

**Malthus Has Been Wrong for Two
Centuries, but Will He Be in the 21st?
Agricultural Research Holds the Key**

Robert L. Thompson

Gardner Endowed Chair in Agricultural Policy

University of Illinois at Urbana-Champaign

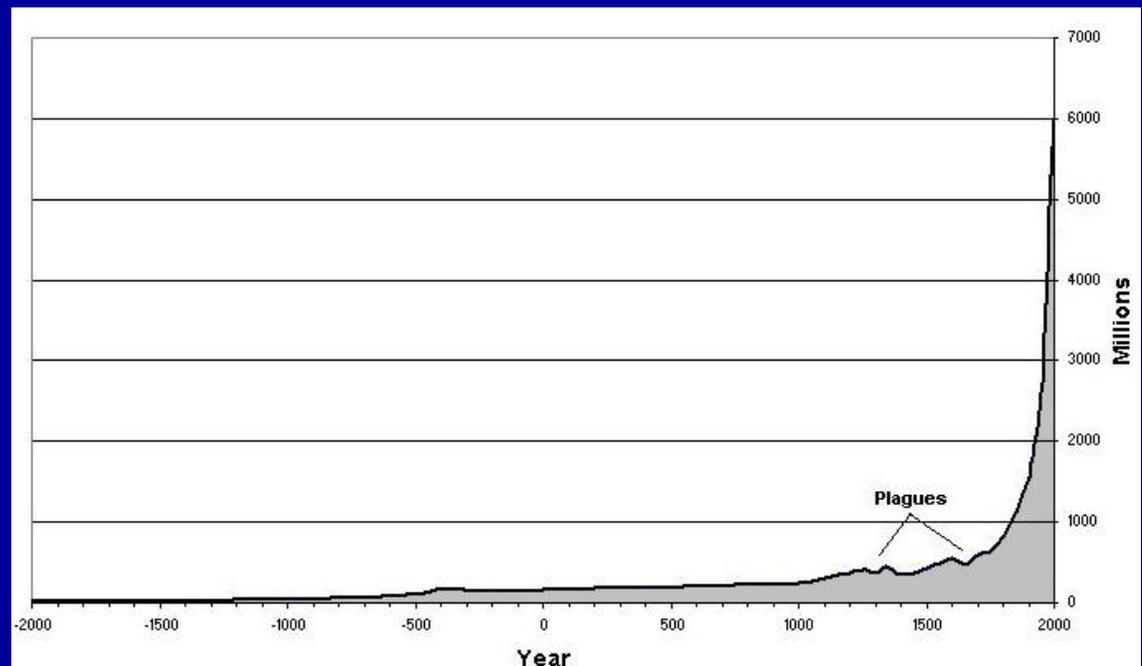
March 5, 2009

Two Centuries of Agricultural Success in Feeding the World

- Since Malthus, prophets of doom have argued population growth will increase food demand faster than agricultural production can grow.
- Public and private sector investments in agricultural research have increased productivity faster than demand growth, with resulting 150 year downward trend in real price of grains.

Evolution of World Population

- It took from the beginning of time to 1804 to get to the first billion people on earth.
- BUT, the population passed:
 - 2 billion in 1927
(123 years later)
 - 3 billion in 1960
(33 years later)
 - 4 billion in 1974
(14 years later)
 - 5 billion in 1987
(13 years later)
 - 6 billion in 2000
(13 years later)
 - 6.5 billion in 2006
(6 years later)



Projected Population Growth

Region	2008	2050	Change	Percent
World	6,705	9,352	+2,647	+ 40
High Income	1,227	1,294	+ 67	+ 6
Low Income	5,479	8,058	+2,579	+ 47
SubSaharan Africa	809	1,698	+ 889	+110
S. Central Asia	1,683	2,605	+ 922	+ 55
Lat. America/Carib	577	778	+ 201	+ 35
N. Af & W. Asia	422	670	+ 248	+ 59

Source: Population Reference Bureau. 2008 World Population Data Sheet, based on U.N. Population Office and U.S. Census Bureau analyses.

