Friedman School
of Nutrition Science and Policy

# Agriculture, Nutrition and Health in International Development


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## How does agriculture contribute to this?


theguardian

News | US | World | Sports | Comment | Culture | Business
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Boom time for Mozambique, once the basket case of Africa

As African lions outpace Asian tigers, one of the world's poorest states is moving from civil war bust to boom – but who will gain?


IRIN humanitarian news and analysis

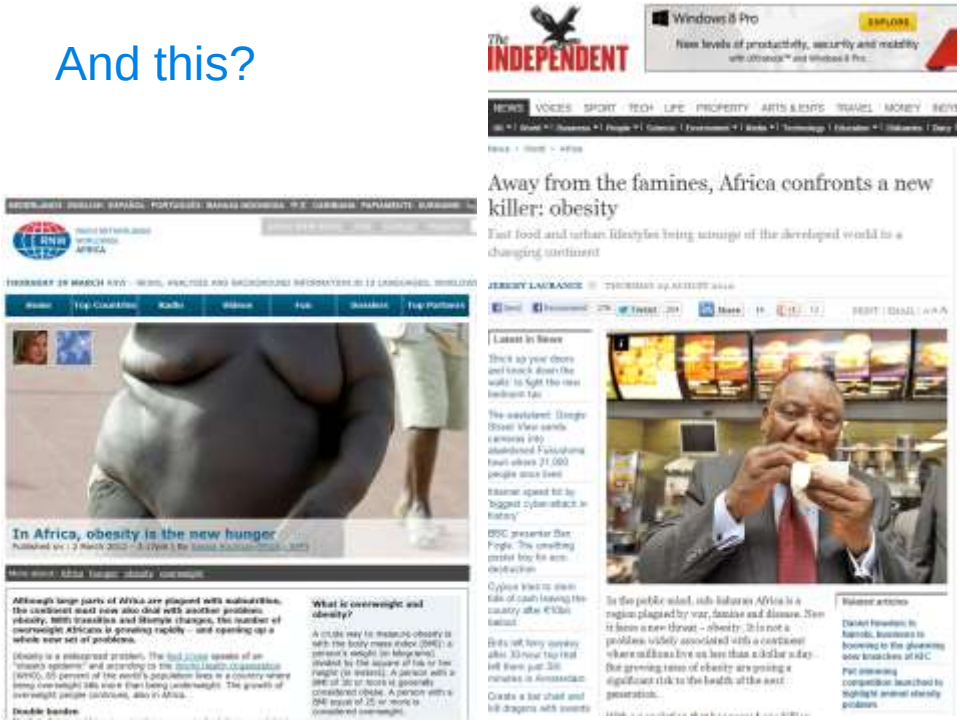
Malnutrition persists alongside Mozambique's economic growth

FEEDBACK | EMAIL | PRINT | READER MODE

Feeding schemes have reduced malnutrition in some areas

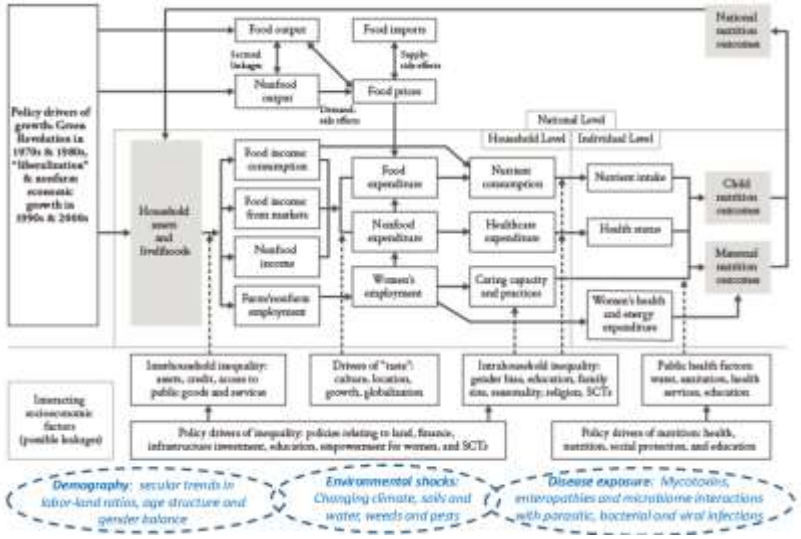
MAPUTO, 4 March 2013 (IRIN) - Mozambique has seen economic growth between seven and eight percent during the last two decades, yet over half the population continues to live below the poverty line. Rates of stunting and chronic malnutrition among Mozambican children have shifted little in the past decade, falling from 48 percent in 2003 to 43 percent today.

