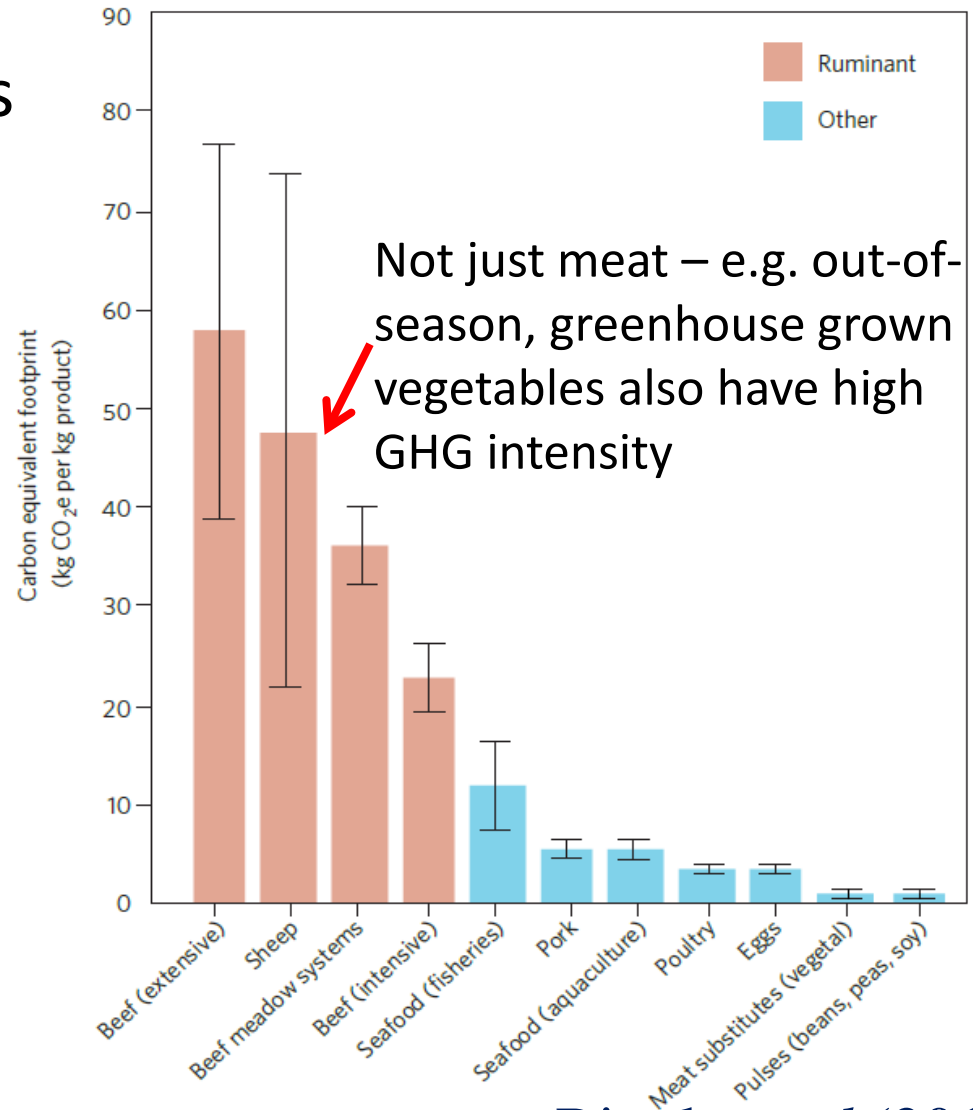
Smith *et al.* (2014)
IPCC WGIII AR5



Agricultural GHG mitigation – demand-side measures



Big differences in the GHG intensity of different foods



Changed consumption patterns

Table 3 Description of the reference scenario and the four dietary variants

Variant	Description
Reference	Agricultural production for 2000–2030 (Bruinsma 2003) and 2030–2050 (FAO 2006). The 2000–2030 projections are country-scale and aggregated to the 24 world regions of the IMAGE model. The projections for 2030–2050 have a continental scale
No Ruminant Meat (NoRM)	As reference, but with complete substitution of proteins from ruminant meat (cattle, buffaloes, sheep and goats) by plant-proteins, starting in 2010 and completed by 2030. By-products such as wool and leather are also assumed to be substituted by other materials
