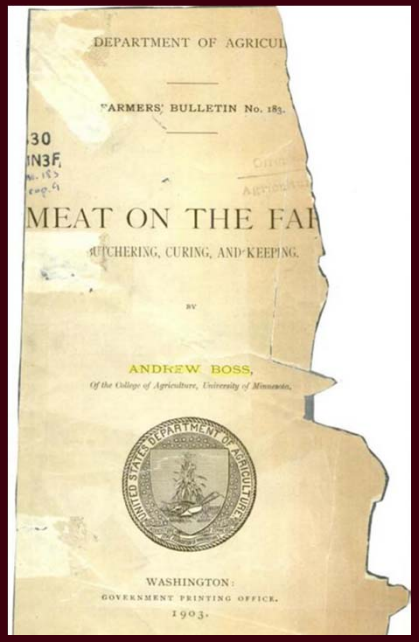
Farm to Fork

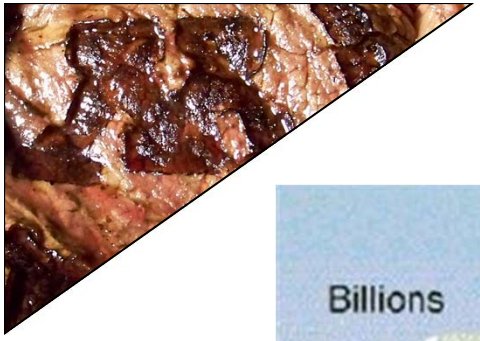
Feeding a Growing Population

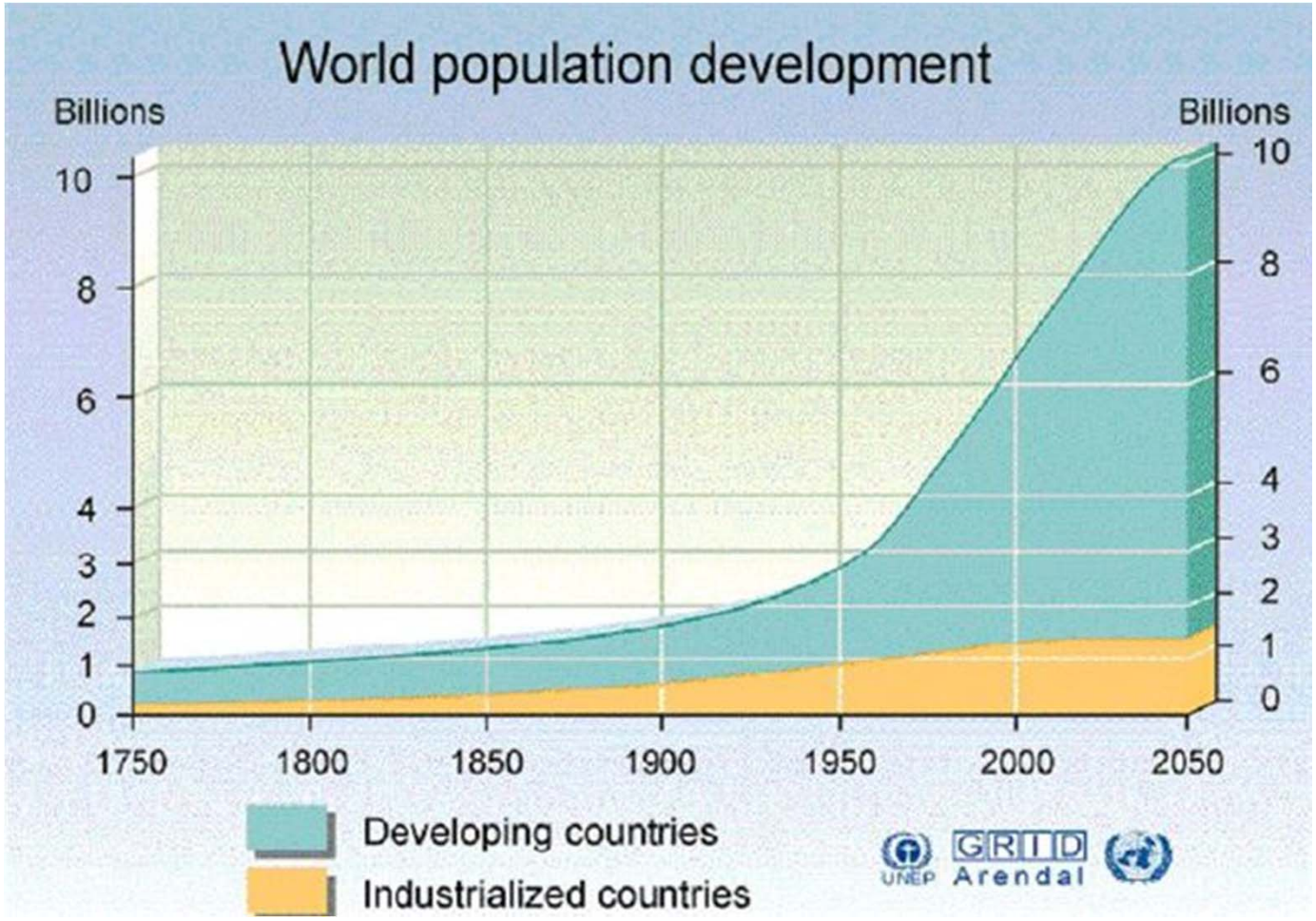


Ryan Cox
University of Minnesota

Feeding the World

From Problem to Challenge to Opportunity




World population development
Billions
Billions
10
8
6
4
3
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2
1
0
1750
1800
1850
1900
1950
2000
2050
Developing countries
Industrialized countries
UNEP
GRID
Arendal