Dynamics of Food Demand Growth

- 1.4 billion people live on less than \$1.25/day; 923 million of them suffer under-nutrition or hunger.
- 3.1 billion people live on less than \$2.50/day; by then, most hunger (calorie) problems solved.
- As their incomes rise from about \$2 to \$10 per day, people eat more meat, dairy products, fruits, vegetables & edible oils, causing rapid growth in raw ag commodity demand.
- After about \$10 per day, people buy more processing, services, packaging, variety, and luxury forms, but not more raw ag commodities.

*Poverty numbers as of 2005, before commodity price explosion.

Huge Growth in Food Consumption Expected from Economic Growth

Country	Population	% < \$1/day	% < \$2/day
China	1318	9.9	34.9
India	1132	34.3	80.4
Indonesia	232	7.5	52.4
Brazil	189	7.5	21.2
Pakistan	169	17.0	73.6
Bangladesh	149	41.3	84.0
Nigeria	144	70.8	92.4
Philippines	85	14.8	43.0
Source: World Bank, World Development Indicators database (2007)			

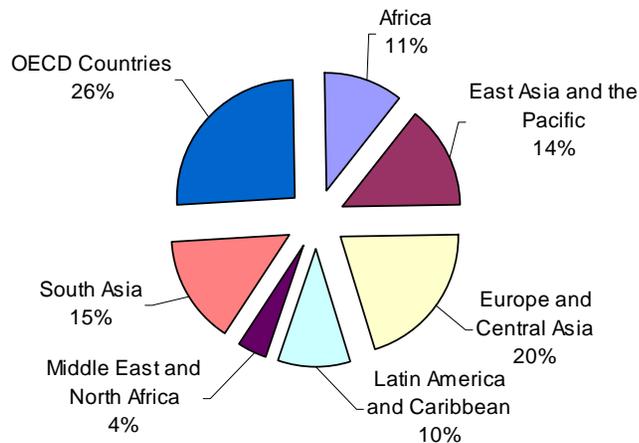
Projected World Food Demand

- World food demand could double by 2050
 - 50% increase from world population growth – all in developing countries
 - 50% increase from broad-based economic growth in low income countries
- The World Bank has estimated that the number of people in developing countries living in households with incomes above \$16,000 per year will rise from 352 million in 2000 to 2.1 billion by 2030.
- How many presently low income consumers are lifted out of poverty will be the *most important* determinant of the future global demand for food.

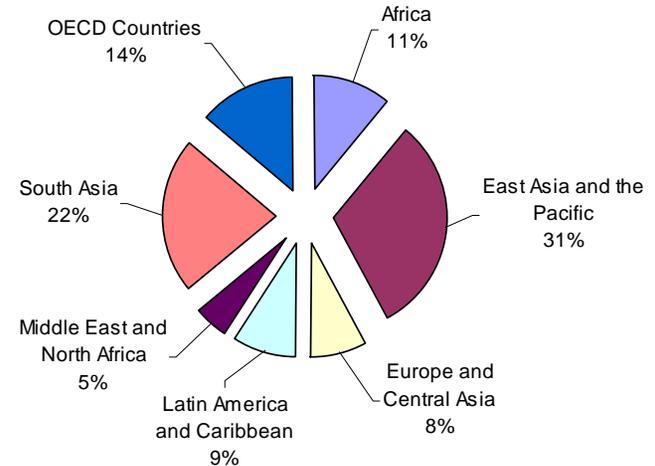
Growing Demands on Forests, Too

- The same forces of population and income growth that increase demand for food also increase demand for things made out of wood, e.g. paper, furniture, building materials; poles.
- In rich countries, growing demand for environmental amenities and preservation of (especially old-growth) forested areas.
- At the same time biofuels production has been claiming more and more land.