No Meat (NoM)	As NoRM, with additional substitution of white meat (pork, poultry) by plant proteins, starting in 2010 and completed by 2030
No Animal Products (NoAP)	As NoM, with additional substitution of milk and eggs by plant proteins, starting in 2010 and completed by 2030
Healthy Diet (HDiet)	“Healthy Eating” recommendations from the Harvard Medical School (Willett 2001) implemented globally for meat and eggs, starting in 2010 and completed by 2030. See also Table 4

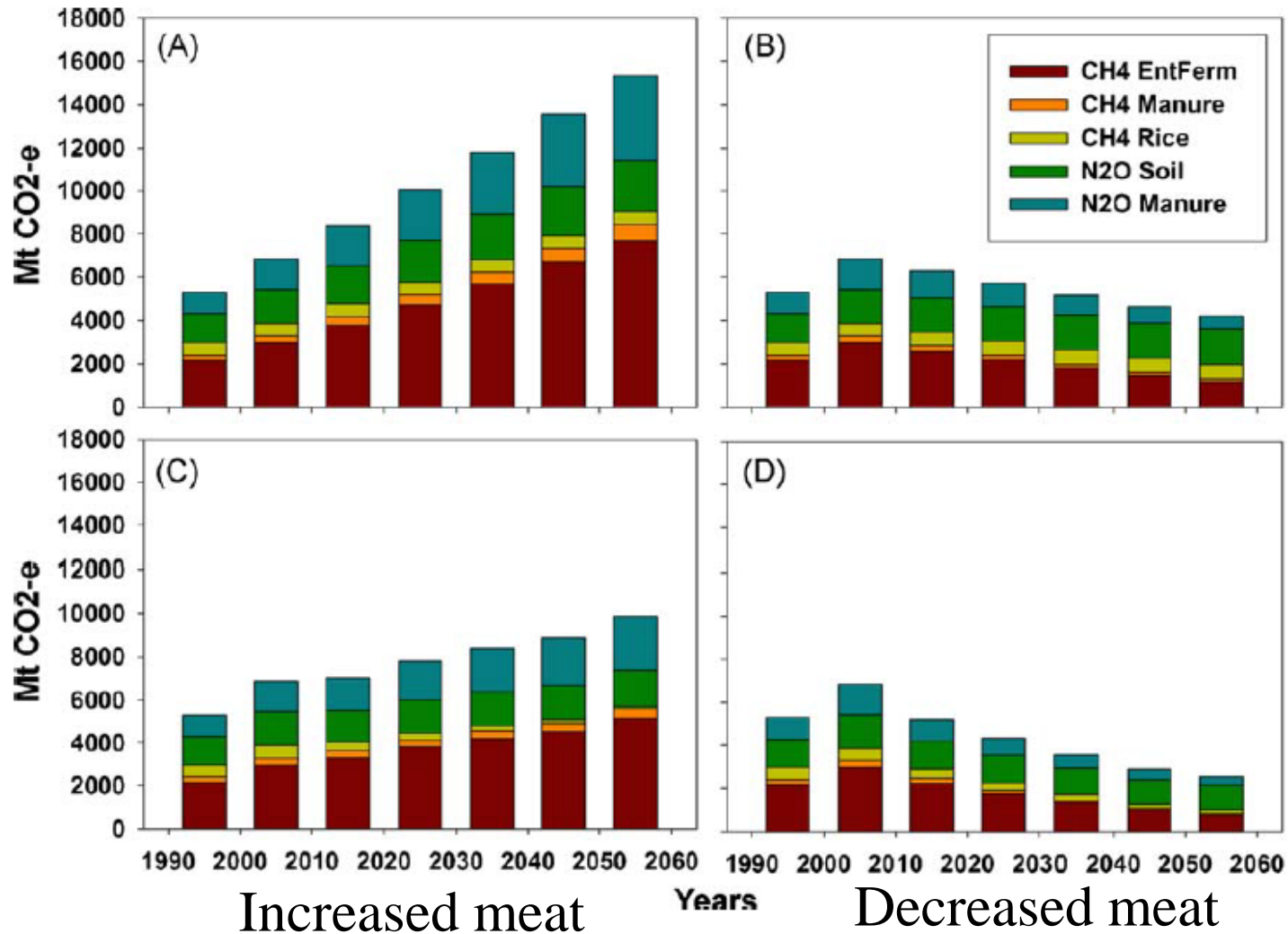
Fewer animal products in global diet allows everyone to be fed, and land is available for energy and nature conservation