Our Challenge

- **By 2050 world population predicted to surpass 9.5 billion**
  - **Of which more than 8 billion will live in the developing world and have a disproportionate increase in income per capita**

- **The FAO estimates to fulfill demand:**
  - **1.1% increase in milk production per year**
  - **1.2-percent increase in meat production per year**

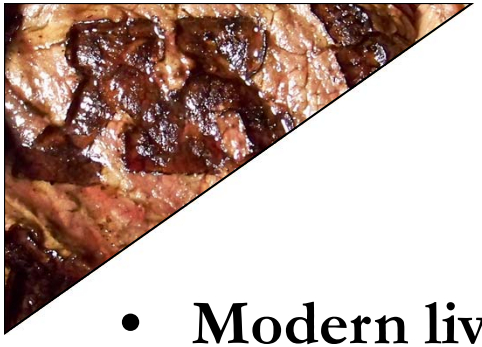
Our Challenge

- Increased competition for resources
- Need to "produce more, using less"
- Sustainability is a balance of:
  - environmental responsibility
  - economic viability
  - social acceptability
- In developing regions, food security is paramount

Our Challenge

- **Within the developed world, environmental impacts are arguably the greatest concern**

- **Land, water and energy are three major limiting resources to increasing future food production**



Our Challenge

- Modern livestock production systems sometimes are perceived as environmentally unfavorable
- However, productivity gains over time have improved resource use within livestock production
- Between 1977 and 2007, the U.S. beef industry reduced
  - feed use 19%
  - land use by 33%
  - water use by 12%
  - GHG emission by 16%

Our Challenge

- The trends are not the answer!
- Researchers have concluded that land use is greater in grass-fed beef production systems
- Capper reported a 302% increase in water use and 68% increase in GHG emissions per kilogram of beef in grass-fed compared to feedlot finishing systems

Our Challenge

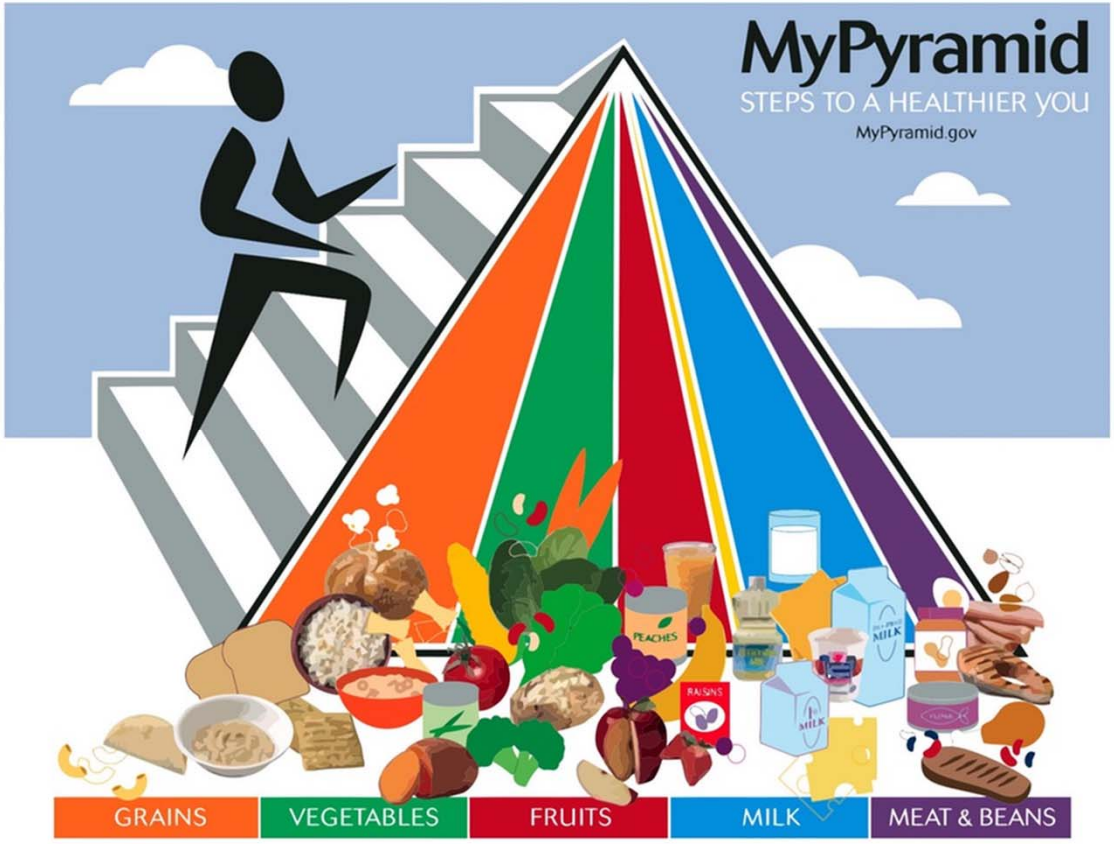
- Going Meat-less isn't the answer either!
- The average American consumes 167 pounds of meat per year
  - U.S. EPA reports that meat production in the United States contributes 3.3% to national GHG emissions
- Withdrawal from meat consumption would cut production by one-seventh, if every one of the 319 million Americans adopted this dietary change
- The annual reduction in national GHG emissions would be equal to less than one-half of one percent