## And this?




## Agriculture, nutrition and health are linked through diverse mechanisms, with many effect modifiers

**Example of a causal framework with selected confounders and effect modifiers**




Source: Framework is from S. Gillespie, J Harris and S Kadiyala, 2012. The Agriculture-Nutrition Disconnect in India: What Do We Know? FPRI Discussion Paper 01187. Washington, DC: IFPRI; confounders added by W.A. Masters, P. Webb, J. Griffiths and R.J. Deckelbaum (2014), "Agriculture, Nutrition and Health in Global Development: Typology and Metrics for Integrated Interventions and Research." *Annals of the New York Academy of Sciences*, forthcoming.

For government policies and programs, we can think in terms of interventions and outcomes

***A Typology of Interventions and Outcomes in Agriculture, Nutrition and Health***

Source: W.A. Masters, P. Webb, J. Griffiths and R.J. Deckelbaum (2014), "Agriculture, Nutrition and Health in Global Development: Typology and Metrics for Integrated Interventions and Research." *Annals of the New York Academy of Sciences*, forthcoming.

| | Interventions: Regional (places) | Interventions: Individual (people) | Outcomes: Individual (people) | Outcomes: Regional (places) |
|---|---|---|---|---|
| ***Agricultural interventions and outcomes*** | • Locally-adapted genetics and other crop or livestock improvement<br>• Local infrastructure, institutional & policy improvement<br>• Local soil & water management, pest control and other agro-ecological improvement | • Access to or provision of seeds and other inputs<br>• Access to or provision of market services and information | • Higher productivity<br>• Higher income<br>• Improved diets<br>• Reduced toxin exposure | • Local wages and employment opportunities<br>• Local credit and insurance options<br>• Local land, water and other resources |
| ***Nutritional interventions and outcomes*** | • Locally appropriate fortification, supplementation, and food quality assurance<br>• Locally appropriate services and information for child care & breastfeeding | • Access to or provision of food nutrients services and information<br>• Access to or provision of food safety services and information | • Improved behaviors, physical growth and cognitive development<br>• Improved micronutrient status<br>• Enhanced reproductive potential | • Local supply of diverse and nutritious foods<br>• Local norms regarding diet, infant feeding, hygiene and sanitation |
| ***Health interventions and outcomes*** | • Local water, sanitation & hygiene<br>• Local deworming, vaccination and vector control<br>• Local health system services for all-cause prevention and treatment | • Access to or provision of health care products, services and information | • Lower morbidity and mortality<br>• Enhanced human productivity<br>• Improved maternal and child health | • Local exposure to disease<br>• Local supply of health care services |
| ***Integrated Research Methods*** | | *Impacts and causal mechanisms can be identified using both natural and controlled experiments varying exposure across individuals* | | |
| | *Impacts of region-wide interventions can be identified only by inference from observational data, using knowledge of individual-level causal mechanisms* | | | |

Friedman School of Nutrition Science and Policy

# Agriculture, Nutrition and Health in International Development

## A lot of data

**(on just a few aspects of this huge and diverse topic)**

- Global trends
  - The end of scarcity?
  - The search for just-right nutrition
- Regional trends
  - Malnutrition as a disease of poverty
  - Africa fell into extreme poverty recently, and is now emerging
    - Trends are closely tied to demographic change,
    - worsened by Africa's delayed green revolution

