Agriculture Arrives Late to Climate Debate

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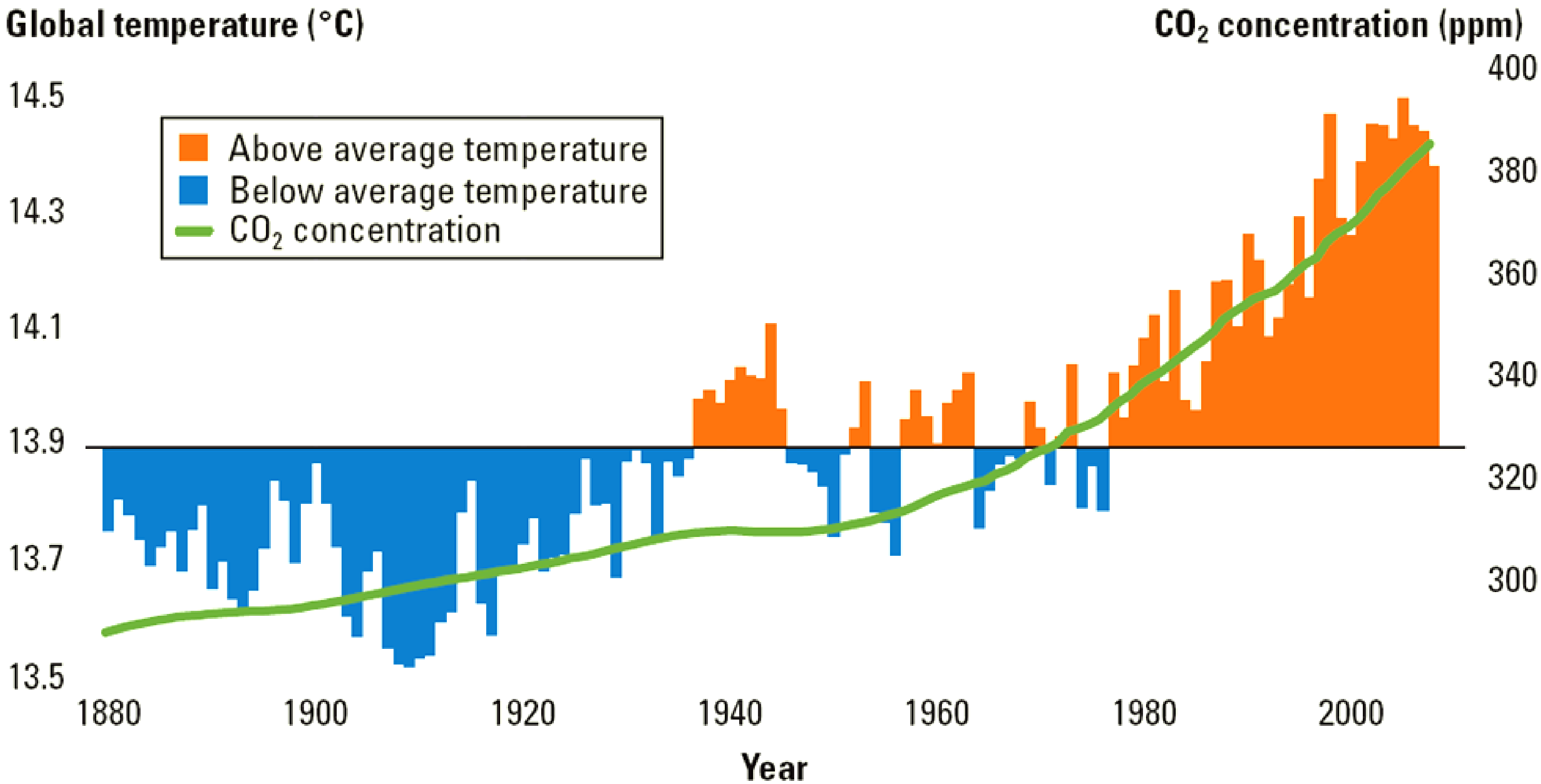
Impact of Climate Change on Agriculture

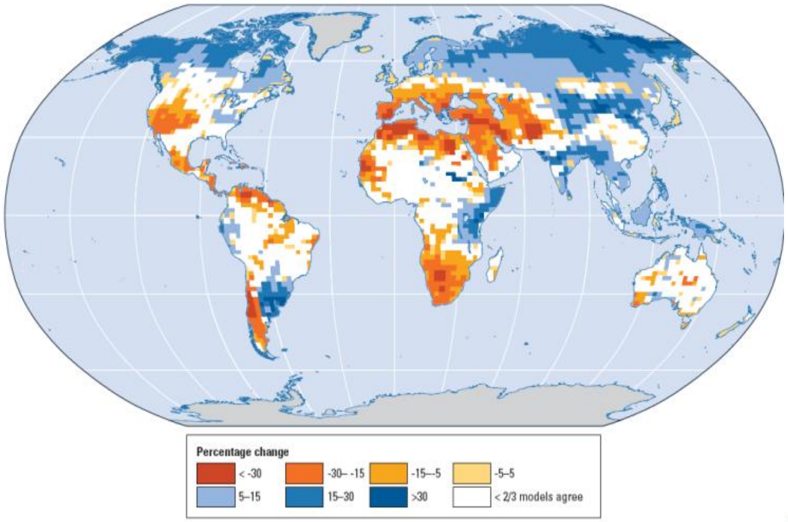
Global annual average temperature and CO_2 concentration continue to climb, 1880–2007