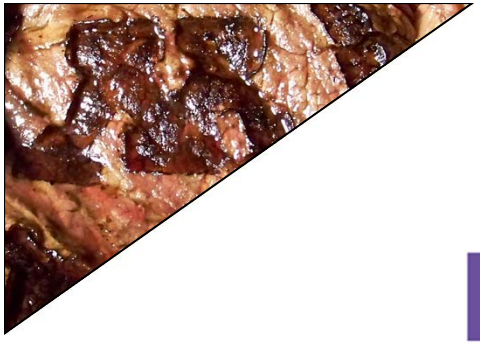
Our Challenge

- **In addition to increased populations and limited resources…**

- **Modern consumer trends continue to shape innovation**

Our Challenge





Our Challenge

Meat & Beans Food Gallery

Meats*
Lean cuts of
beef strip steak
ham
pork chop

Poultry*
chicken breast

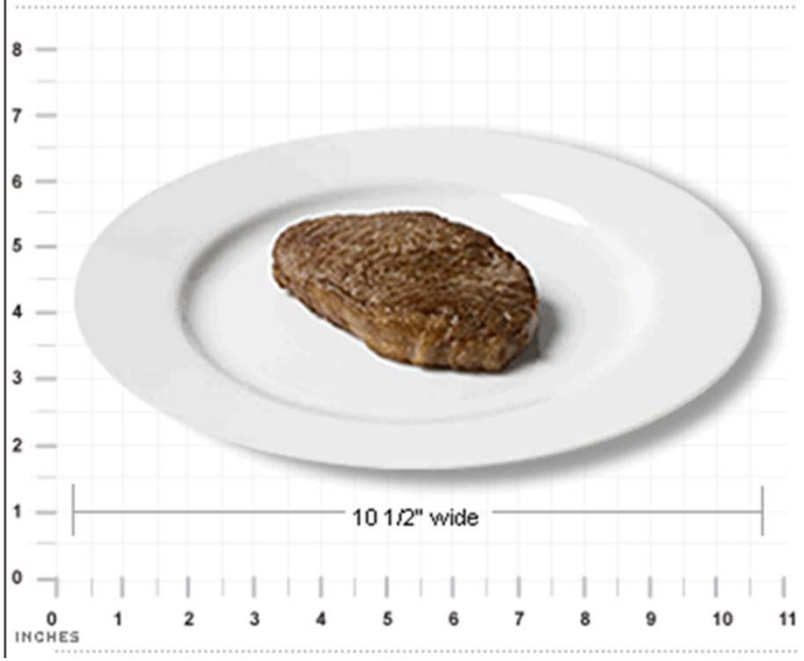
Fish*
salmon steak
shrimp

Seeds & nuts
almonds
cashews
mixed nuts
walnuts

Dry beans & peas
cooked black

Beef Strip Steak — 5 ounces cooked weight

Meat and Beans Group: counts as 5 ounce equivalents meat and beans



Our Challenge

- **CONVENIENCE**
- **“The 4:30 Meal Problem”**

Our Challenge

- Women in 1900
- According to a survey at the time, a typical woman spent 44 hours a week preparing meals and cleaning up after them
- Equates to approximately 6.5 hours per day

Bowers, Douglas, Food Review, January 1, 2000

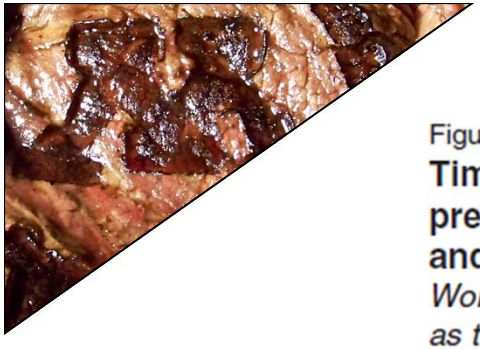


Figure 1

Time that women spend per day preparing food, by income category and labor force participation

Women spend less time preparing food as time requirements of paid work increase, an effect that is less pronounced among low-income women[1]