Larger Fraction of Ag Production to Move Through Trade



Distribution of Arable Land



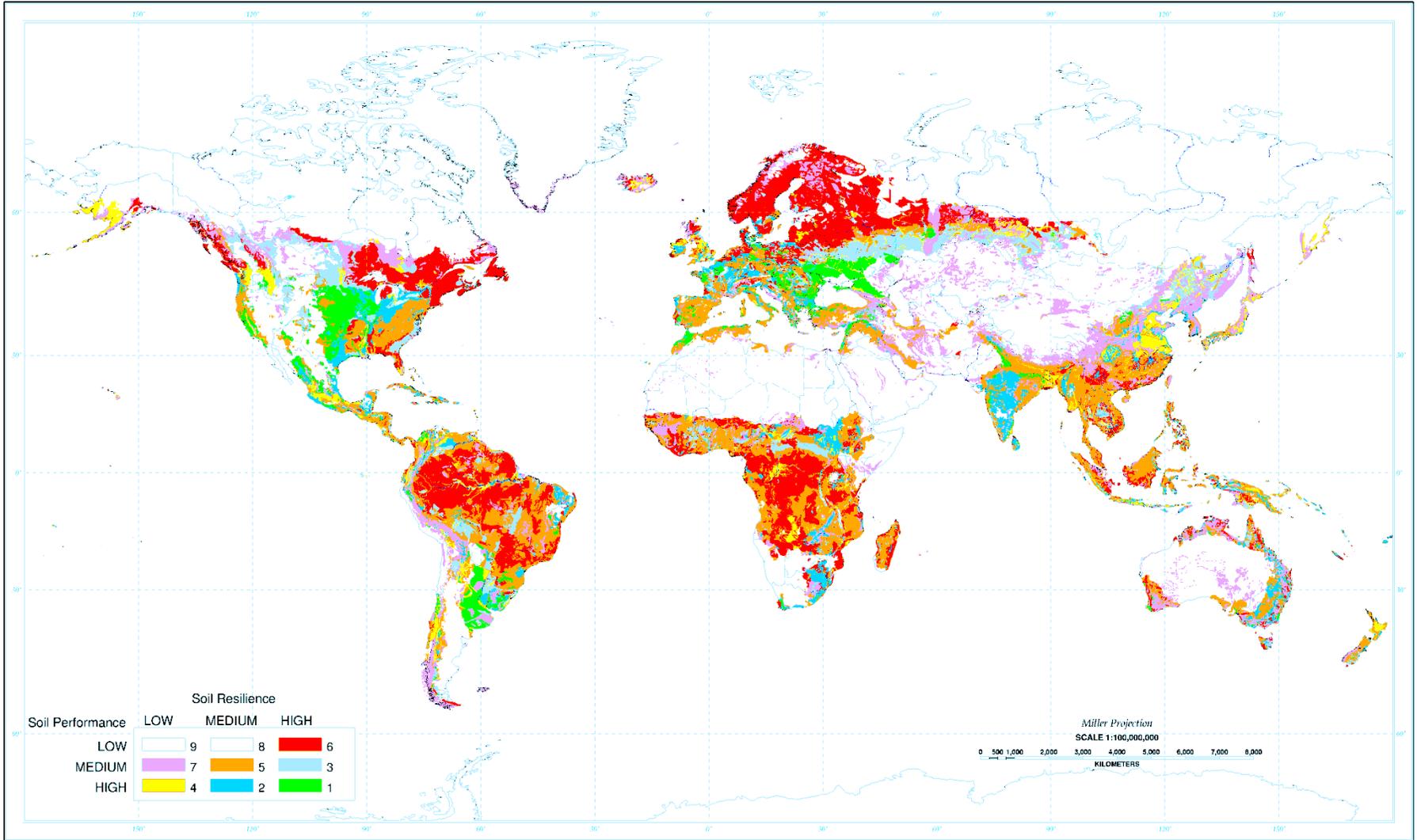
Distribution of World Population

- With population growth, urbanization and broad-based economic development, many low-income countries' food consumption will outstrip their production capacity, and they will become larger net importers.