Land based GHG emissions:

	GtC eq.
2000	3.0
2050-Reference	3.3
2050-NoRM	1.7
2050-NoM	1.5
2050-NoAP	1.1
2050-HDiet	2.1

Reducing GHG emissions – dietary change vs. technical mitigation

Without
technical
mitigation



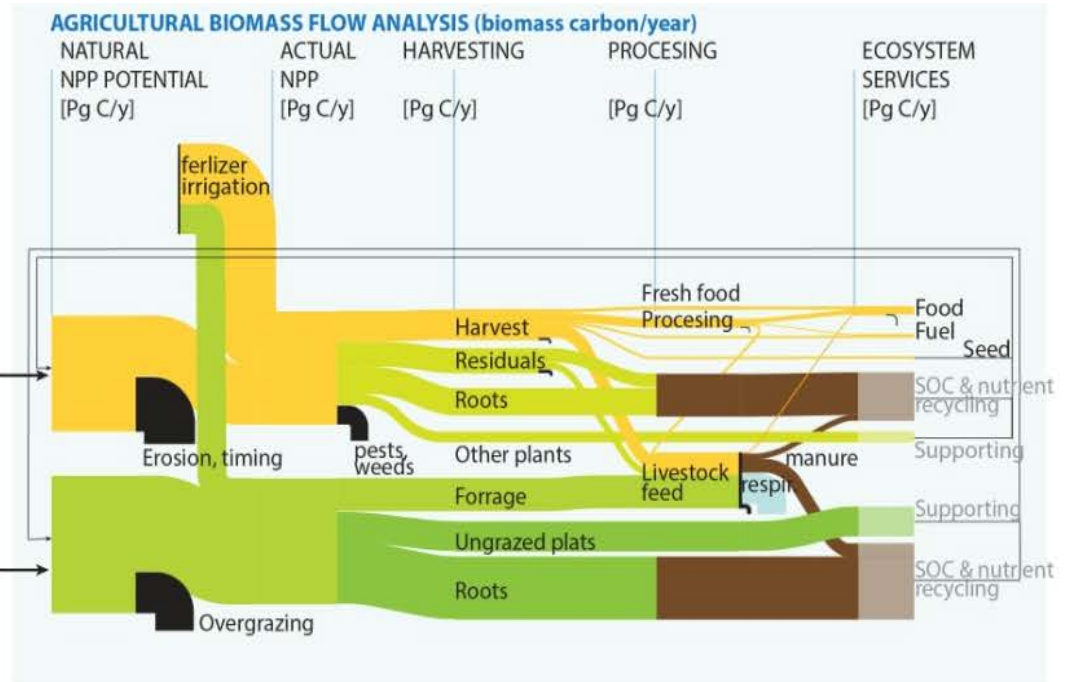
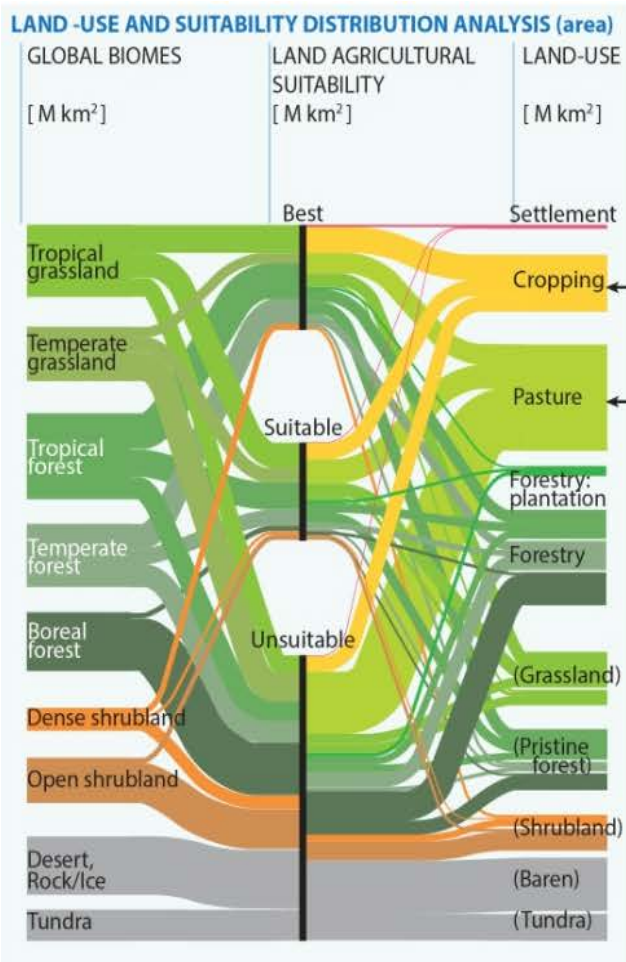
With
technical
mitigation