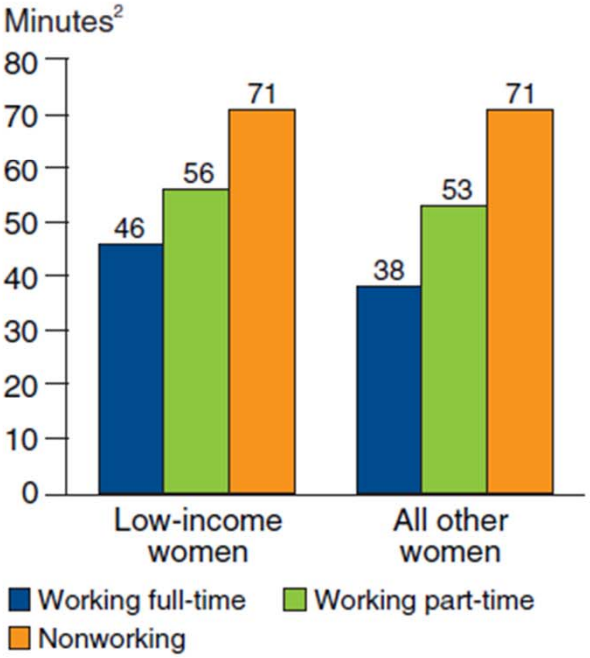
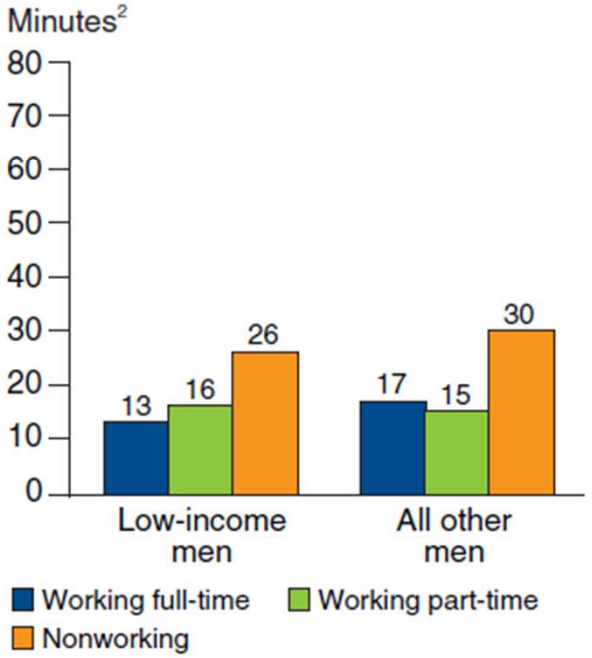


Figure 2

Time that men spend per day preparing food, by income category and labor force participation

Low-income men also spend less time preparing food as time requirements of paid work increases, but rising income increases the time spent preparing food[1]

