

The Future of Food Security

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SUSTAINABLE DEVELOPMENT GOALS



Global Goals for achievement by 2030 adopted by United Nations General Assembly in 2015.

Dimensions of Food Security

- Global Food Security
 - Can the world's farmers feed its larger population better than today at reasonable cost without damaging the environment?
- National Food Security
 - Every government has to ensure that its people have a reliable, safe and nutritious, reasonably priced supply of food available from some combination of domestic production and imports.
 - What is the potential for self-sufficiency that is economically efficient and environmentally sustainable?
- Household Food Security
 - Availability, ability to access; utilization?

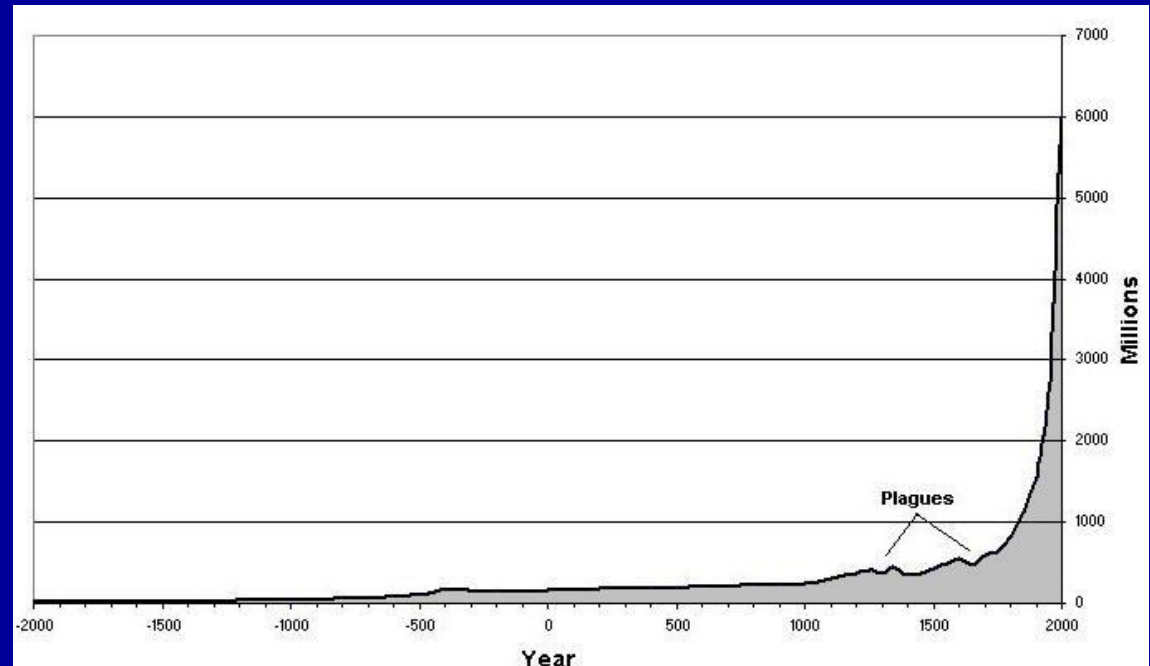
Household Food Security

- **Availability:** Is there a safe, reliable, and reasonably priced supply of all essential nutrients available from local production or the market year around?
- **Access:** Does a household have the purchasing power to access a nutritionally balanced diet from home grown sources or the marketplace?
- **Utilization:** Is a person healthy enough so that the nutrients ingested can actually be absorbed and used by the body?

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 1999
(12 years later)
 - 7 billion in 2011
(12 years later)
 - 8 billion in 2023
(12 years later)

In 1798, Malthus wrote that food production could not keep up with population growth and that starvation would limit the size of the world's population.



Malthus Got It Wrong

- With the development of ocean shipping, vast new areas of land were brought into agricultural production in North and South America and Oceania.
- Engineering research developed machines that enabled every farmer to cultivate far larger areas of land and manage larger herds of livestock and poultry flocks.
- Research on genetics and on control of insects, diseases and weeds resulted in big increases in production per hectare of land and per animal.
- Instead of limiting population as Malthus predicted, global food output has grown faster than consumption, the cost of food has trended downwards, and the world's population is now over 7.8 billion.

But Not All Is Well

- While there may be plenty of food grown in the world, millions have been left behind with inadequate diets—deficient in calories, vitamins, minerals and/or amino acids.
- According to FAO, before COVID-19 struck, an estimated 750 million people (10% of world's population) were affected by “severe food insecurity,” and 690 million were “hungry.”*
 - “Hungry” means lack sufficient purchasing power to access even 1,800 calories per day, not enough for an adult to put in a medium level of physical activity.

