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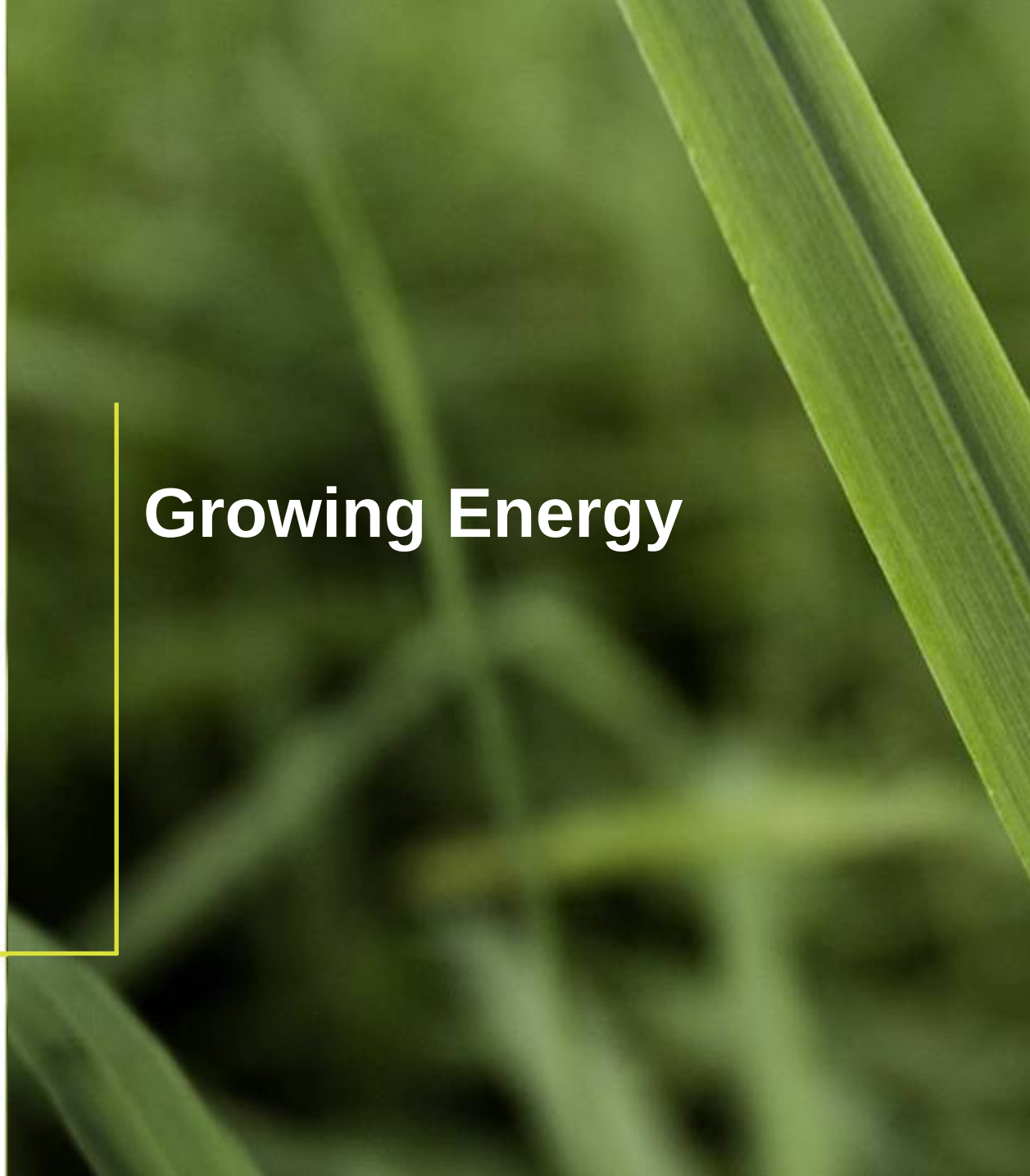
Growing Energy



"Farming looks mighty easy when your plow is a pencil, and you are a thousand miles from the corn field."