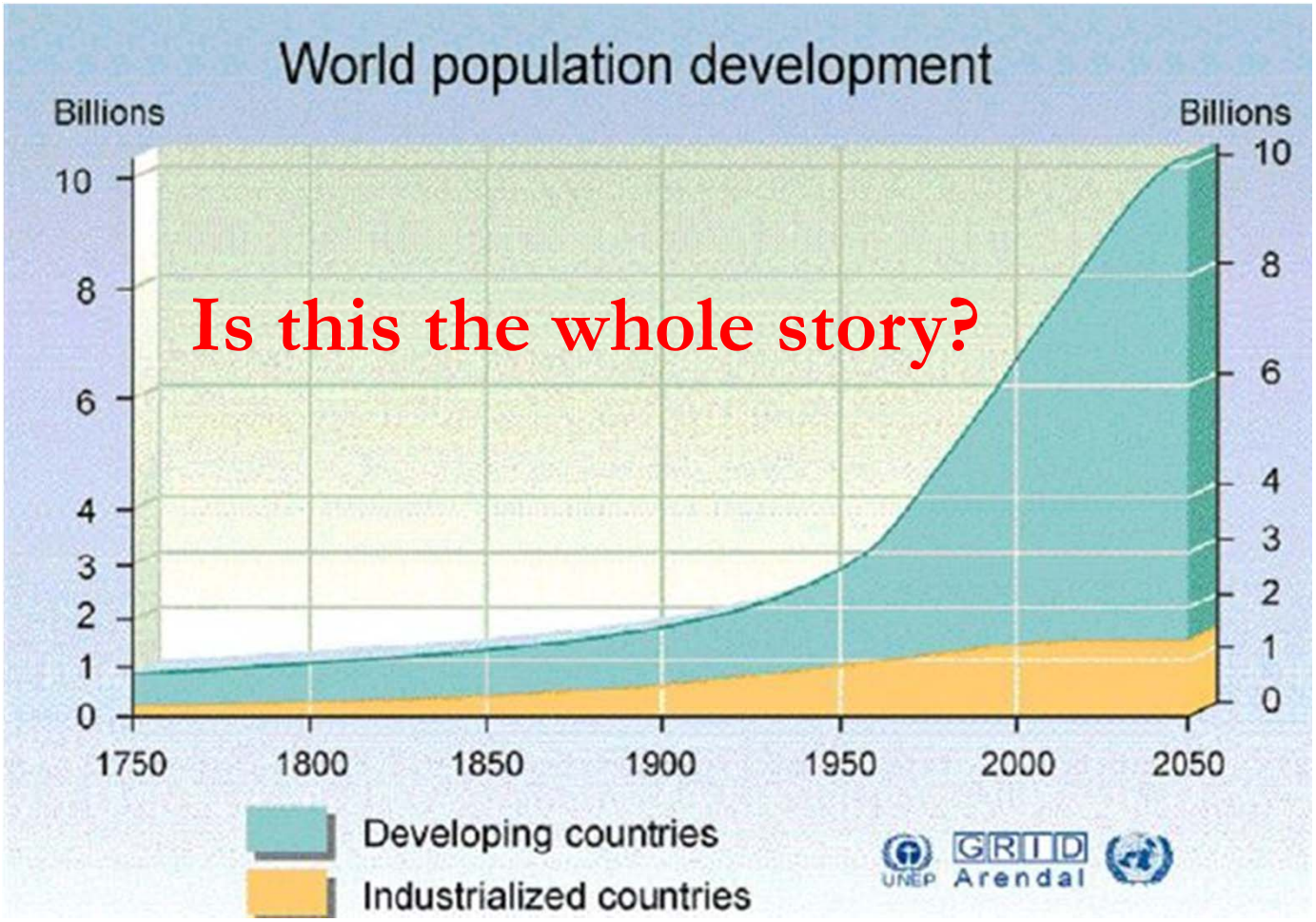


From Challenge to Opportunity

"The hungry eyes of toiling millions are turned, with mingled hope and fear, upon us, to see what new and better solution we can possibly offer of the great problems on which their well-being and destiny depend."

John Milton Gregory, March 11, 1868