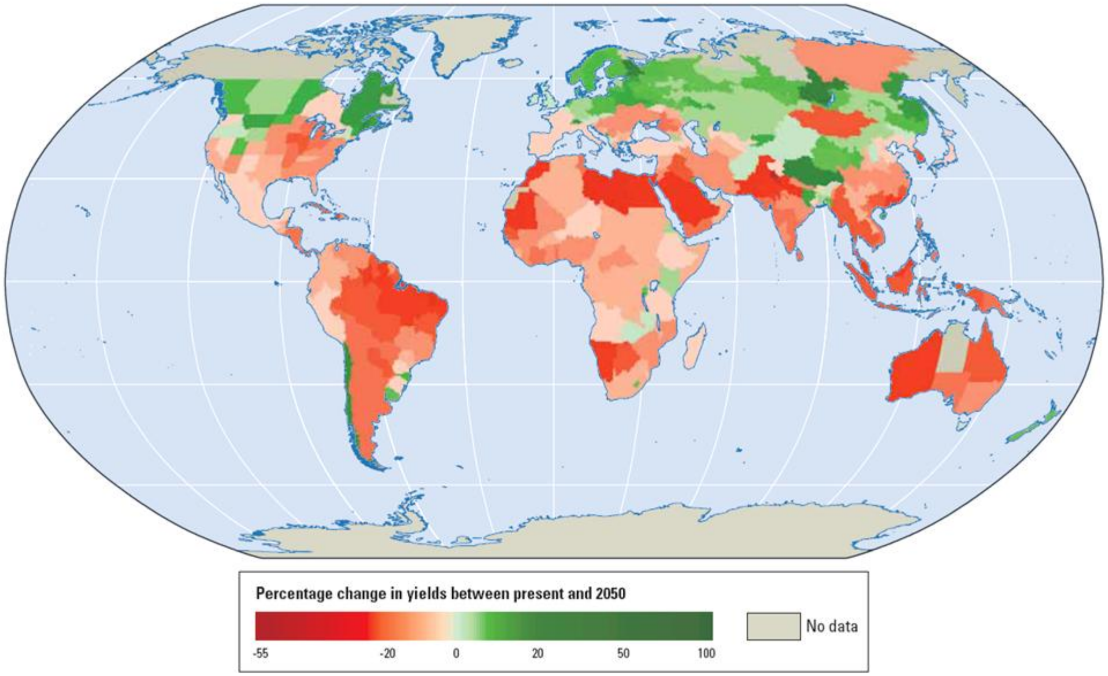
Source: Adapted from Karl, Melillo, and Peterson 2009.

Weather variability due to climate change will result in **27 percent** decline in global productivity by 2050

Water availability is projected to change dramatically by the middle of the 21st century in many parts of the world.