- Dwight Eisenhower

The Real "Crime Against Humanity"?

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Corn Yield Trends (Bushel Per Acre)			
	1990	2000	2005
World Average	59	70	75
USA	113	137	149
Argentina	60	93	109
China	74	78	80
Brazil	33	47	54
India	23	29	31
Sub-Saharan Africa	22	24	25

Source: Monsanto/Doane Forecast

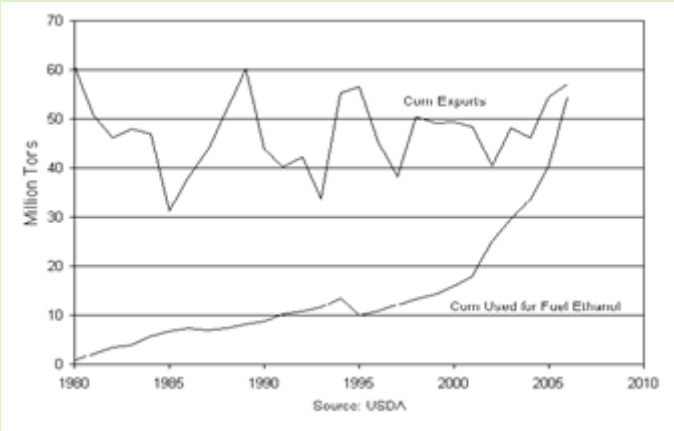
Indirect Land Use Conversion (ILUC)

Are U.S. Farmers….

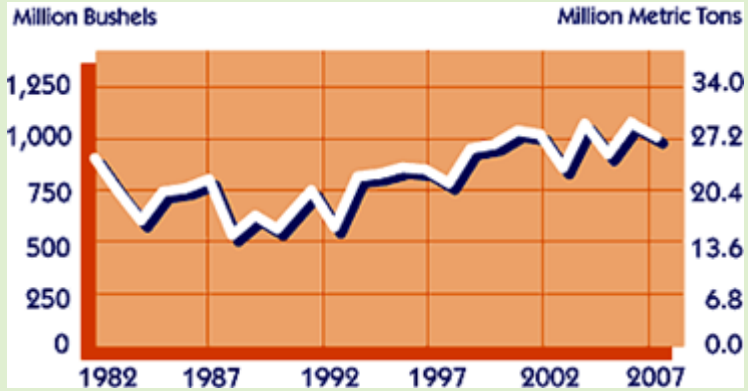
…Responsible For Tropical Deforestation?

Indirect Land Conversion?