Inauguration of the Illinois Industrial University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Is this the whole story?
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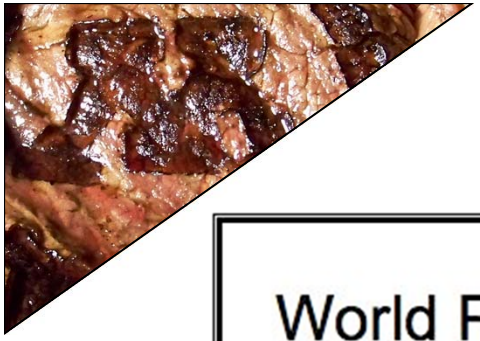
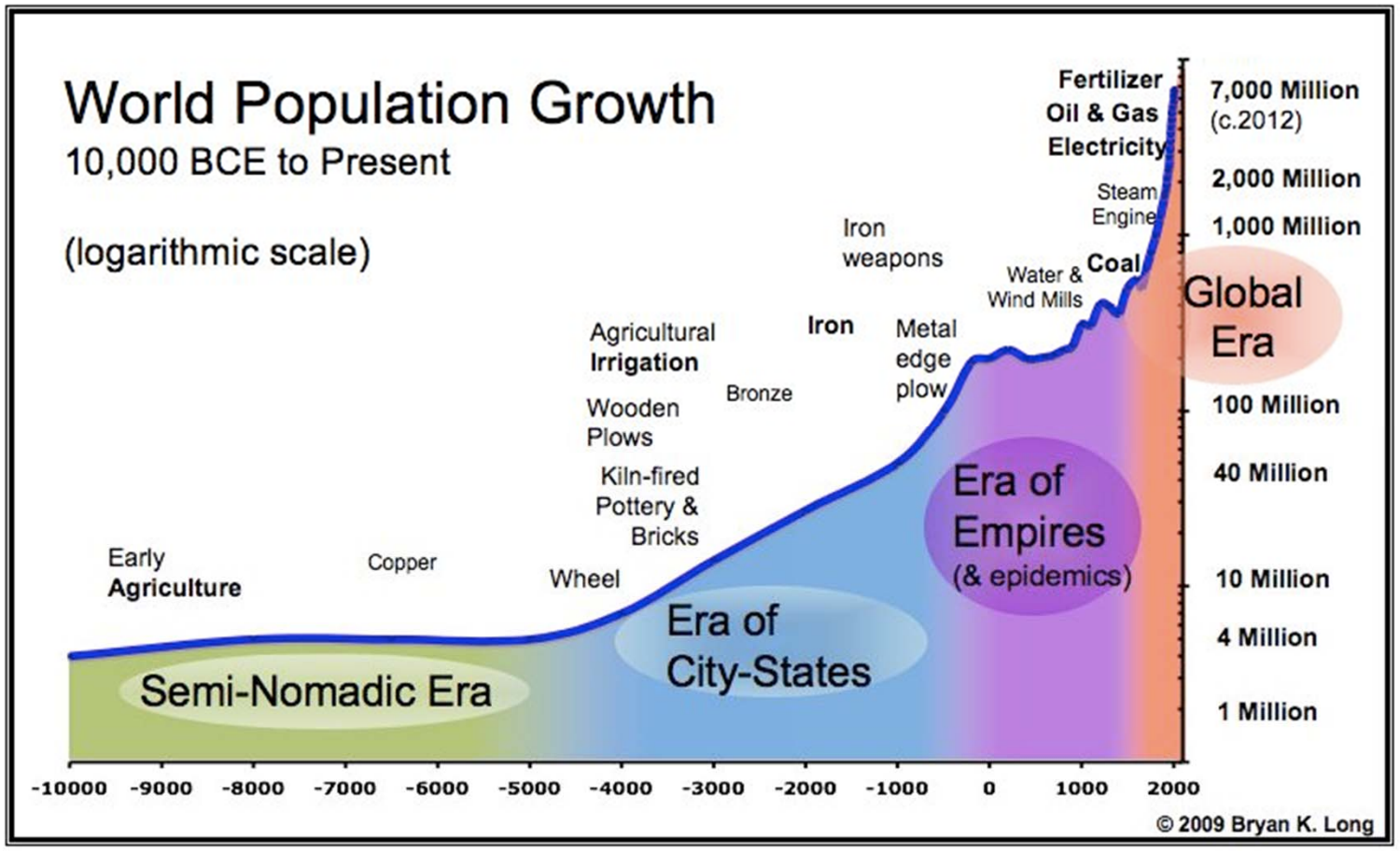
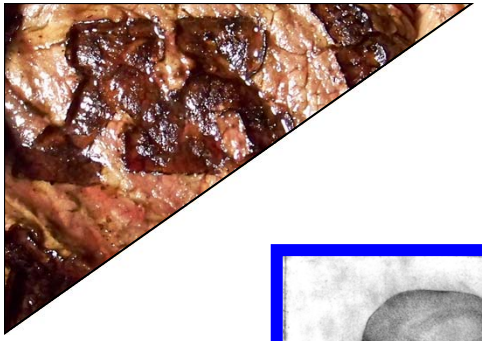
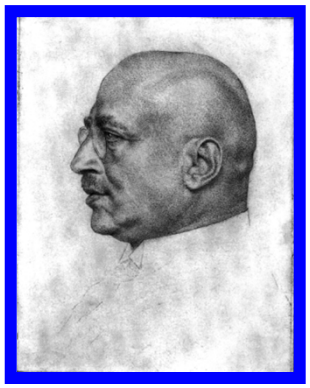