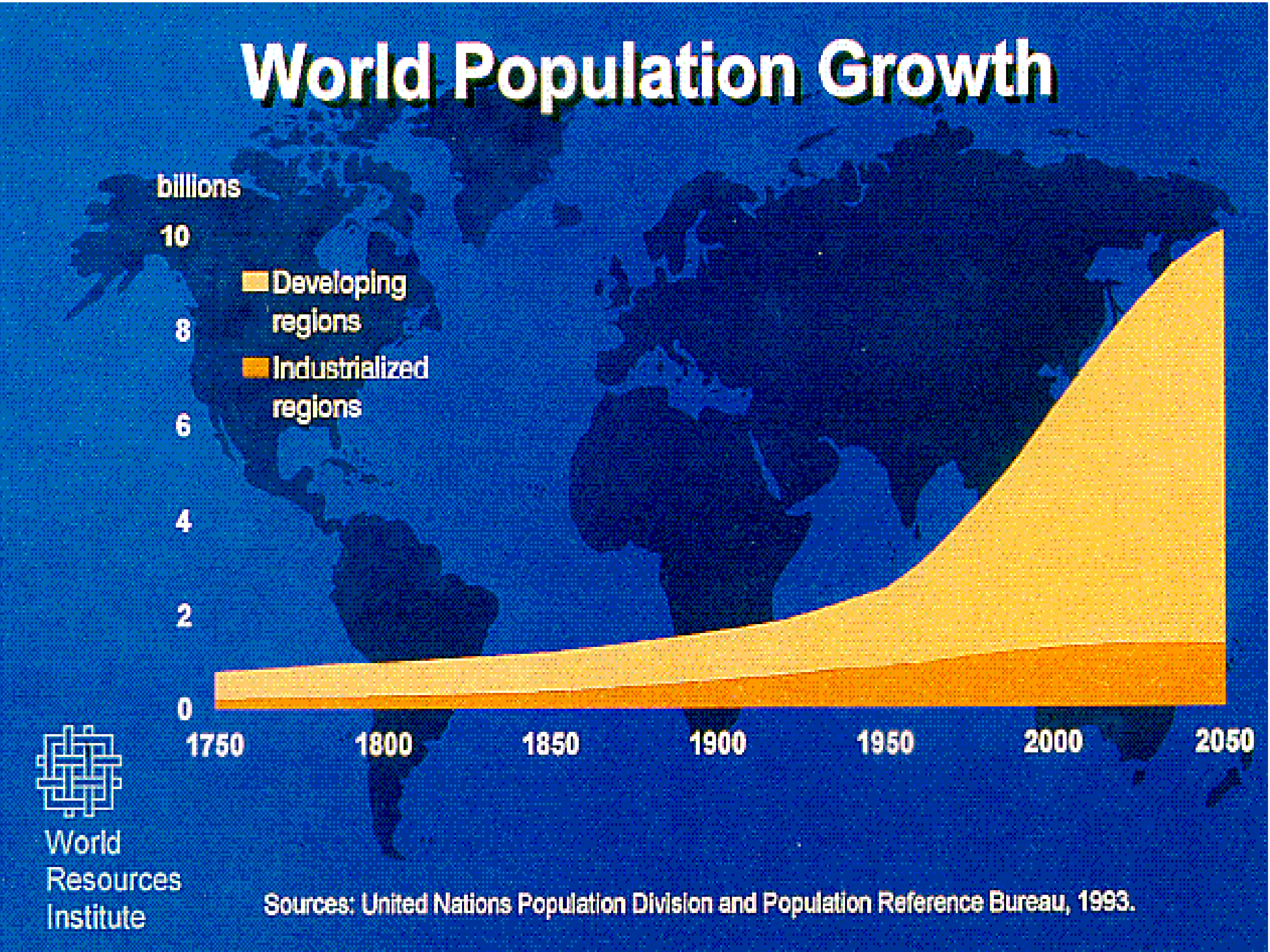


Climate change will depress agricultural yields in most countries in 2050, given current agricultural practices and crop varieties



Sources: Müller and others 2009; World Bank 2008c.

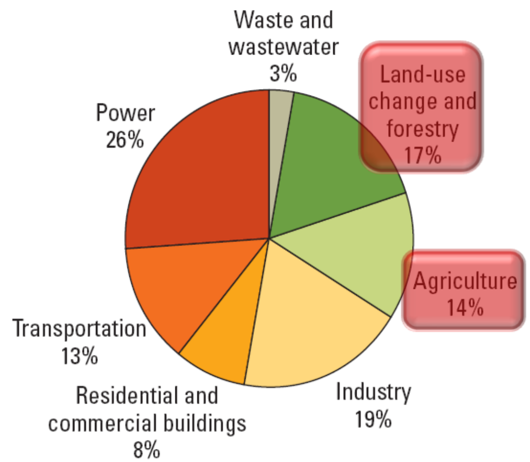
Note: The figure shows the projected percentage change in yields of 11 major crops (wheat, rice, maize, millet, field pea, sugar beet, sweet potato, soybean, groundnut, sunflower, and rapeseed) from 2046 to 2055, compared with 1996–2005. The values are the mean of three emission scenarios across five global climate models, assuming no CO_2 fertilization (a possible boost—of uncertain magnitude—to plant growth and water-use efficiency from higher ambient CO_2 concentrations). Large negative yield impacts are projected in many areas that are highly dependent on agriculture.


World Population Growth
billions
10
8
6
4
2
0
Developing regions
Industrialized regions
1750
1800
1850
1900
1950
2000
2050
World Resources Institute
Sources: United Nations Population Division and Population Reference Bureau, 1993.


According to the International Food Policy Research Institute,
annual investments of $7 billion needed for climate adaptation


Agriculture's Contribution to Climate Change

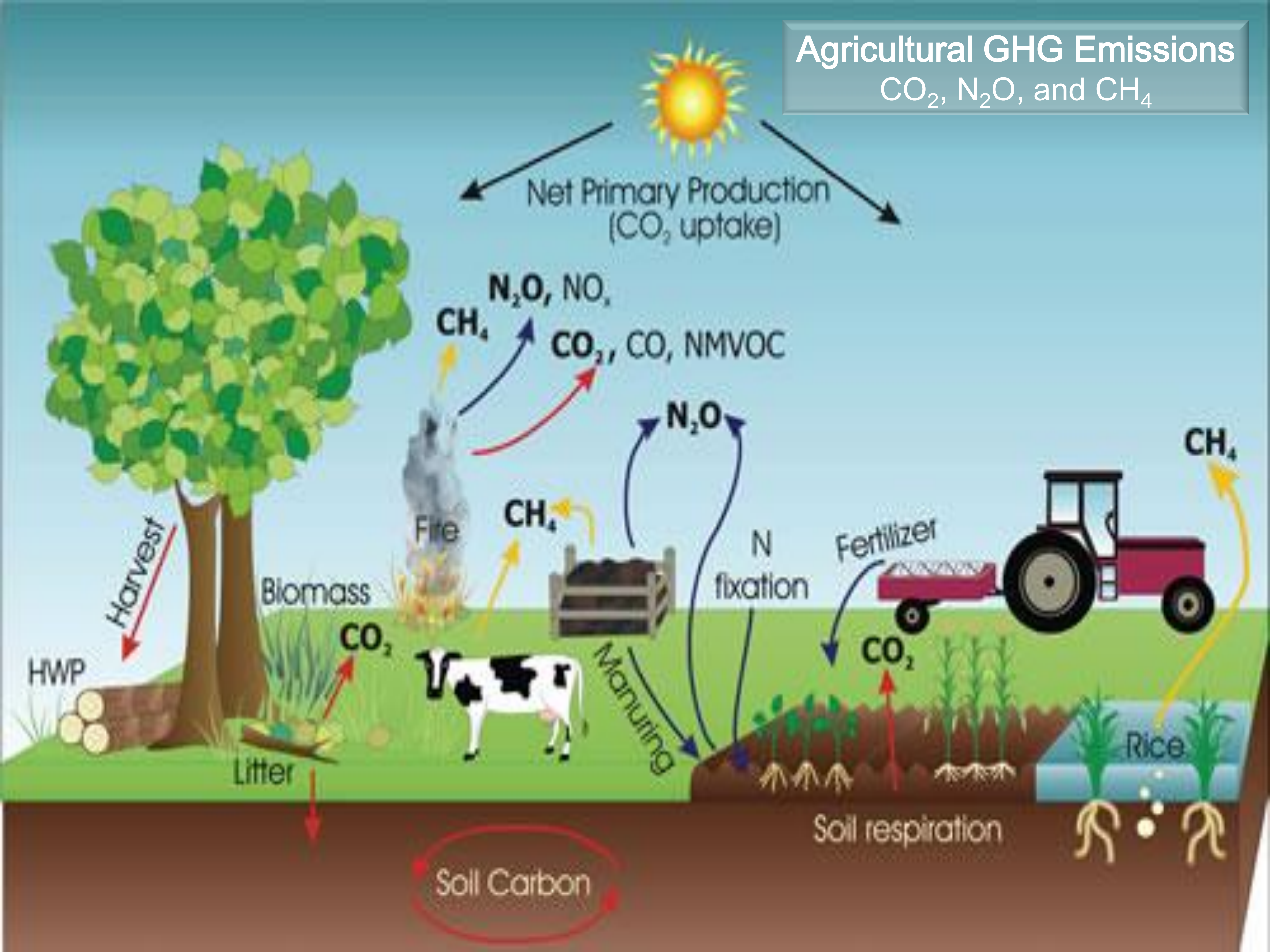
Agriculture and Land-use Change Emit <u>31 Percent</u> of GHGs