# Global trends: The end of food scarcity?

## Did we beat Malthus?

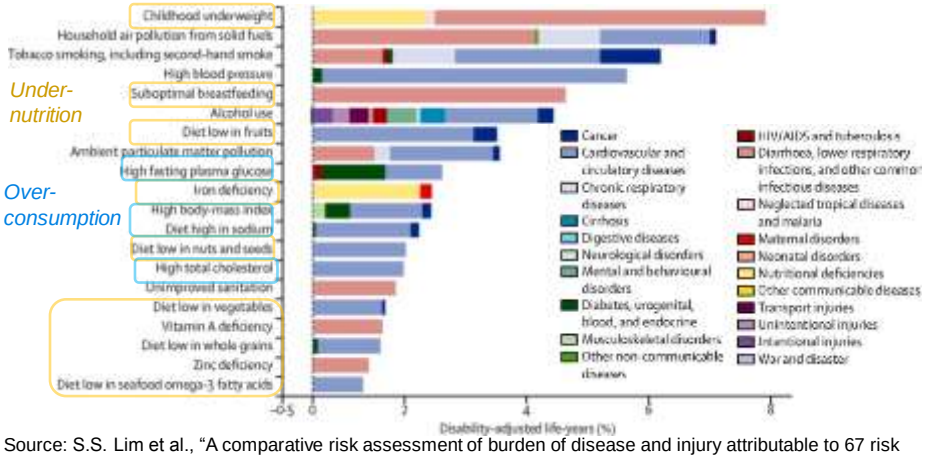
**Real agricultural prices have fallen since 1900, even as world population growth accelerated**


Source: USDA, Economic Research Service using Fuglie, Wang, and Ball (2012). Depicted in the chart is the Grilli-Yang agricultural price index adjusted for inflation by the U.S. Gross Domestic Product implicit price index. The Grilli-Yang price index is a composite of 18 crop and livestock prices, each weighted by its share of global agricultural trade (Pfaffenzeller et al., 2007). World population estimates are from the United Nations.

Source: K. Fuglie and S. L. Wang, "New Evidence Points to Robust but Uneven Productivity Growth in Global Agriculture," *Amber Waves,* September 2012. Washington: Economic Research Service, USDA.

# Undernutrition has long been the world's leading cause of disease and disability

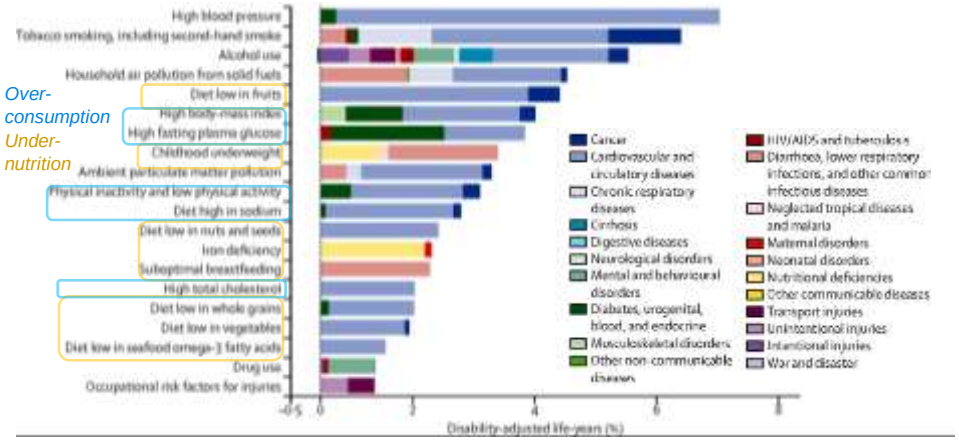
## Percent of disability-adjusted life years lost, by risk factor (1990)




Source: S.S. Lim et al., "A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010," *The Lancet*, v.380, no. 9859, 15 Dec. 2012–4 Jan. 2013, pages 2224-2260.

# Globally, we are now Goldilocks, facing too little *and* too much, looking for just-right nutrition

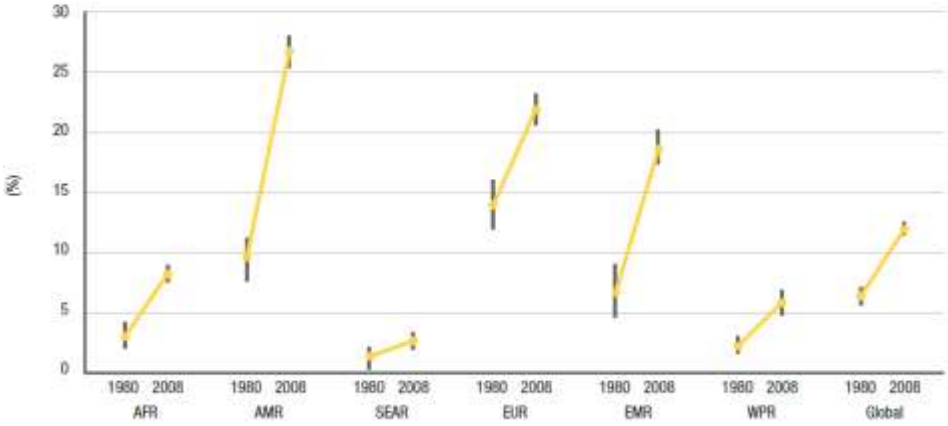
Percent of disability-adjusted life years lost, by risk factor (2010)