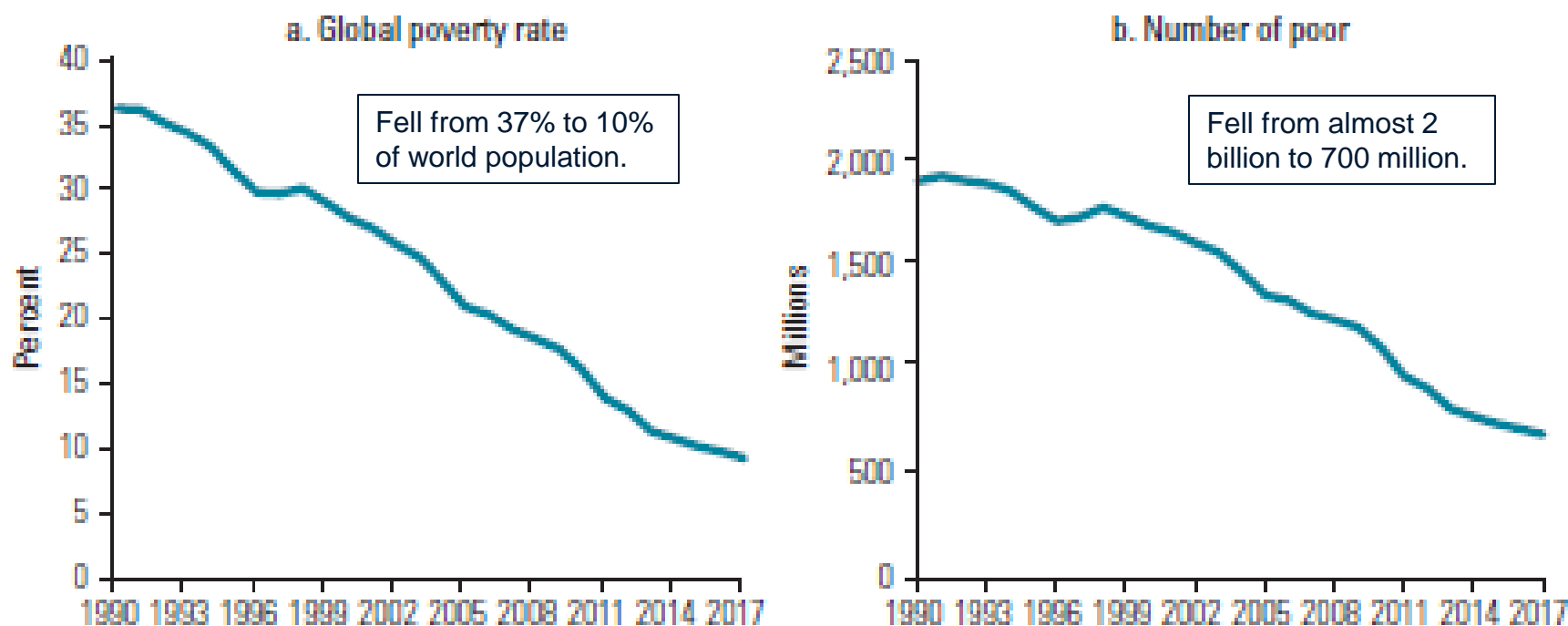
*Source: FAO. [The State of Food Security and Nutrition in the World 2020.](#)

Hunger & Food Insecurity Widespread

- War, natural disaster, and economic crises cause a great deal of hunger in the world, but chronic hunger is due mainly to poverty.
- Emergency feeding programs like yours play an essential role in addressing such human crises, and there will always be short-term local crises.
- However, to really “solve” the world’s chronic hunger problem (SDG#2), the world’s poverty problem must be solved (SDG#1).
- And 80% of extreme poverty is rural.
 - Most are farmers; the majority are female; half are children; most have little or no schooling.
 - Despite being farmers, most are net food buyers.

Incredible Progress Was Made at Reducing Poverty and Associated Hunger Over Three Decades

FIGURE 0.1 Global Poverty Rate and Number of Poor at the US\$1.90-a-Day Poverty Line, 1990–2017



Source: PovcalNet (online analysis tool), World Bank, Washington, DC, <http://iresearch.worldbank.org/PovcalNet/>.

Note: The global coverage rule is applied (see annex 1A in chapter 1 in this report).

COVID-19 Reversed Progress

- COVID-19 has pushed 131 million people back into extreme poverty (Pew estimate).
- The “new poor” characterized by:
 - More urban than rural, living in congested urban settings and working in sectors affected by lockdowns and mobility restriction.
 - More engaged in informal services or manufacturing, including food processing.
- Food availability disrupted in some places, and global food prices have been rising.