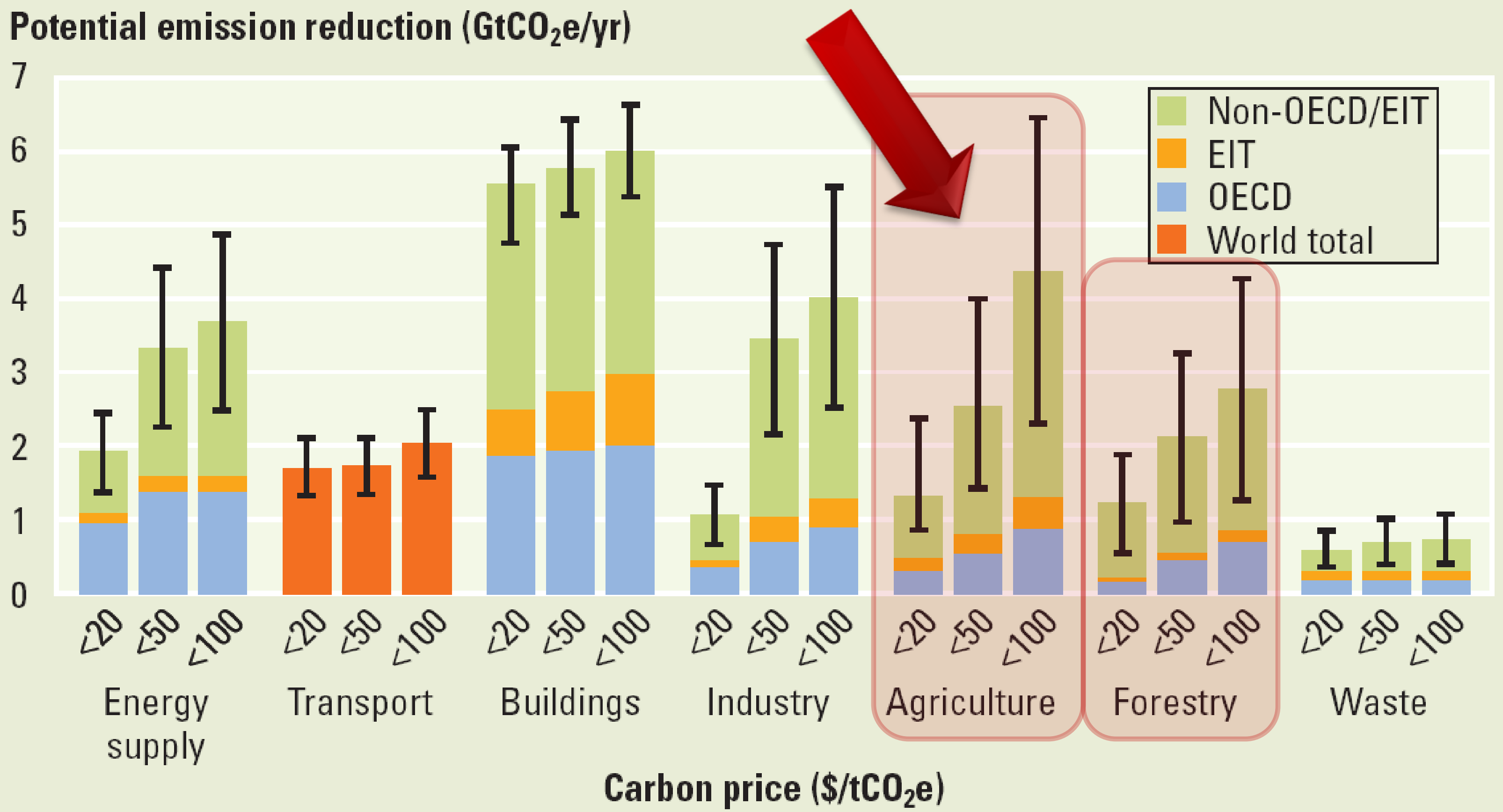
Source: IPCC 2007a, figure 2.1.