Source: S.S. Lim et al., "A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010." *The Lancet*, v.380, no. 9859, 15 Dec. 2012–4 Jan. 2013, pages 2224-2260.

# Obesity rates are rising everywhere

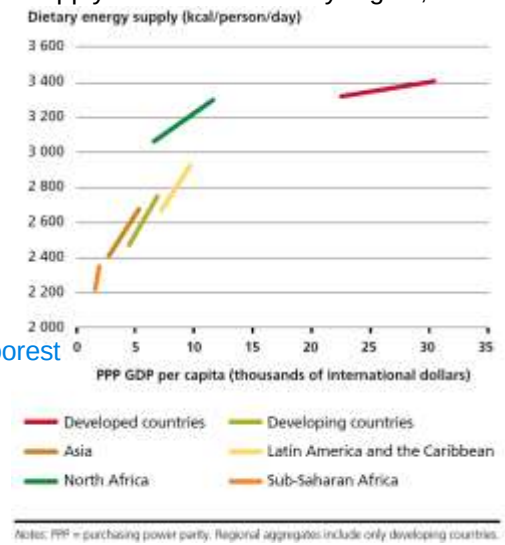
**Figure 9.** Age-standardized prevalence (%) of obesity (body mass index ≥30 kg/m²) among adults aged 20 years and over by WHO region, 1980 and 2008




Note: AFR=Africa, AMR=Americas, SEAR=SE Asia, EUR=Europe, EMR=Eastern Medit., WPR=Western Pacific
Source: WHO, World Health Statistics 2012.

# But Africa is still far from food abundance

Food supply and real income by region, 1990-2010

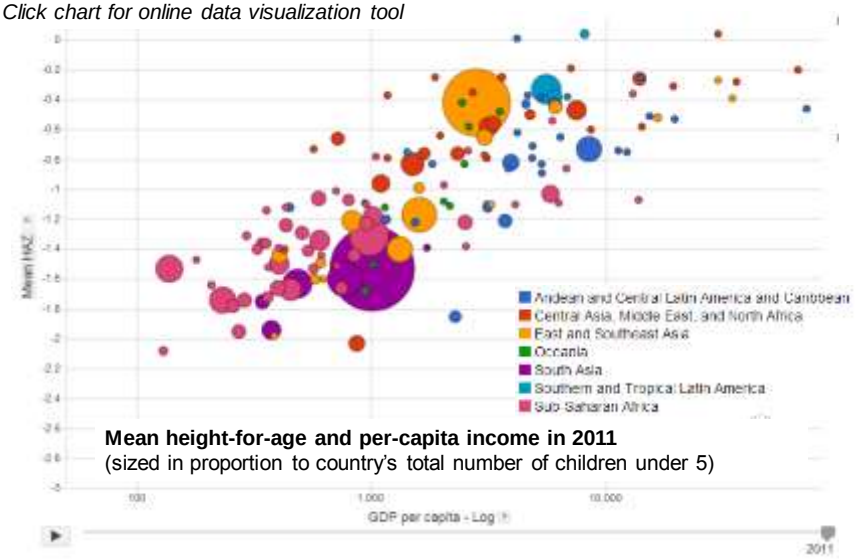



Africa has
the least food,
because it is the poorest

Source: FAO, *The State of Food Insecurity in the World 2012. Rome: Food and Agriculture Organization.*