Disproportionate Regional Impact

- While all regions of the world have been affected, the projected increase in global poverty has been concentrated in:
 - South Asia (78 million), and
 - Sub-Saharan Africa (40 million)*
- It will take years to make up for the years of progress in reducing poverty and associated insecurity that have been lost.
- There will be plenty for food banks and other food aid programs to do.

Global Food Security: Prospects for the Future

Projected Population Growth to 2050

(millions)

Region	2020	2050	Change	Percent
World	7,773	9,876	+2,103	+ 27
High Income	1,219	1,309	+ 90	+ 7
Low-Middle Income	6,554	8,567	+2,013	+ 31
East & S.E. Asia	2,303	2,385	+ 82	+ 4
South+Central Asia	2,042	2,557	+ 515	+ 25
Sub-Saharan Africa	1,094	2,192	+1,098	+100
Latin America/Carib	651	759	+ 108	+ 17
N. Africa & W. Asia	525	785	+ 260	+ 50

Source: Population Reference Bureau. [2020 World Population Data Sheet](#).

Dynamics of Food Demand Growth

- As their incomes start to rise, very low income people spend most of the first increments to income on food.
- By about \$2 per day most “hunger” problems (ability to access enough calories) can be solved
- As their incomes rise from about \$2 to \$10 per day, most people eat more meat, dairy products, fruits, vegetables & edible oils, causing rapid growth in demand for raw ag commodities.
- After about \$10 per day, people buy more processing, services, packaging, variety, and luxury forms, but not more raw ag commodities.

Regional Distribution of Poverty

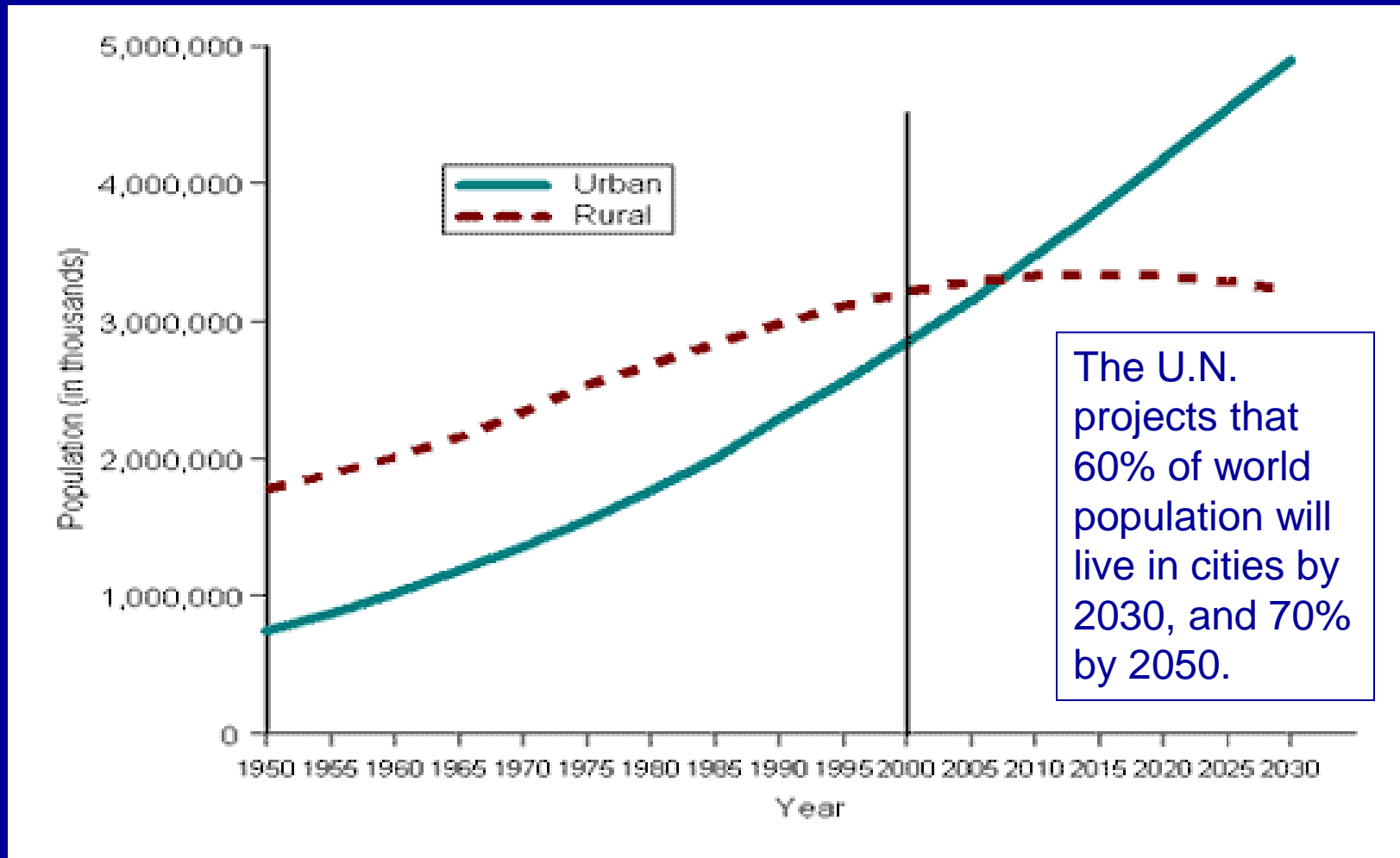
(Less than \$1.90* per capita per day), 2015