World Population Growth
10,000 BCE to Present
(logarithmic scale)
Fertilizer
Oil & Gas
Electricity
Steam Engine
Coal
Water & Wind Mills
Iron weapons
Iron
Metal edge plow
Agricultural Irrigation
Wooden Plows
Bronze
Kiln-fired Pottery & Bricks
Wheel
Copper
Early Agriculture
Semi-Nomadic Era
Era of City-States
Era of Empires
(& epidemics)
Global Era
7,000 Million
(c.2012)
2,000 Million
1,000 Million
100 Million
40 Million
10 Million
4 Million
1 Million
-10000 -9000 -8000 -7000 -6000 -5000 -4000 -3000 -2000 -1000 0 1000 2000
© 2009 Bryan K. Long





Fritz Haber (1868-1934)

Nobel Prize in Chemistry, 1918

-"for the synthesis of ammonia from its elements"

Carl Bosch (1874-1940)

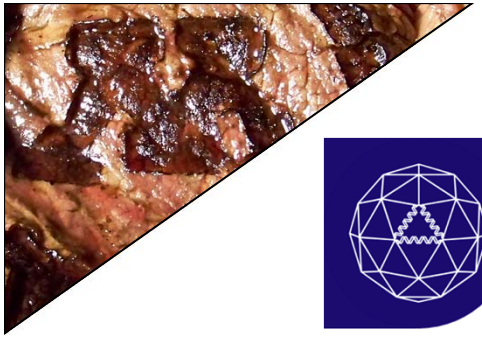
Ammonia to nitrate, 1914

Nobel Prize in Chemistry, 1931

Reactive N and Grain Production

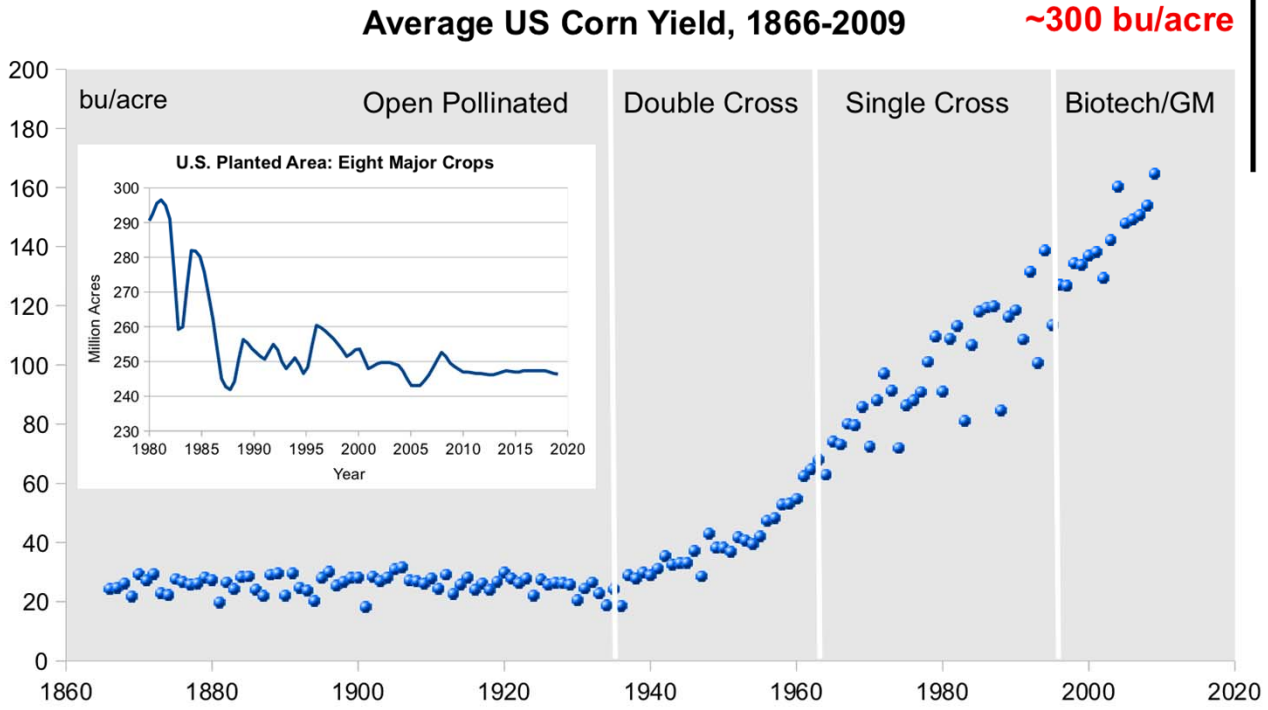
- Haber-Bosch have facilitated agricultural intensification
- 50% of world's population is alive because of it
- Half the N in our bodies is synthetically fixed N
- An additional 3 billion people by 2050 will be sustained by it

Loerch, 2016



Average US Corn Yields: No End in Sight

Current Test Yield: ~300 bu/acre



Sources: USDA-NASS; Troyer, *Crop Science* 46.2 (2006): 528; Pioneer (Rupert and Butzen, Crop Sci, 19(2))

Loerch, 2016

Measurable Impacts

- Corn, milk, beef production, etc.
- Food costs
- Discoveries and Commercialization
- Students
  - Scientists: academia and industry
  - Consultants and educators
  - Food producers

Loerch, 2016

HOW IS WATER USED?

441 GALLONS
to produce one pound of boneless beef

OVER 713 GALLONS
go into the production of one cotton t-shirt

39,090 GALLONS
to manufacture a new car

36 MILLION GALLONS
per day leaks from the New York City work supply system

Source: http://factsaboutbeef.com/2013/04/11/the-reality-of-water-management-raising-cattle/

ENOUGH

Beef farmers and ranchers have decreased their carbon footprint by 30% since 1975.

1975

2016

7 head of cattle can produce as much as 10 did in 1975.

Source: http://arrowcattlequip.com/blog/timeline-of-changes-beef-cattle-north-america/

ENOUGH

IN THE LAST 50 YEARS

the beef industry has:

INCREASED BEEF PRODUCTION BY

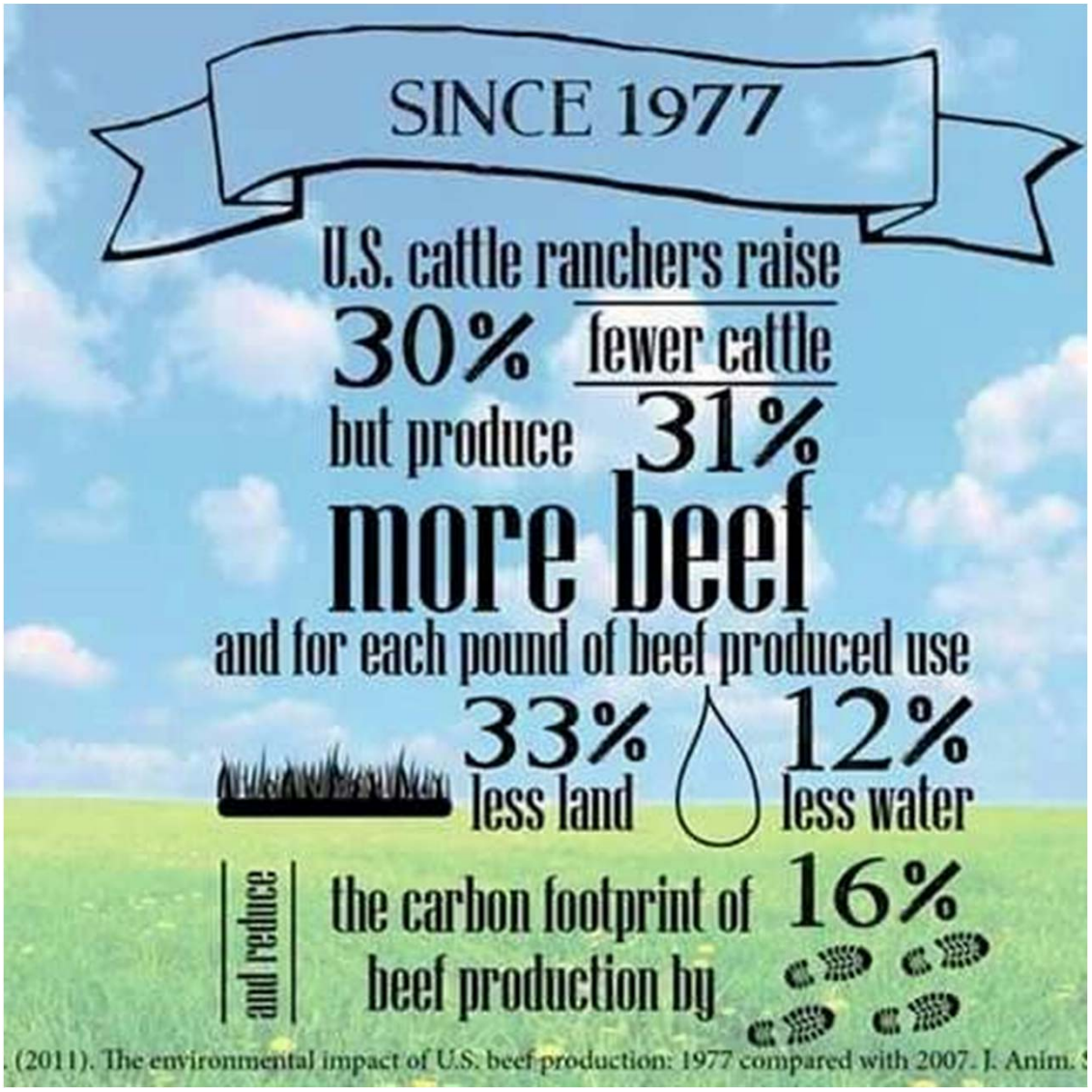
80%

DECREASED ACRES OF CORN GROWN TO FEED CATTLE BY

6%

Source: Elam, T. E., Preston, R. L. 2004. Fifty years of pharmaceutical technology and its impact on the beef we provide to consumers.

ENOUGH


SINCE 1977
U.S. cattle ranchers raise
30% fewer cattle
but produce 31%
more beef
and for each pound of beef produced use
33% less land
12% less water
and reduce
the carbon footprint of beef production by 16%
(2011). The environmental impact of U.S. beef production: 1977 compared with 2007. J. Anim.

IF WE NO LONGER USED TECHNOLOGIES TO RAISE BEEF CATTLE WE WOULD NEED:

10M more cattle in the U.S. beef herd

3M more fed cattle to harvest

81M more tons of feed

17M more acres of land for grazing and growing feed

138B more gallons of water

Source: http://sustainablebeef.org/_assets/SBRC-Hayes%20White-Paper-Roll-Out.pdf

ENOUGH

IF WE NO LONGER USED INNOVATION
TO RAISE PIGS WE WOULD NEED

710M
More Pigs

394M
Metric tons of feed

106M
Hectares of land

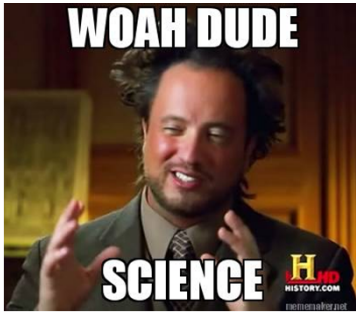
710M
Litres of water

Source:
Knapp, J. Elanco Animal Health. 2014 Food Forward Report. Data on file.

ENOUGH™

So what's the bottom line?

Our Charge



- To double food production, 70% will need to come from new technologies
- Today we produce 1 gallon of milk with 90% less land and 65% less water than 80 years ago
- To produce 13 million tons of beef: now vs 30 years ago
  - 30% fewer animals
  - 20% less feed and 15% less water
  - 35% less land

Loerch, 2016

Our Charge

- **A commitment to sound science and innovation is at the forefront of feeding the world**

- **Critical to increase resources and opportunities for the scientific community to accelerate advances**

IFT℠

feeding the minds that feed the world

Thank You

Ryan Cox, Ph.D.
Associate Professor, Meat Science
Department of Animal Science
University of Minnesota
155D Haecker Hall
1364 Eckles Avenue
St. Paul, MN 55108-6118
Phone: 612-624-3063
Email: ryancox@umn.edu

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