Note: Share of anthropogenic (human-caused) greenhouse gas emissions in 2004 in CO_2e (see figure 1 for the definition of CO_2e). Emissions associated with land use and land-use change, such as agricultural fertilizers, livestock, deforestation, and burning, account for about 30 percent of total greenhouse gas emissions. And uptakes of carbon into forests and other vegetation and soils constitute an important carbon sink, so improved land-use management is essential in efforts to reduce greenhouse gases in the atmosphere.

Agricultural GHG Emissions
CO_2, N_2O, and CH_4




Agriculture's Impact on Climate Change



Source: Barker and others 2007b, figure TS.27.
Note: EIT = economies in transition. The ranges for global economic potentials as assessed in each sector are shown by black vertical lines.

World Bank and IPCC

Climate Change 2007:
Mitigation of Climate Change

Recent trends in both public and private energy funding indicate that the role of 'technology push' in reducing GHG emissions is often overvalued and may not be fully understood.

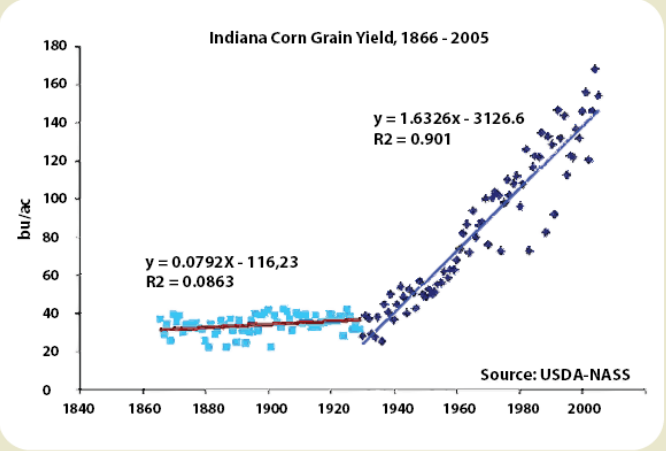
Ultimately, it is only by creating a demand-pull market (rather than supply-push) that technological development, learning from experience, economies of scale in production and related cost reductions can result.

– Intergovernmental Panel on Climate Change

Agricultural technology is characterized by a demand-pull. Farmers want and are willing to pay for new technologies that reduce labor and inputs, as this increases income or reduces cost. As a result, the environment and the public receive a benefit at no additional cost to the consumer.

Yield Gains

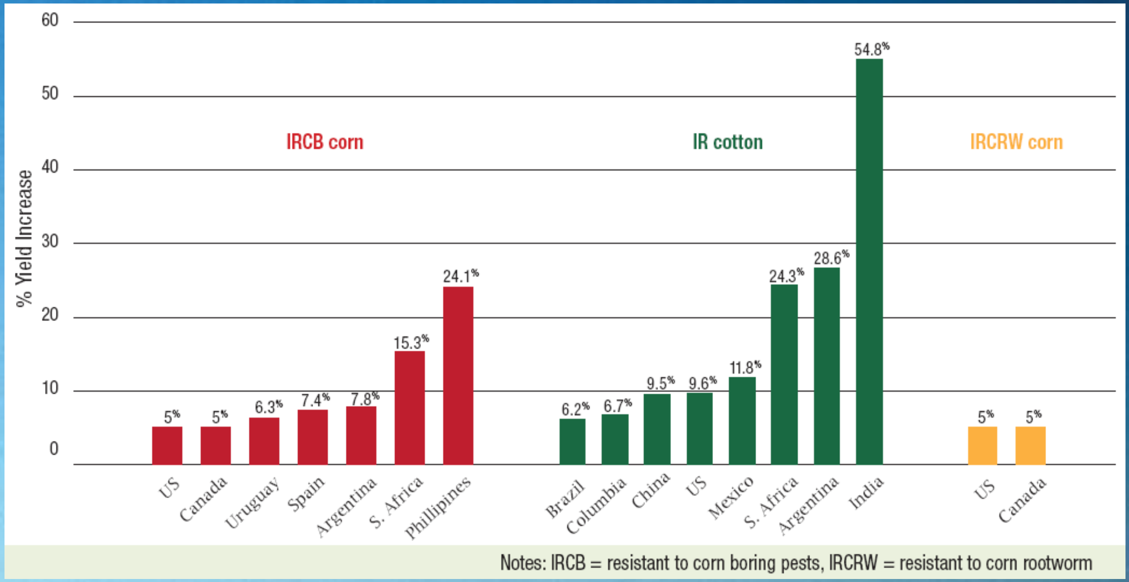
Corn grain yields in Indiana, USA from 1866 to about 1930 changed very slowly. With plant breeding technologies, such as the adoption of hybrid seed corn in the 1930's, and better crop management coming to farmers' fields, yield increased substantially.