Region	Millions	Percent
Sub-Saharan Africa	413.3	41.1
South Asia	216.4	12.4
East Asia & Pacific	47.2	2.3
Latin America & Carib.	25.9	4.1
Middle East & N. Africa	18.6	5.0
E. Europe & Central Asia	7.1	1.5
Total	735.9	10.0

*Income corrected for differences in purchasing power across countries.

Source: World Bank. [World Development Indicators](#).

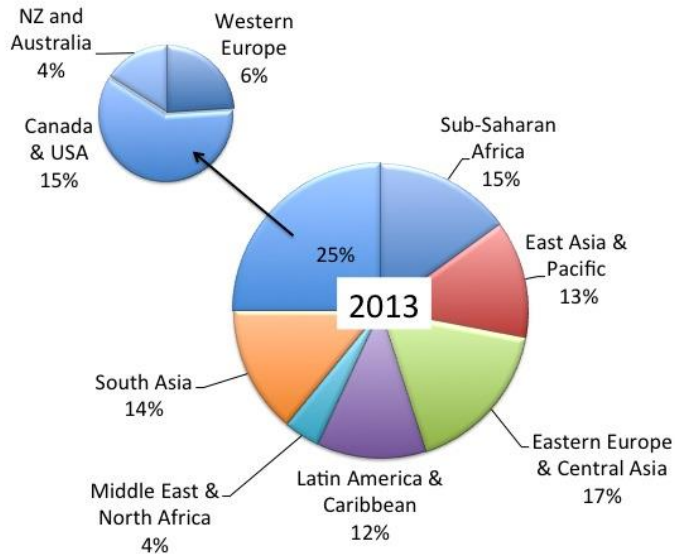
Urbanization Also Changes Diets



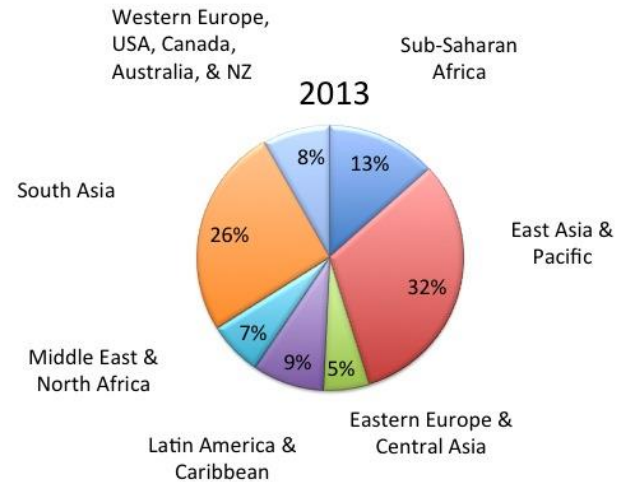
The Global Challenge

- World demand for food will grow 50-60% by 2050, with population growing 27% from 7.8 to 9.9 billion, and urbanization and poverty reduction changing dietary patterns.
- Post-harvest losses take about 1/3 of production.
- If losses can be cut by half, world food production will still have to grow by over 40%.
- To add complexity, climate change is shifting all agroecological zones and increasing the frequency of extreme climatic events.

The world's agricultural resources are not distributed around in the world in the same proportions as is population.