U.S. Corn for Ethanol and for Exports

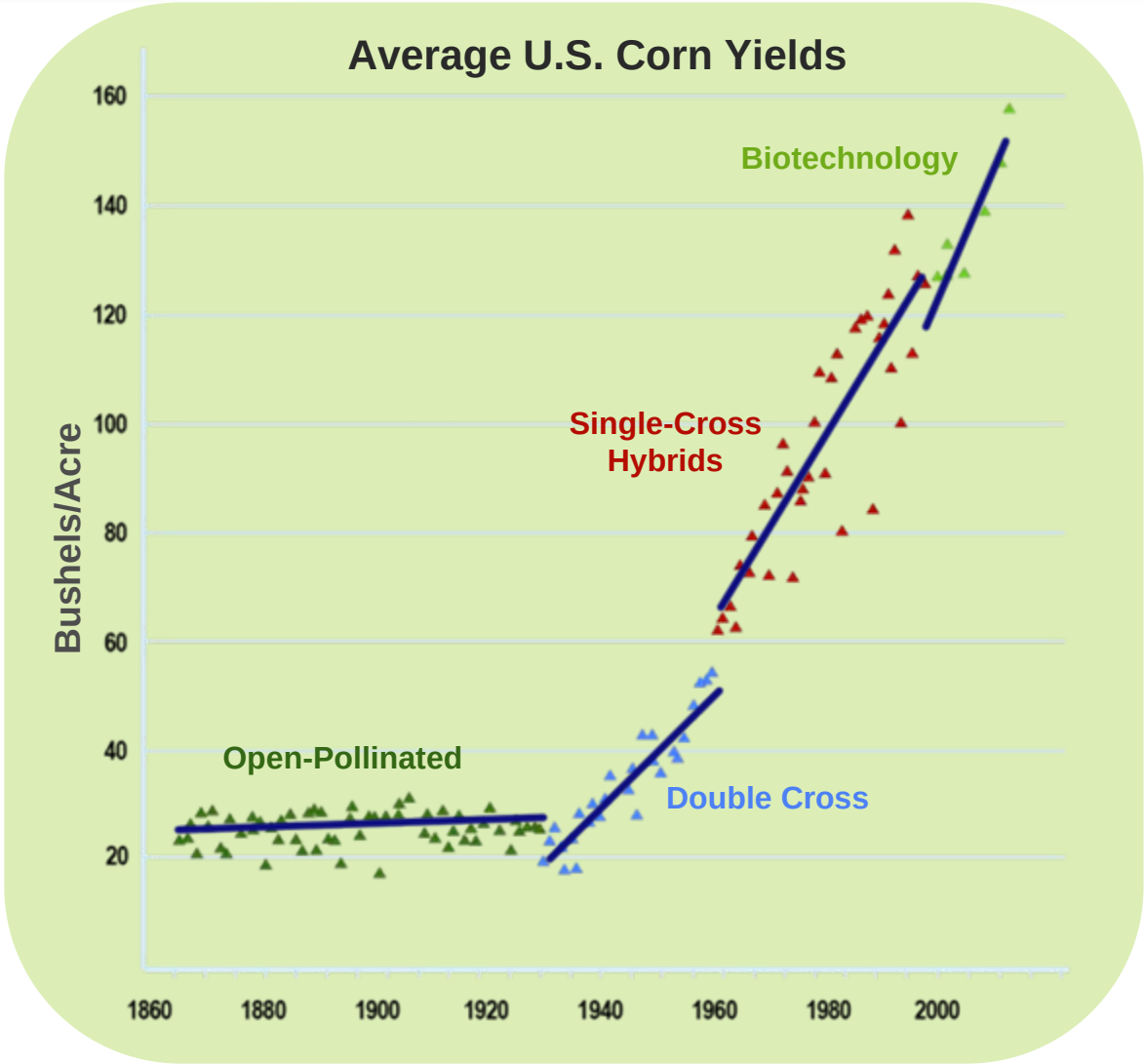


U.S. Soybean Exports



Is U.S. biofuel production leading to a decrease in corn or soybean exports?

Can ILUC Models Predict Innovation?