Historical corn grain yields for Indiana (USA) from 1866 to 2008. Source of yield data: USDA-NASS (2008).

Yield Gains Continued

Biotech crops deliver significant yield increases to farmers



http://www.pgeconomics.co.uk/pdf/focusonyieldeffects2009.pdf

Biotech Crops Result in Reduced Carbon Emissions

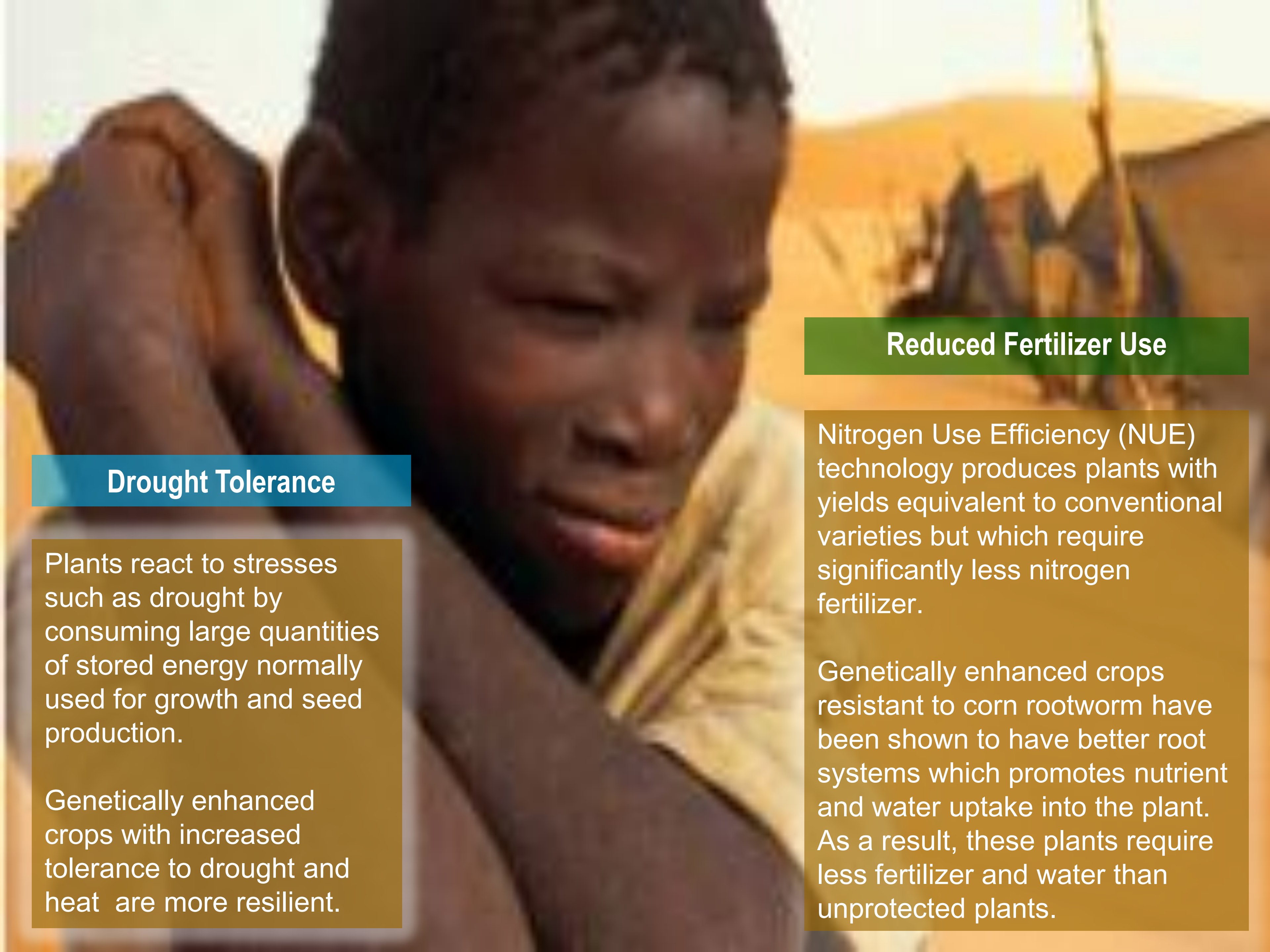
Reduced fuel use = 1.14 billion kg CO_2

Soil carbon sequestration = 13.10 billion kg CO_2

That's the same as taking 6.3 million cars off the road

According to the IPCC, 89 percent of ag mitigation potential is from soil carbon sequestration

http://www.pgeconomics.co.uk/pdf/2009globalimpactstudy.pdf



Drought Tolerance

Plants react to stresses such as drought by consuming large quantities of stored energy normally used for growth and seed production.

Genetically enhanced crops with increased tolerance to drought and heat are more resilient.

Reduced Fertilizer Use

Nitrogen Use Efficiency (NUE) technology produces plants with yields equivalent to conventional varieties but which require significantly less nitrogen fertilizer.

Genetically enhanced crops resistant to corn rootworm have been shown to have better root systems which promotes nutrient and water uptake into the plant. As a result, these plants require less fertilizer and water than unprotected plants.

Proposed measures for mitigating greenhouse gas emissions from agricultural ecosystems, their apparent effects on reducing emissions of individual gases where adopted (mitigative effect), and an estimate of scientific confidence that the proposed practice can reduce overall net emissions at the site of adoption.