Food demand must be managed because sustainable intensification alone will not suffice

Scenarios	Yields		Demand side reduction measures:	
	Current trends in yields	Yield gap closures (sustainable intensification)	50% Food waste reduction	Healthy diets
CT1	X			
CT2	X		X	
CT3	X		X	X
YG1		X		
YG2		X	X	
YG3		X	X	X

Food demand must be managed because sustainable intensification alone will not suffice



Food demand must be managed because sustainable intensification alone will not suffice

Current yield trend



Yield gap closure only



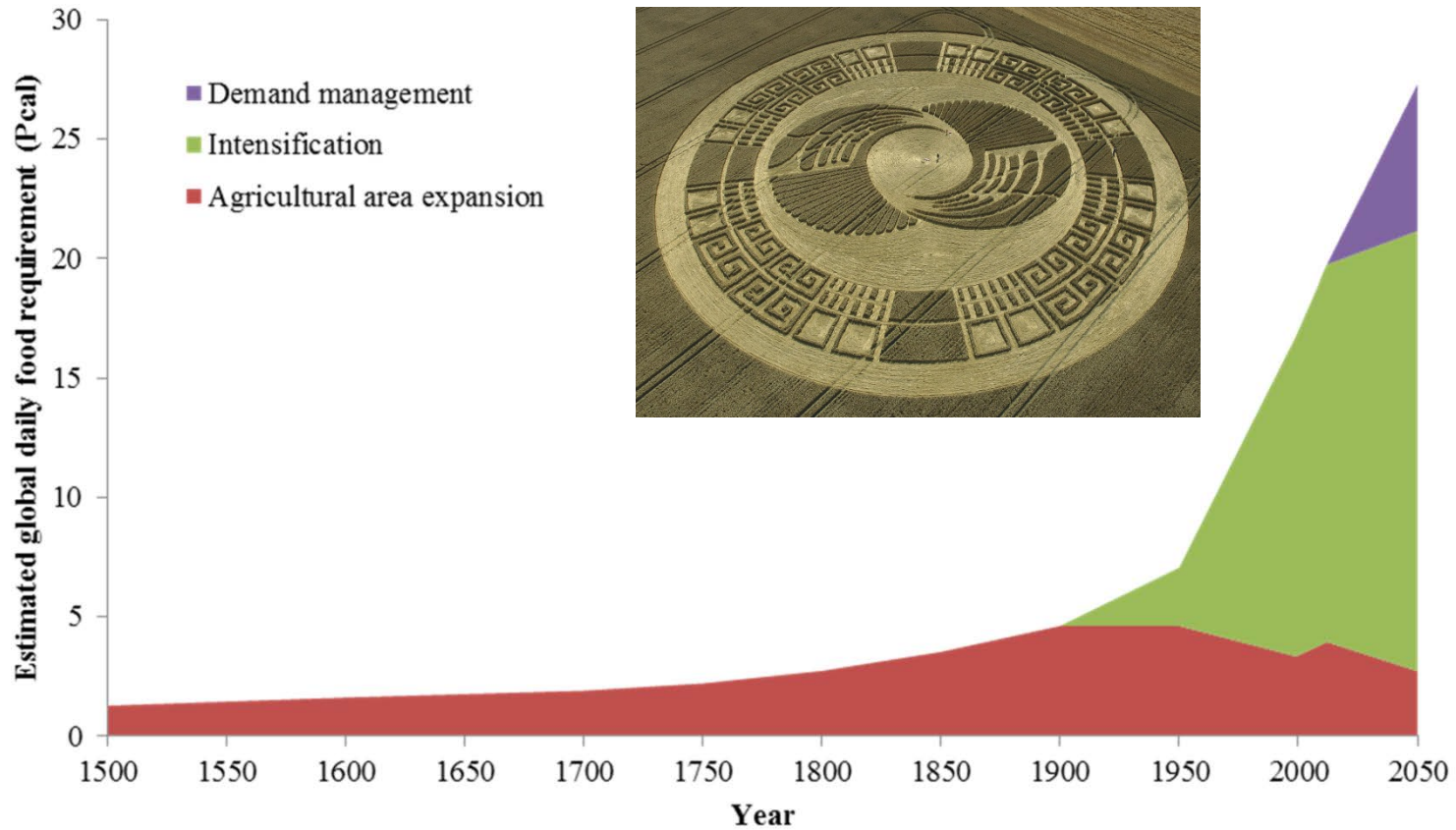
Yield gap closure + demand options



	units	2009*	CT1	CT2	CT3	YG1	YG2	YG3
Cropland	Mkm ²	15.6	22.5 (+44%)	18.7 (+20%)	17.6 (+12%)	18.2 (+16%)	16.0 (+2%)	14.6 (-6%)