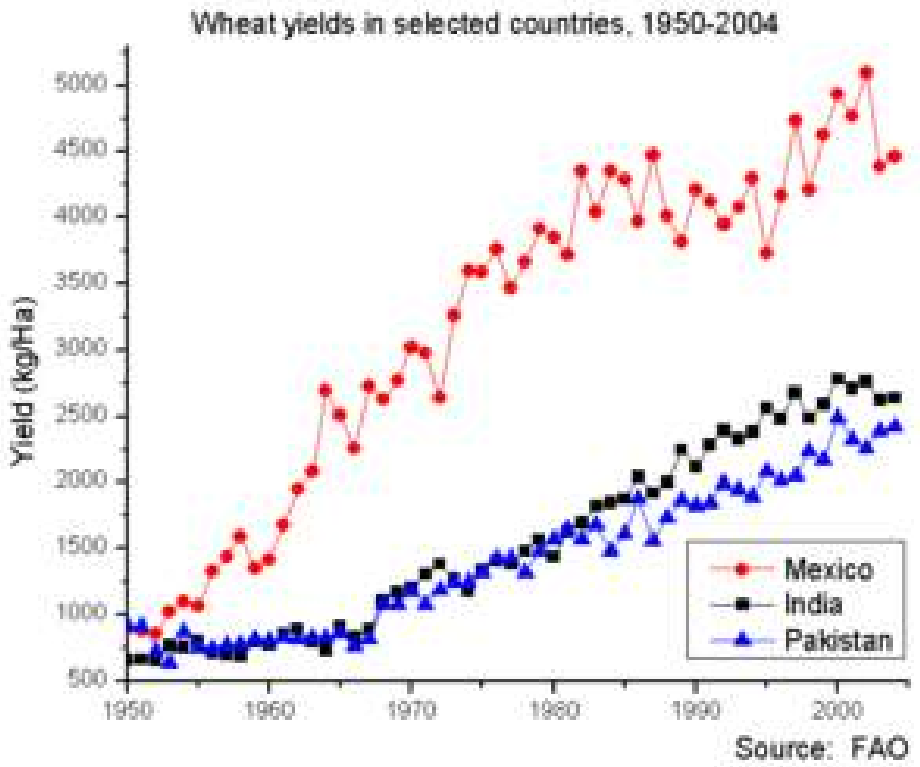


Hybrid genetics & biotechnology have driven a **five-fold increase** in average U.S. corn yields since 1940.