		Mitigative effects[a]			Net mitigation[b] (confidence)	
Measure	**Examples**	**CO_2**	**CH_4**	**N_2O**	**Agreement**	**Evidence**
Cropland management	Agronomy	+		+/-	***	**
	Nutrient management	+		+	***	**
	Tillage/residue management	+		+/-	**	**
	Water management (irrigation, drainage)	+/-		+	*	*
	Rice management	+/-	+	+/-	**	**
	Agro-forestry	+		+/-	***	*
	Set-aside, land-use change	+	+	+	***	***
Grazing land management/ pasture improvement	Grazing intensity	+/-	+/-	+/-	*	*
	Increased productivity (e.g., fertilization)	+		+/-	**	*
	Nutrient management	+		+/-	**	**
	Fire management	+	+	+/-	*	*
	Species introduction (including legumes)	+		+/-	*	**
Management of organic soils	Avoid drainage of wetlands	+	-	+/-	**	**
Restoration of degraded lands	Erosion control, organic amendments, nutrient amendments	+		+/-	***	**
Livestock management	Improved feeding practices		+	+	***	***
	Specific agents and dietary additives		+		**	***
	Longer term structural and management changes and animal breeding		+	+	**	*
Manure/biosolid management	Improved storage and handling		+	+/-	***	**
	Anaerobic digestion		+	+/-	***	*
	More efficient use as nutrient source	+		+	***	**
Bio-energy	Energy crops, solid, liquid, biogas, residues	+	+/-	+/-	***	**

Notes:

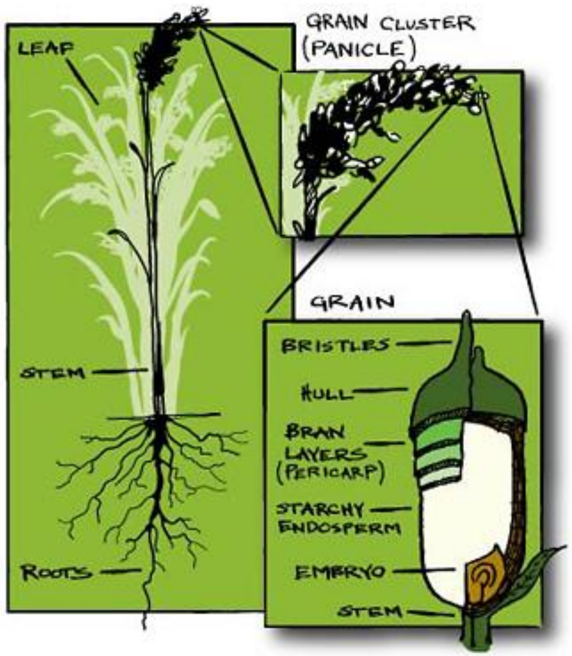
[a] + denotes reduced emissions or enhanced removal (positive mitigative effect);
- denotes increased emissions or suppressed removal (negative mitigative effect);
+/- denotes uncertain or variable response.

[b] A qualitative estimate of the confidence in describing the proposed practice as a measure for reducing net emissions of greenhouse gases, expressed as CO_2-eq: Agreement refers to the relative degree of consensus in the literature (the more asterisks, the higher the agreement); Evidence refers to the relative amount of data in support of the proposed effect (the more asterisks, the more evidence).

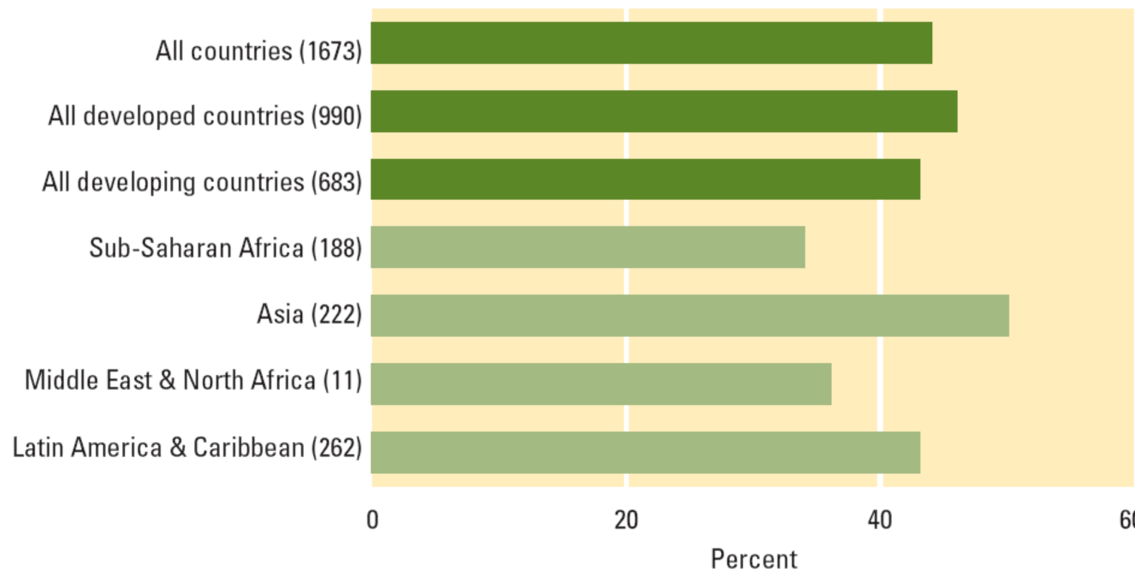
Source: adapted from Smith et al., 2007a.