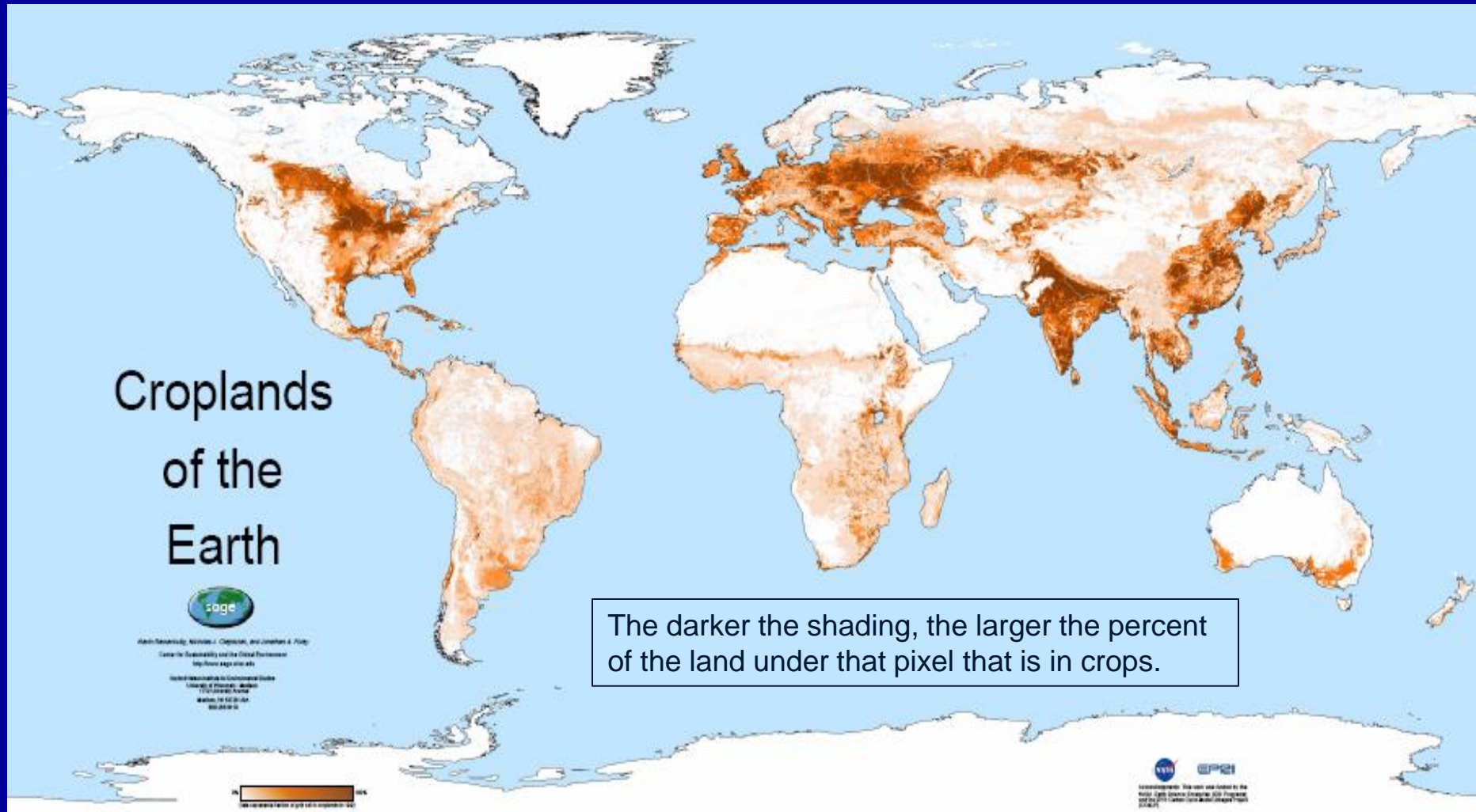
Distribution of Arable Land



Distribution of World Population

East and South Asia have more than twice as much of the world's population than of the arable land, and virtually all of their arable land is already in production. The Middle East & North Africa have land, but lack enough fresh water.

Croplands of the Earth

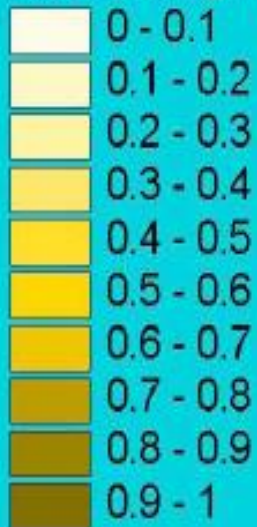


Source: Center for Sustainability and the Global Environment (SAGE), University of Wisconsin.

Grazing Lands of the World

There is an even larger area of land which does not receive enough rainfall for annual crop production which can grow grass that ruminant livestock* can convert into milk and meat, thereby contributing to the world's food supply.