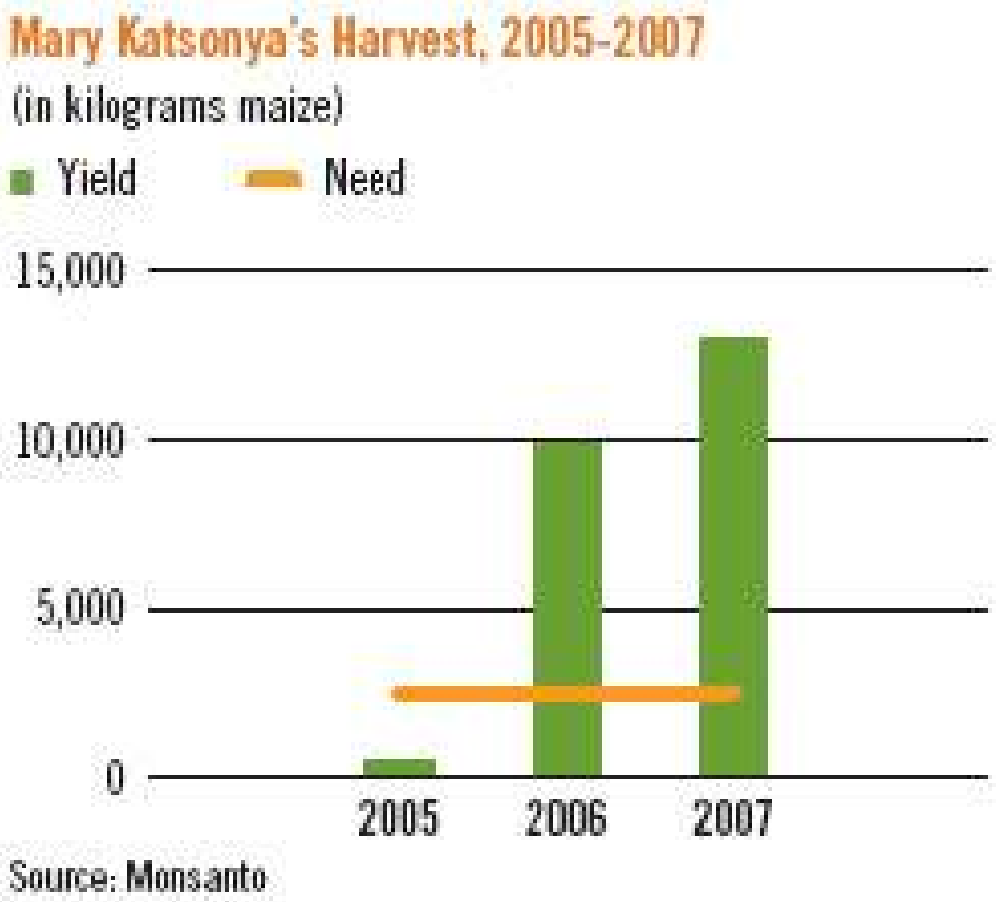
Data Source: USDA

Or a 300% Increase In Global Wheat Yields?

Nobel Laureate Dr. Norman Borlaug