Pasture	Mkm ²	32.8	35.2 (+7%)	32.6 (-1%)	26.8 (-18%)	36.0 (+10%)	33.1 (+1%)	27.1 (-17%)
Net Forest cover	Mkm ²	26.1	23.1 (-12%)	24.7 (-6%)	26.1 (+0%)	24.2 (-7%)	25.6 (-2%)	27.1 (+4%)
Tropical Pristine Forests	Mkm ²	7.9	7.2 (-9%)	7.4 (-7%)	7.4 (-6%)	7.4 (-6%)	7.6 (-4%)	7.6 (-4%)
Total GHG emissions	GtCO ₂ /y	13.5	22.2 (+64%)	16.1 (+20%)	11.7 (-13%)	19.2 (+42%)	15.0 (+11%)	10.2 (-25%)
Carbon sink potential	GtCO ₂ /y	14.7	14.5 (-1%)	14.6 (-0%)	14.8 (+0%)	14.6 (-1%)	14.7 (+0%)	14.7 (+0%)
Fertiliser use	Mt/y	103	166 (+61%)	136 (+32%)	125 (+22%)	226 (+120%)	196 (+90%)	175 (+70%)
Irrigation water use	km ³ /y	2889	6496 (+125%)	5328 (+84%)	5075 (+76%)	5051 (+75%)	4413 (+53%)	4157 (+44%)



How will food demand be met in future?