Fraction of grid cell



The darker the shading, the larger the percent of the land under that pixel that is in grazing.

Grazing Lands of the World

*Ruminants include cattle, sheep, goats, bison, buffalo, deer and camels.

Source: Center for Sustainability and the Global Environment (SAGE), University of Wisconsin.

The Land Constraint

- There is at most 10% more arable land available worldwide that isn't presently forested or subject to erosion or desertification, and...
- Loss and degradation of many soils continues:
 - Urbanization, infrastructure construction, nutrient mining, erosion, desertification, natural reserves; reforestation.
- The area of land in global farm production could be expanded significantly more than 10%...
 - But only by destruction of forests, with accompanying loss of wildlife habitat, biodiversity and carbon sequestration capacity, accelerating global warming.

The Land Constraint (cont'd.)

- The only environmentally sustainable alternative is to increase productivity on the fertile, non-erodible soils already in crop production.
- Most available cropland is in remote areas of South America and Sub-Saharan Africa where infrastructure is minimal, and soils are inferior in quality to many already in production.

Water--A Growing Constraint

- In their irrigation farmers account for 70% of the world's fresh water use.
- With the rapid urbanization underway, cities are outbidding agriculture for available fresh water.
- The world's farmers, who are being called on to increase ag production, will have to do it using less fresh water than they are using today.
 - i.e., they have to increase the “crop per drop,” the average productivity of the water they use.
- This will require investments in research to develop water saving technologies and to increase the drought tolerance and water use efficiency of the crop varieties being grown.

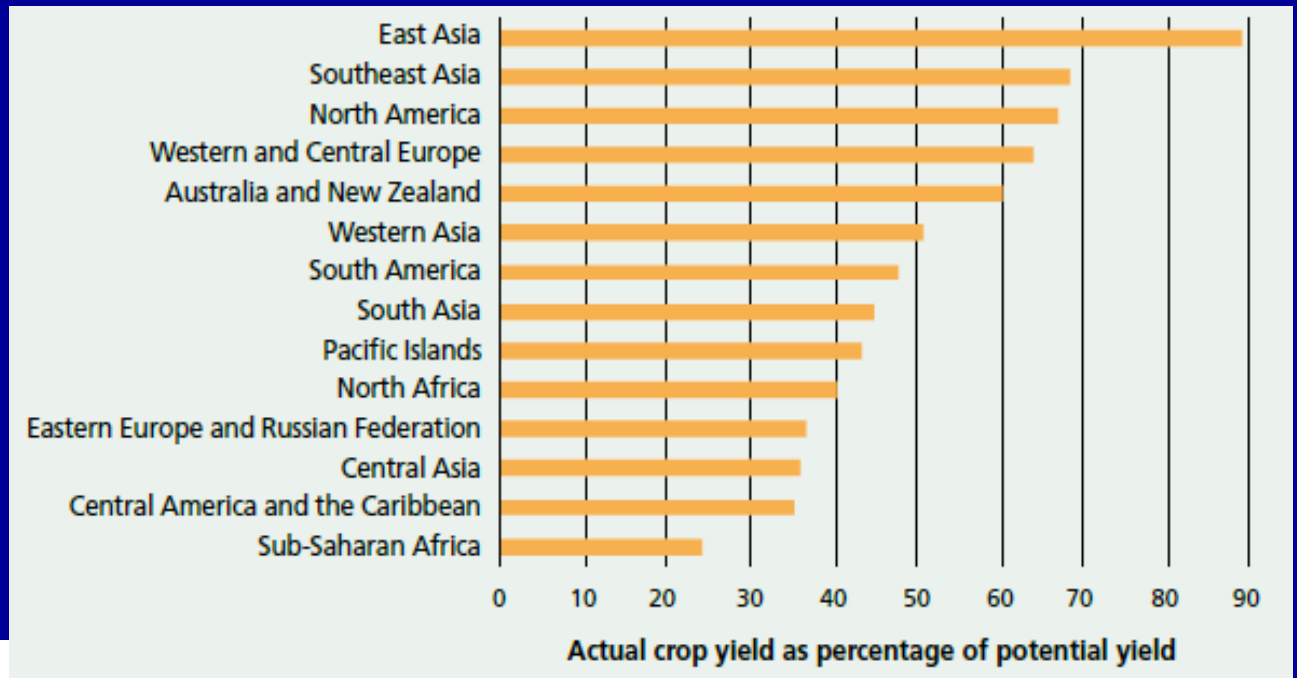
Solving the Water Constraint

- There is one source of optimism that the productivity of the water used in agriculture can be increased. Water is priced at zero to most of the world's farmers, signaling that it is much more abundant than it is in reality.
 - Anything priced at zero will be wasted.
- There are better technologies available today that increase water use efficiency than farmers are using in many parts of the world, but with water priced at zero, it doesn't pay to adopt them.
- If the politically difficult hurdle of starting to charge farmers for the water they use can be overcome, this would stimulate adoption of the available technologies.