Or Adoption of Technology?…



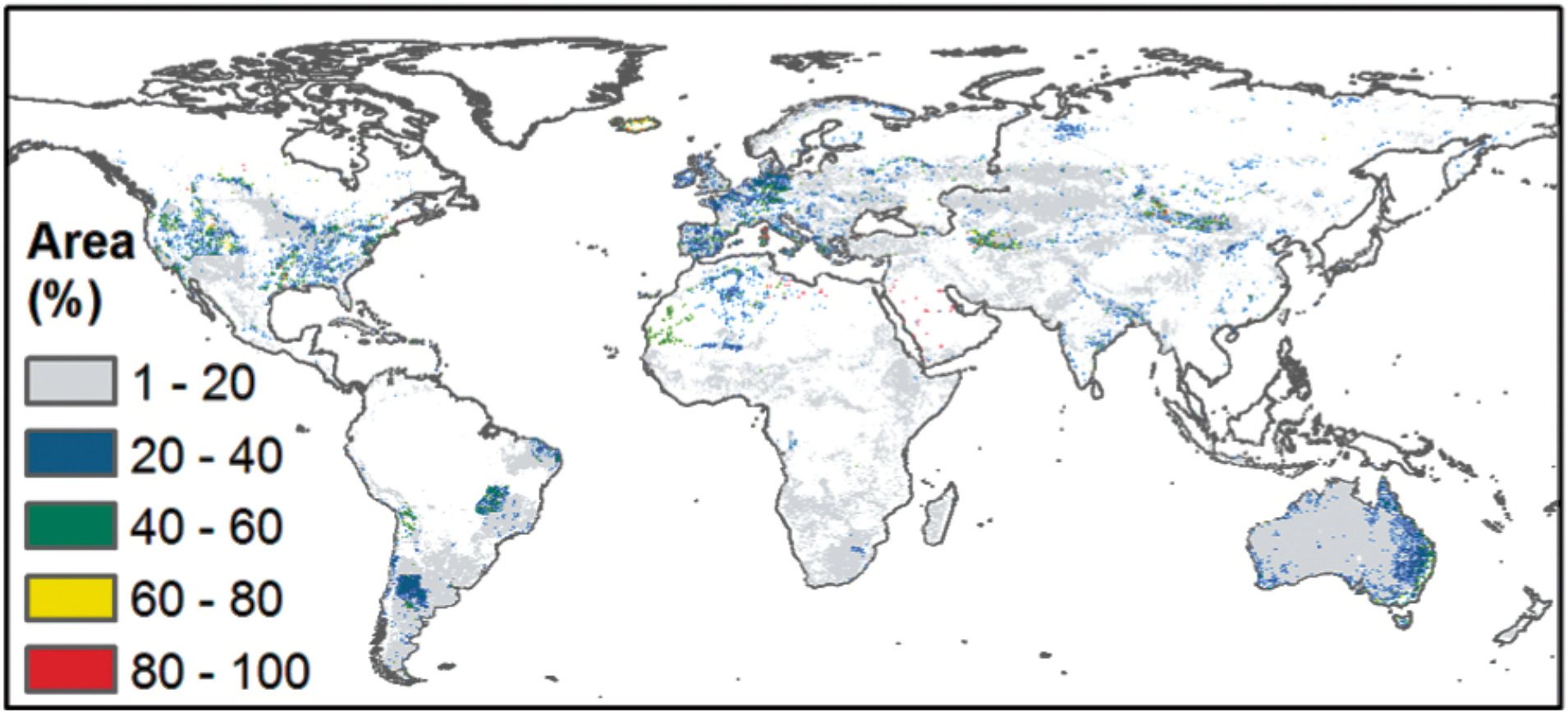
2005 – Non-hybrid varieties from saved seed