Smith (2014b)

Other papers arriving at similar conclusions.....

ARTICLE

doi:10.1038/nature13959

Global diets link environmental sustainability and human health

David Tilman^{1,2} & Michael Clark¹

Diets link environmental and human health. Rising incomes and urbanization are driving a global dietary transition in which traditional diets are replaced by diets higher in refined sugars, refined fats, oils and meats. By 2050 these dietary trends, if unchecked, would be a major contributor to an estimated 80 per cent increase in global agricultural greenhouse gas emissions from food production and to global land clearing. Moreover, these dietary shifts are greatly increasing the incidence of type II diabetes, coronary heart disease and other chronic non-communicable diseases that lower global life expectancies. Alternative diets that offer substantial health benefits could, if widely adopted, reduce global agricultural greenhouse gas emissions, reduce land clearing and resultant species extinctions, and help prevent such diet-related chronic non-communicable diseases. The implementation of dietary solutions to the tightly linked diet-environment-health trilemma is a global challenge, and opportunity, of great environmental and public health importance.



Cancer risk increases with higher consumptions of red and processed meats...

Carcinogenicity of consumption of red and processed meat

In October, 2015, 22 scientists from ten countries met at the International Agency for Research on Cancer (IARC) in Lyon, France, to evaluate the carcinogenicity of the consumption of red meat and processed meat. These assessments will be published in volume 114 of the IARC Monographs.¹

Red meat refers to unprocessed mammalian muscle meat—for example, beef, veal, pork, lamb, mutton, horse, or goat meat—including minced or frozen meat; it is usually consumed cooked. Processed meat refers to meat that has been transformed through salting,

more than 200 g per person per day.⁴ Less information is available on the consumption of processed meat.

The Working Group assessed more than 800 epidemiological studies that investigated the association of cancer with consumption of red meat or processed meat in many countries, from several continents, with diverse ethnicities and diets. For the evaluation, the greatest weight was given to prospective cohort studies done in the general population. High quality population-based case-control studies provided additional evidence. For both

day of red meat and an 18% increase (95% CI 1.10–1.28) per 50 g per day of processed meat.¹²

Data were also available for more than 15 other types of cancer. Positive associations were seen in cohort studies and population-based case-control studies between consumption of red meat and cancers of the pancreas and the prostate (mainly advanced prostate cancer), and between consumption of processed meat and cancer of the stomach.

On the basis of the large amount of data and the consistent associations



Lancet Oncol 2015

Published Online
October 26, 2015
[http://dx.doi.org/10.1016/S1470-2045\(15\)00444-1](http://dx.doi.org/10.1016/S1470-2045(15)00444-1)

For more on the IARC Monographs see <http://monographs.iarc.fr/>

18% increase in risk of colorectal cancer = increase of 1/100 people



Taxes on food by GHG emissions?