Underperformance of Agriculture

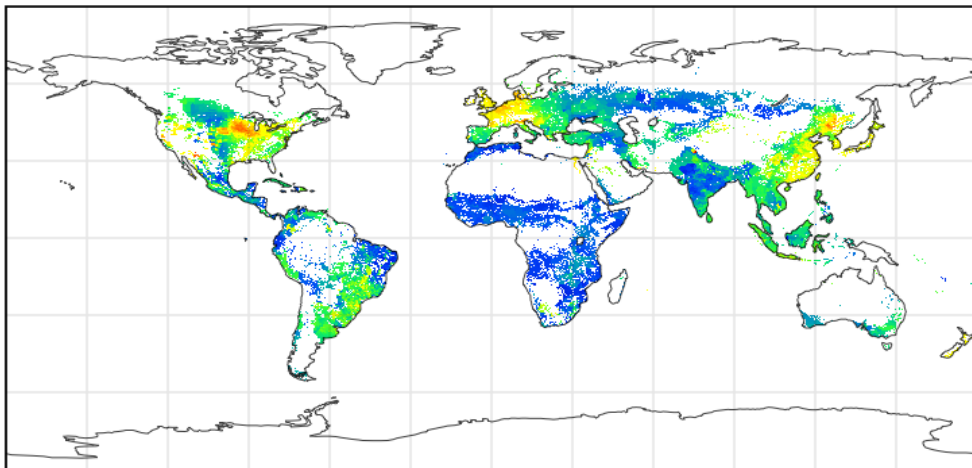
- The agricultural sector in many low income countries is underperforming relative to its potential that would be consistent with both economic efficiency and environmental sustainability.
- It produces less food and cash income for farm households and contributes less output to their national food supply.

Crop Yield Gap



Actual crop yield as percentage of potential yield

Source: FAO.



0.00884 3.32569 6.64254 9.95939 13.27624

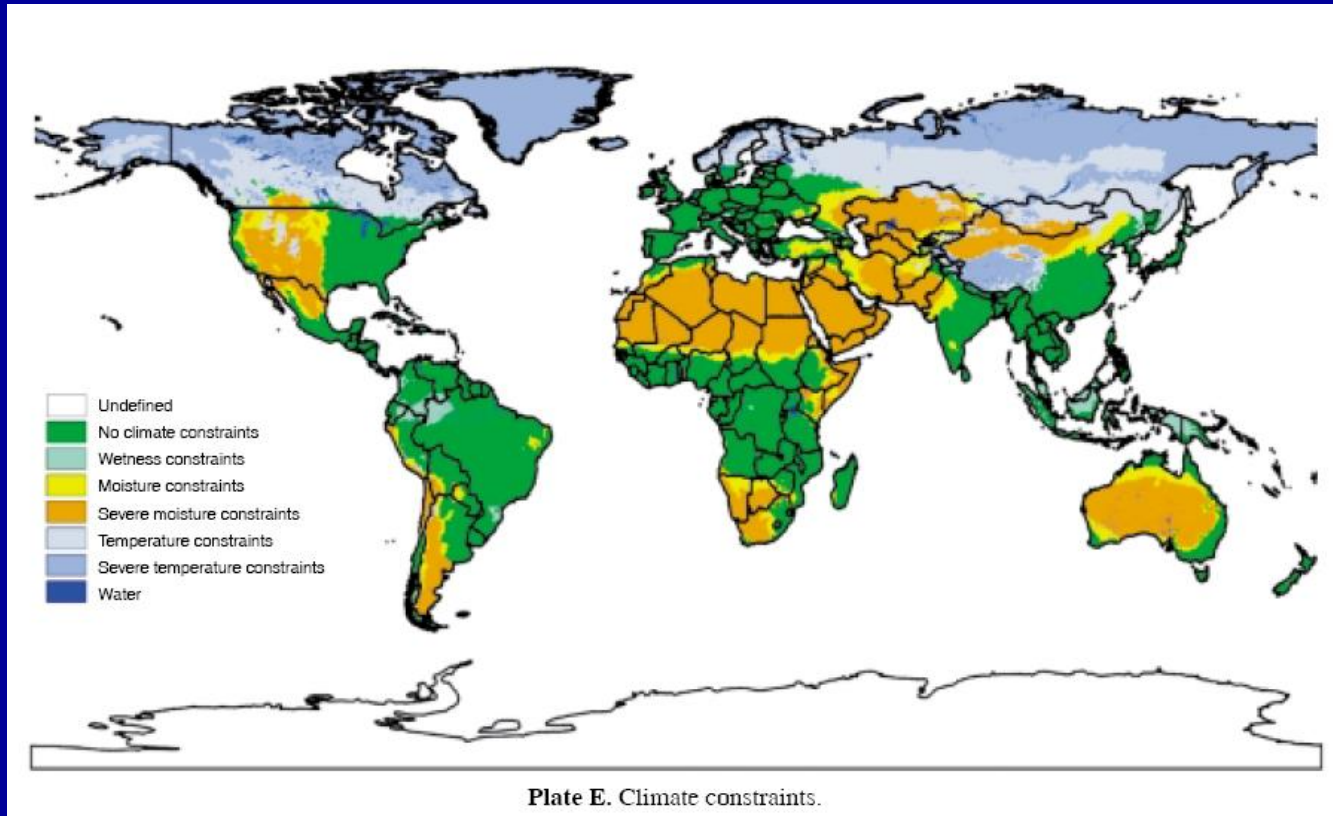
Equirectangular projection centered on 0.0° Data Min = 0.00884, Max = 13.27624