2006 - $70 of hybrid seed and fertilizer

2007 – Chose hybrids, not saved seed

FAO STAT: Malawi maize yields average 1,200 kg/hectare vs. over 8,000 for USA

Or Bringing >1 Billion Acres Of Abandoned Agricultural Land Back Into Production?



Campbell et al., Env. Sci. Technol. (2008) ***ASAP Article***, 10.1021/es800052w

Innovation: Increased Biomass Yield

Public Variety **Ceres Cultivar**

Innovation: Low Nitrogen

- Reduces fertilizer requirements in crops
- Minimizes use as yields increase
- Lower N_2O –a greenhouse gas

Control **New Trait**

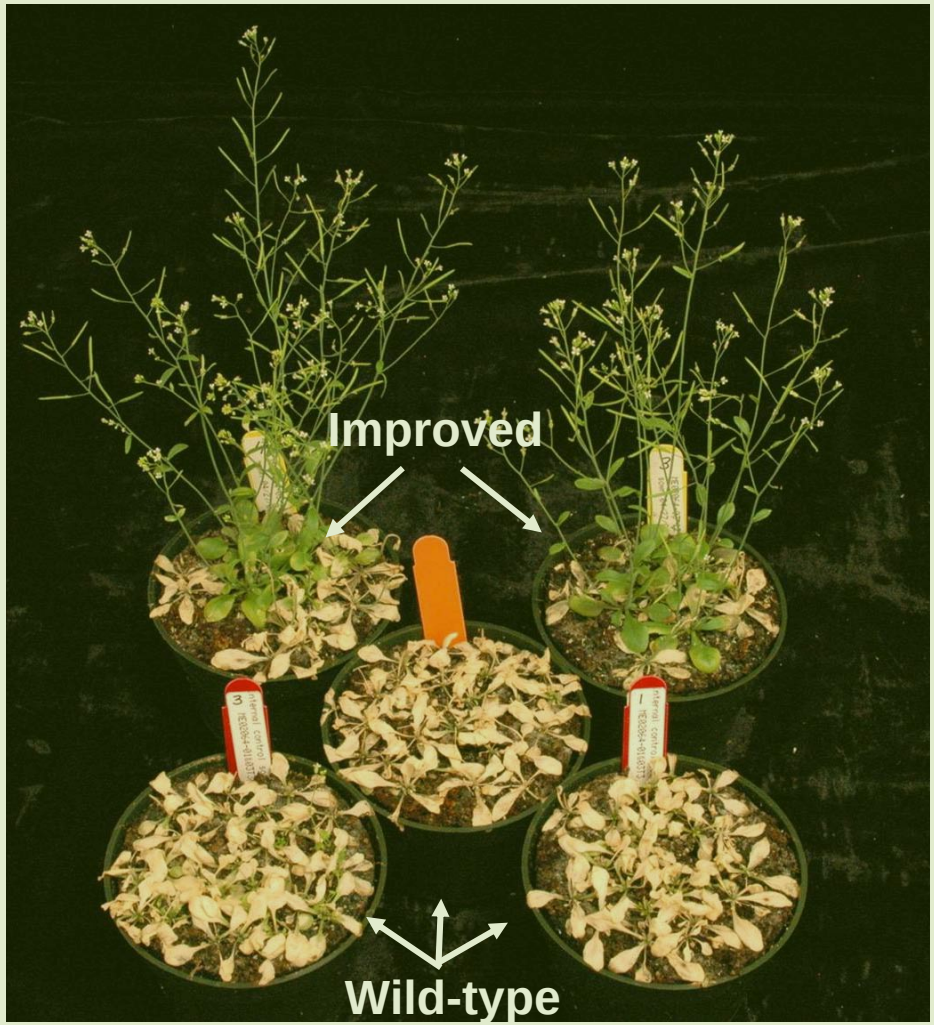
Innovation: Drought-Tolerance

Securing high yields on marginal land

Time-Lapse Photography Over Two Days

Control ***Drought-Tolerance Trait***

Salt Tolerance… (75% sea water)



Some “Recent” Innovations…

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- 1900 - Rediscovery of Mendel’s Laws
- 1935 - Hybrid genetics
- 1953 - Structure of DNA
- 1983 - Biotechnology in plants
- 1995 - Marker-assisted breeding
- 2001 - First plant genome sequenced

- What will the next 66 years bring?

Some Predictions…by a Techno-Optimist

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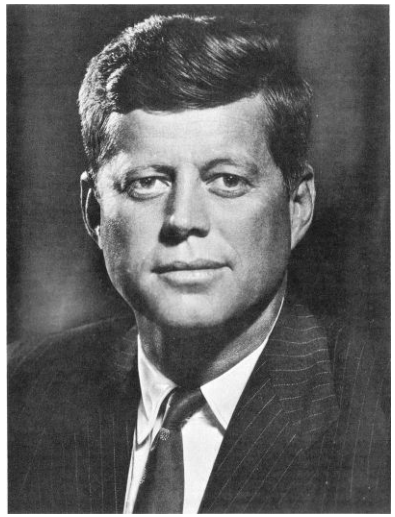
- **Near term**
  - Accelerated yield increases from markers
  - Broader adoption of hybrids
  - Drought tolerance (<5 yrs)
  - Improved nitrogen use efficiency (<10 yrs)
- **Mid-term**
  - Doubling of average US corn yields by 2030
  - Quadrupling of global grain yield averages by 2030
- **Long Term** (within the next 66 years…)
  - Nitrogen fixing grain crops
  - Perennial grain crops
- All will require genetic manipulation; breeding, markers, mapping, genomics, transgenes, cisgenes and…R&D funding, political will, positive regulatory environments

“For the great enemy of the truth is very often not the lie – deliberate, contrived and dishonest, but the myth, persistent, persuasive, unrealistic. We enjoy the comfort of opinion without the discomfort of thought.”