IPCC

Feeding the R&D Pipeline



Estimated returns to investment in agricultural R&D are high in all regions—averaging 43 percent



Source: Alston and others 2000.
a. Based on studies carried out from 1953 to 1997. Number of observations in parentheses.

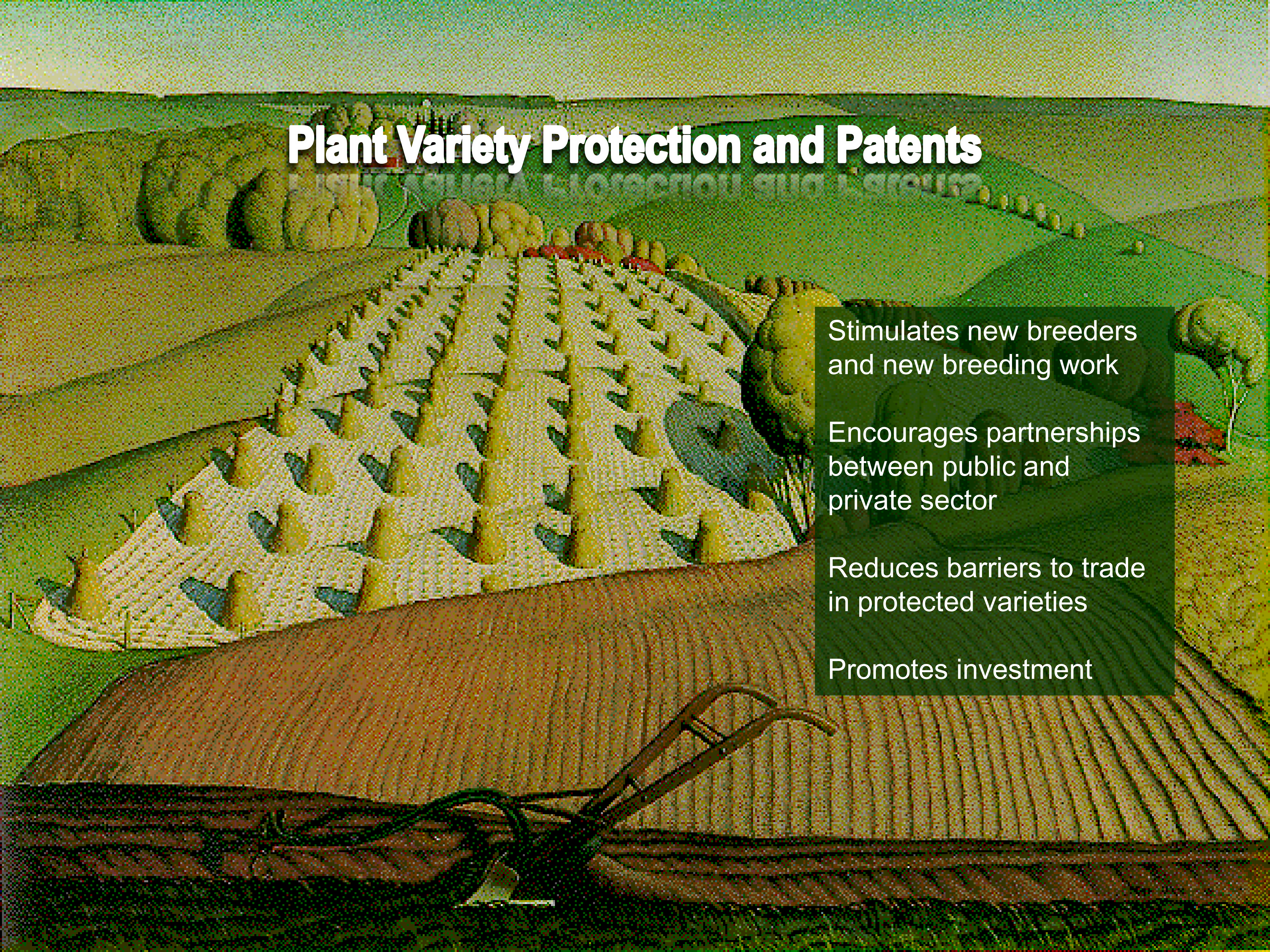
Returns High - Investments Low

41 percent of ag R&D from the private sector in 2005

R&D growth rates declined precipitously between 1976 and 2000

http://www.fao.org/fileadmin/templates/wsfs/docs/expert_paper/12-Beintema-Elliott_InvestmentAgR_D.pdf

Plant Variety Protection and Patents



- Stimulates new breeders and new breeding work
- Encourages partnerships between public and private sector
- Reduces barriers to trade in protected varieties
- Promotes investment

Conclusions

- Climate change will significantly increase the challenge of achieving food security for all
- Farmers will need to produce more with less (less water, less fertilizer) while conserving soil and forests
- Agriculture and land use change have the potential to mitigate more CO_2 emissions than the energy sector and at lower costs
- Farmers are willing to pay for new agricultural technologies
- Investments in ag research deliver high returns in all regions
- Ag technologies available today to begin making a difference with respect to mitigation and adaption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