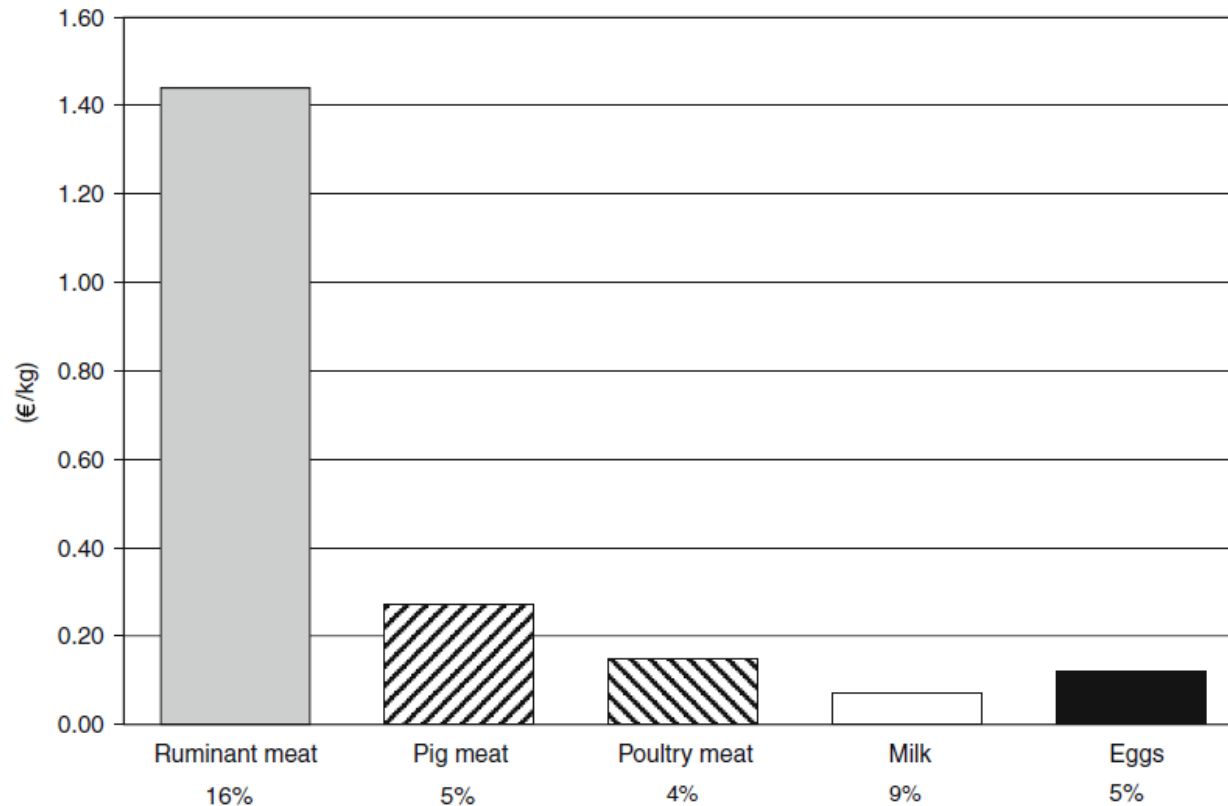


Fig. 9 Taxes per kg (fresh weight) food product for GHG weighted consumption taxes on animal food equivalent to €60 per ton CO₂-eq. Percentages on top of bars show the corresponding relative increase in consumer price

Other aspects to consider

- Not all grassland is suitable for conversion to cropland (too wet/dry) – best way to get human edible food from this land is *via* ruminants. But concentrate feed must be reduced
- Food is immensely socially and culturally important – deeply embedded in all cultures and self-identities
- Resistance to interference in personal choice – could be political suicide!
- Resistance from the meat, livestock and dairy industries – and e.g. organic movement
- Food taxes are a blunt instrument and lead to a range of other issues (e.g. food access / social justice / equity)
- Greenhouse gases are not the only relevant measure of sustainability
- Opportunity for high-quality, grass fed beef/lamb to fill a niche as a more occasional, luxury product (with high premium)

Conclusions

- We can feed 9-10 billion people
- Food supply needs to be increased whilst reducing environmental impact of agriculture
- Need to find options and policies that co-deliver improved food security and improved environmental outcomes
- Some promising supply-side measures (e.g. efficiency improvements) improve food security and reduce environmental impact
- Demand-side measures (e.g. changing diets, waste reduction) are under-researched, for food security and for potential to reduce environmental impact
- We need to change consumption patterns (demand-side measures) – techno-fixes are not enough to make the necessary changes

Implications for policy

- Supply-side measures should be implemented immediately with focus on sustainable intensification
- Demand-side measures – it will take time for behaviour change to occur - policy should be introduced quickly, and should aim to co-deliver to other policy agendas
- Joined-up policy to address multiple objectives is required now more than ever.



Thank you for your attention