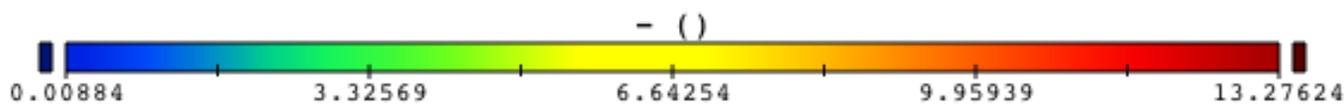
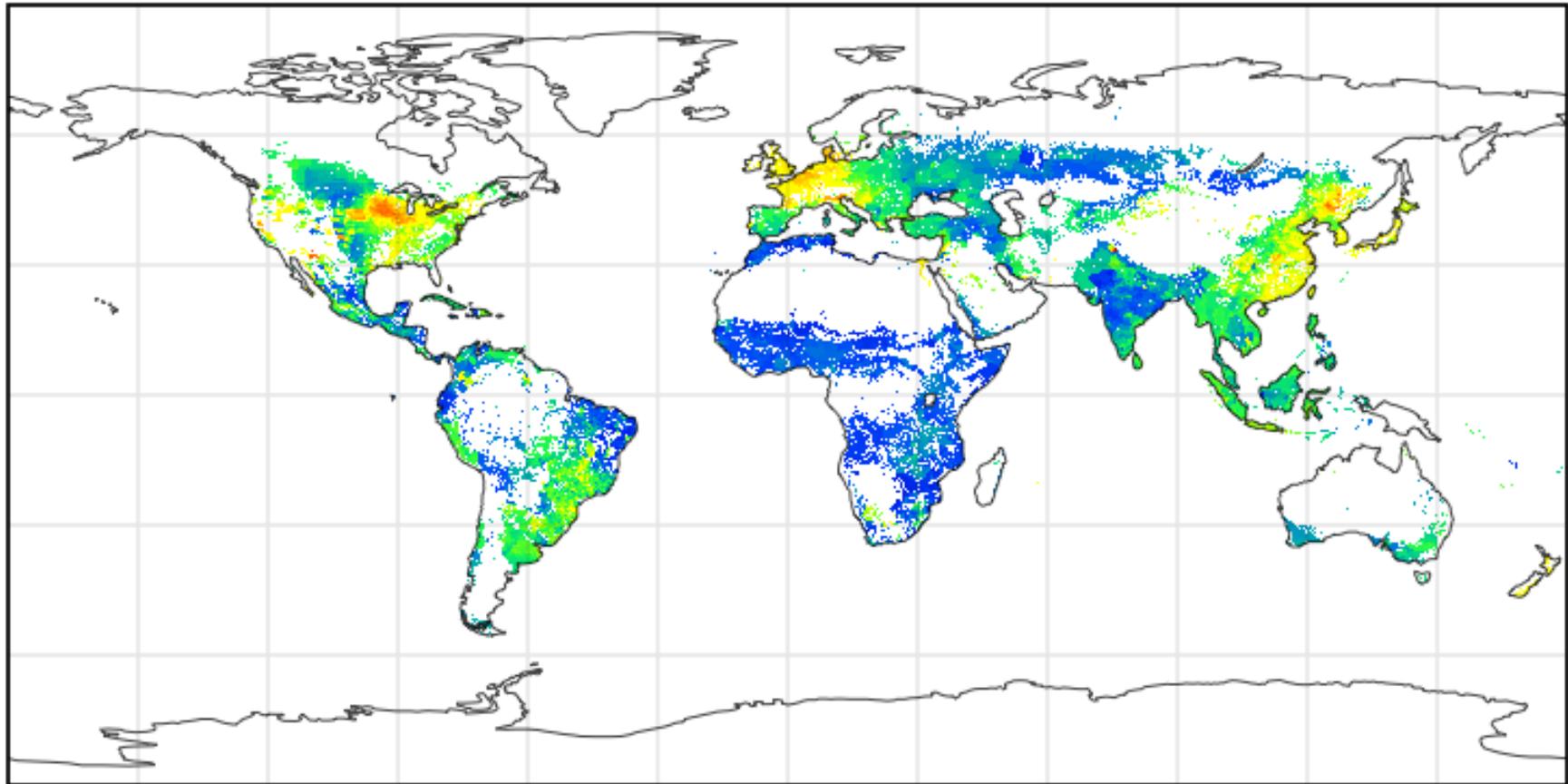
The Land Constraint

- There is at most 12% more arable land available that isn't presently forested or subject to erosion or desertification – and degradation of many soils continues.
- The area of land in farm production could be doubled...
- But only by massive destruction of forests and loss of wildlife habitat, biodiversity and carbon sequestration capacity
- The only environmentally sustainable alternative is to at least double productivity on the fertile, non-erodible soils already in crop production.