# Nutritional status is closely correlated with income

*Click chart for online data visualization tool*

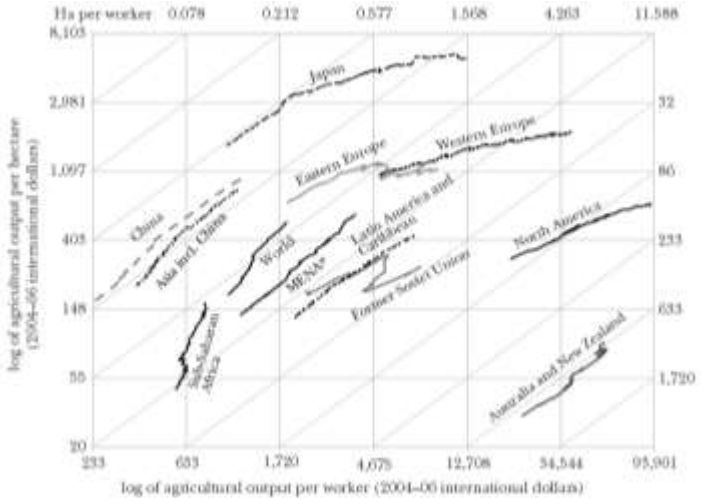



**Mean height-for-age and per-capita income in 2011**
(sized in proportion to country's total number of children under 5)

Source: M. Ezzati et al., 2012. Trends in child anthropometry, 1985-2011. Documentation available online at www1.imperial.ac.uk/publichealth/departments/ebs/projects/eresh/majidezzati/healthmetrics/childmaternalundernutrition with data visualization available at: www.google.com/publicdata/explore?ds=as9p2ifsat2l5.

# The race is run in two directions at once

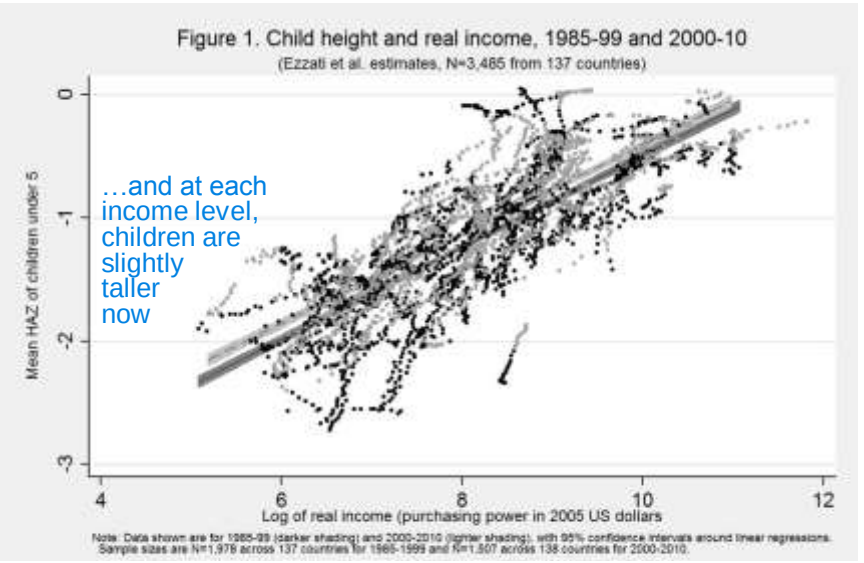
Land and Labor Productivity by Region, 1961– 2011




*Notes:* Diagonal lines show a given level of land area per agricultural worker, labeled along the top and right axis. Output is total estimated value of 192 crop and livestock commodities. Land is harvested and permanently pastured area, and labor is the total number of economically active workers in agriculture. MENA is Middle East and North Africa.

Source: Alston, Julian M., and Philip G. Pardey. 2014. "Agriculture in the Global Economy." *Journal of Economic Perspectives*, 28(1): 121-46. Online at http://pubs.aeaweb.org/doi/pdfplus/10.1257/jep.28.1.121.

# Malnutrition as a disease of poverty

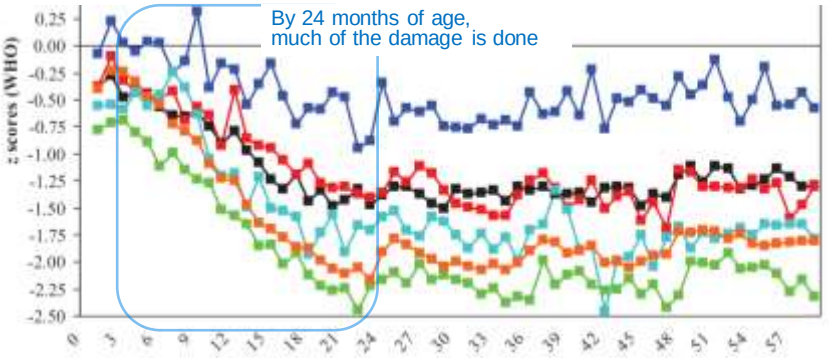



Source: W.A. Masters, 2013. "Child Nutrition and Economic Development", *Nutrition in Pediatrics*, 5th ed. (chapter 44), edited by C.P. Duggan, J.B. Watkins, B. Koletzko and W.A. Walke, Shelton, CT: PMPH-USA.