Map Interpretation: Grain yields (maize, wheat and rice) in metric tons per hectare rise from lowest (dark blue) to highest (dark red). Source: Center for Sustainability and the Global Environment (SAGE), University of Wisconsin.

Sources of Observed Differences in Crop Yields in Different Locations

- Genetic potential embodied in the seeds of each crop being grown.
- Climatic conditions (level and variation in temperature and precipitation)
- Quality of soil (fertility, water holding capacity; resilience)
- Supplementation of soil fertility and precipitation with fertilizer and irrigation.
- Losses of yield potential from inadequately controlled disease or insect infestations or competition from weeds.

Climate Constraints Changing



- Warming greater over land than over water and greatest at higher latitudes.
- Changing spatial distribution of precipitation
- Increased frequency of extreme climatic events

Agriculturally Important Effects of Climate Change

- More carbon dioxide enhances plant growth
- Higher temperature extends growing season in high latitudes; likely detrimental in low latitudes
- Water availability (increased need for irrigation)
- Increased risk from greater climatic variability and more frequent extreme events
- Proliferation of pests and diseases further north
- Sea-level rise causes loss of cropland
- Greater erosion and loss of soil fertility from greater surface water runoff.

Adaptations Will be Required Due to Global Climate Change

- As all agro-ecosystems shift with climate change, larger investments in adaptive plant and animal breeding are needed just to sustain present productivity levels.
 - e.g. introduce more drought or heat tolerance.
- Change the mix of what crops are produced in some geographic locations.
- More of world agricultural production will move through international trade.

Agricultural Research Potential

- Fortunately, we are in the golden age of the biological and information sciences.
- Modern science gives us potential to:
 - Improve nutritional content of staples (augment deficient vitamins, minerals and amino acids).
 - Increase tolerance to drought, wetness, temperature, salt,.... (to increase yields and/or planted area under adverse or variable conditions)
 - Internalize resistance to insects and diseases to reduce pesticide use.
 - Slow down product deterioration.
 - Increase precision in application of fertilizer nutrients and pest control media. (Over application is bad economics and bad environmental practice.)

Priorities for Ending Extreme Poverty

(World Bank President Jim Yong Kim, 4/7/2015)

- Increase agricultural productivity.
- Build infrastructure to provide access to energy, irrigation and markets.
- Invest in health and education, especially for women and children.
- Implement social safety nets & provide social insurance.
- Promote freer trade that provides greater access to markets for the poor and enables low- & middle-income country entrepreneurs to grow their businesses and create new jobs.

Long-Run Prospects

- The world's farmers need to increase agricultural production at least 40% in the next 30 years using less water and little, if any, more land than today.
- Malthus has been wrong for more than two centuries, and there is no more reason for him to be right in the 21st century than in the 19th or 20th.
- However, he will continue to be wrong only if investments in agricultural development increase global agricultural production faster than demand grows.

Long-Run Prospects

- Whether world food prices trend upwards, downwards or sideways in the 21st century will depend on whether agricultural research increases land and water productivity faster, slower or at the same speed as world demand for food grows.
- A long-term increase in the price of food would be devastating to low-income consumers who spend a large fraction of their incomes on food and increase the incidence of hunger.

Thank You.

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