Inherent Land Quality Assessment



Grain Yields Around the World



Equirectangular projection centered on 0.0°E

Data Min = 0.00884, Max = 13.27624

Climate Imposes Constraints on World Ag Production



Water A Growing Constraint

- Farmers use 70% of the fresh water used in the world. They are both the largest users and the largest wasters of water.
- Water is priced at zero to most farmers, signaling that it is much more abundant than in reality. Anything priced at zero will be wasted.
- With rapid urbanization, cities are likely to outbid agriculture for available water.
- The world's farmers need to double food production using less water than today. Biofuels will add further to this challenge.

Adaptations Will be Required Due to Global Warming

- Need adaptive plant (and animal) breeding , just as has been done successfully to relax physical constraints in given regions for more than a century, e.g. introduce more drought or heat tolerance.
- Change the mix of what crops are produced in a given geographic location
- Rely more on international trade.

Need Research to At Least Double Food System Productivity

- Make presently unusable soils productive
- Increase genetic potential (of individual crops and/or farming system) (ditto for farm animals)
- Achieve as much of that potential as possible by:
 - Improving nutrition of that crop
 - Increasing water availability and control
 - Reducing competition from weeds for water, nutrients and sunlight
 - Reducing losses from disease and insects
- Reduce post-harvest losses

Agricultural Research Potential

- Most productivity enhancement potential of Green Revolution technologies already exploited.
- But biotechnology opens new frontiers:
 - Improve nutritional content of grains, etc.
 - Increase tolerance to drought, wetness, temperature, salt, aluminum toxicity, (to increase yields and/or planted area under adverse or variable conditions)
 - Internalize resistance to diseases; viruses
 - Reduce pesticide use, esp. insecticides
 - Herbicide-resistant varieties
 - Slow down product deterioration

Public vs. Private Agricultural Research

- Historical public support of biological research key to agricultural development (“public good”)
- Private sector did most of the mechanical, pesticide & animal pharmaceutical research (could patent resulting intellectual property)
- Private sector role in biological ag research only took off after late 1970s when Congress and European parliaments cut appropriations and encouraged private sector to take on this role

Intellectual Property Protection

- To satisfy their shareholders, the private sector has to be able to internalize return on its investment in ag research.
- If public sector doesn't pay for the agricultural research, farmers must pay for it (both successes and failures) in the price of the inputs they buy *each* year.
- A key challenge: How to solve ag problems of low income farmers in LDCs (especially in an era of climate change) who can't afford to pay for the inputs embodying the new technology & the country lacks foreign exchange to pay for it?

Decline in ODA Investments in Agriculture Development

- Between 1980 to 2005, foreign aid to LDCs for ag development dropped from \$8 billion to \$3.4 bill./yr (from 17 to 3% of the whole)
- In the 1980s, 25% of US foreign aid went to agriculture; dropped to 6% by 1990 and 1% last year.
- Share of World Bank lending going to agriculture fell from 30% in 1978 to 16% in 1988 to 8% in 2006.

Long-Run Prospects

- Since Malthus, prophets of doom have argued population growth will increase food demand faster than agricultural production can grow.
- Public and private sector investments in agricultural research have increased productivity faster than demand growth, with resulting 150-year downward trend in real price of grains.
- Need to double world food production by 2050 using less water and little more land than today and also produce feedstocks for biofuels production.

Long-Run Prospects

- Future world market price trend will depend on whether research increases land and water productivity faster than world demand grows.
- Need to rebuild public support (including foreign aid) for ag research to increase productivity in low income, foreign-exchange constrained countries.

Chicago Initiative on Global Agricultural Development

- Increase support for ag research, education and extension.
- Increase support for rural and ag infrastructure
- Improve national and international institutions that deliver ag development assistance
- Improve U.S. policies harmful to ag development abroad

[http://www.thechicagocouncil.org/
globalagdevelopment/](http://www.thechicagocouncil.org/globalagdevelopment/)

“To the people of the poor nations, we pledge to work alongside you to make your farms flourish...”

President Barack Obama
Inaugural Address, Jan. 20, 2009

“The President and I intend to focus new attention on food security so that developing nations can invest in food production, affordability, accessibility, education, and technology.”

Secretary of State Hillary Clinton
UN High-Level Meeting for Food
Security, January 26, 2009