- John F. Kennedy



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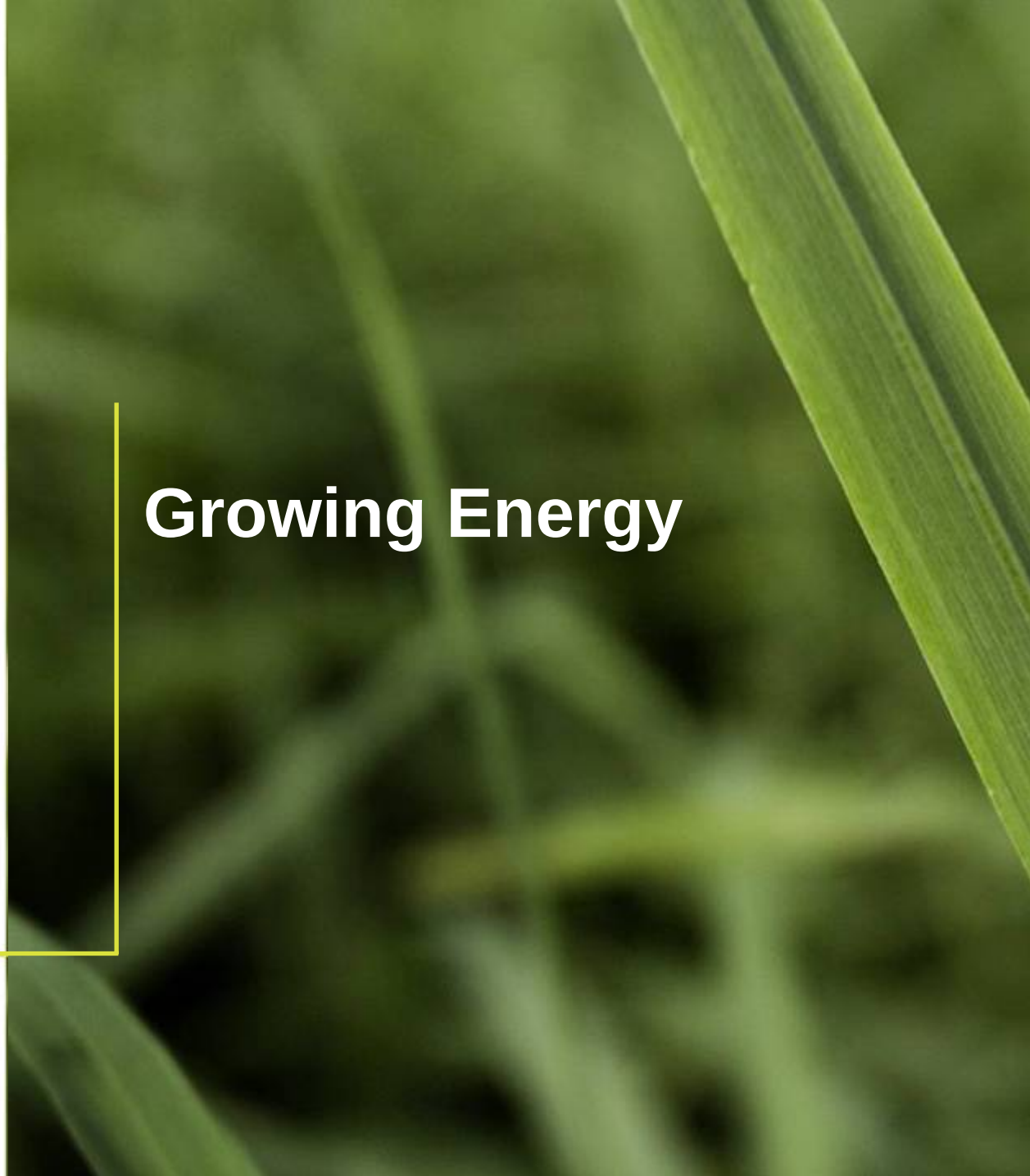

A Few Questions on ILUC Models….

- **Is conventional wisdom correct?**
  - CW on food versus fuel has proven to be wrong. Current biofuel production volumes are not driving up food prices; oil prices drive food prices.
- **Is "the Science settled"?**
  - Science is generating hypotheses, testing them against the available data and choosing those that best fit the data. Can ILUC models (hypotheses) fit the historical data? Can they hindcast or backcast previous trends in agriculture?
- **Will ILUC penalties slow deforestation?**
  - How will penalizing U.S. biofuels producers change the decisions made by illegal timber operations in the Third World?
- **Yield, yield & yield**
  - Do ILUC models correctly estimate potential increases in global agricultural yield and productivity e.g. 700% corn yield increases in Africa? Do they account for new high yielding biomass feedstocks e.g. switchgrass or miscanthus?
- **Are they politically feasible?**
  - Will U.S. producers be economically responsible for foreign land owner's use decisions?
- **Perhaps all land use change is direct?**
  - By holding governments and land owners directly responsible, can we begin to define a more predictable, transparent carbon playing field that will drive efficiencies in tillage and sequestration practices?