# Malnutrition as a disease of poverty inside households

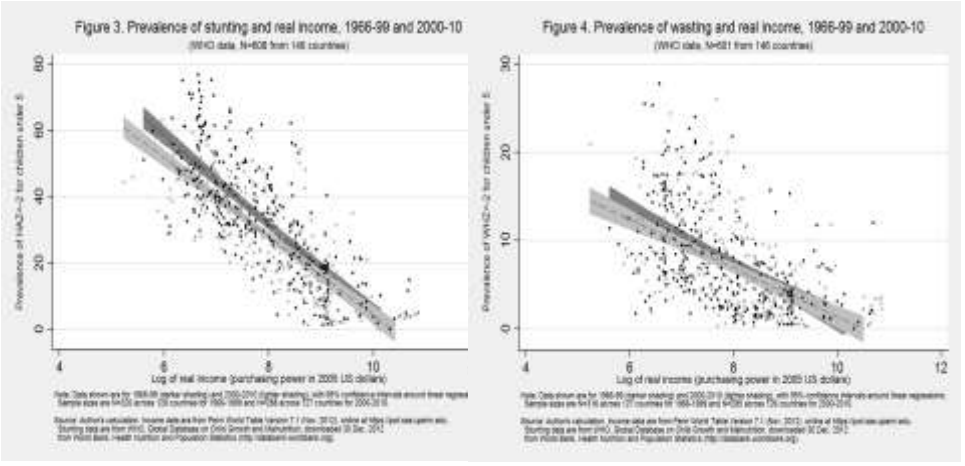
**Mean height-for-age z scores relative to WHO standards, by region (1-59 months)**

- EURO: Armenia, Kazkhst., Kyrgyst., Moldova, Mongolia, Montenegro, Turkey (1997-2005)
- EMRO: Egypt, Jordan, Morocco, Yemen (1997-2007)
- PAHO: Boliv., Brazil, Colomb., Dom.Rep., Guatem., Haiti, Hondur., Nicarag., Peru (1999-2006)
- WPRO: Cambodia, Mongolia (2005)
- AFRO: Thirty countries (1994-2006)
- SEARO: Bangladesh, India, Nepal (2004-2006)




Source: CG Victora, M de Onis, PC Hallal, M Blössner and R Shrimpton, "Worldwide timing of growth faltering: revisiting implications for interventions." Pediatrics, 125(3, Mar. 2010):e473-80.

# Higher-income countries have lower prevalence of stunting and wasting

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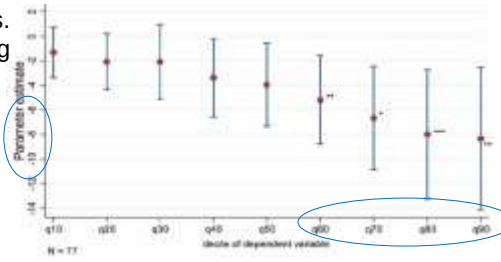
# Income growth is most correlated with wasting where wasting is most prevalent

Income vs. child wasting

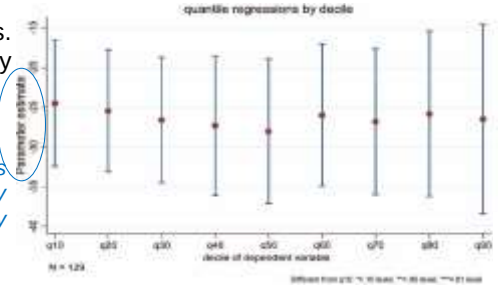
*Higher average income is associated with lower wasting where it is most widespread*



Most wasting

Income vs. household poverty

*Higher average income is associated with lower poverty at all levels on poverty*

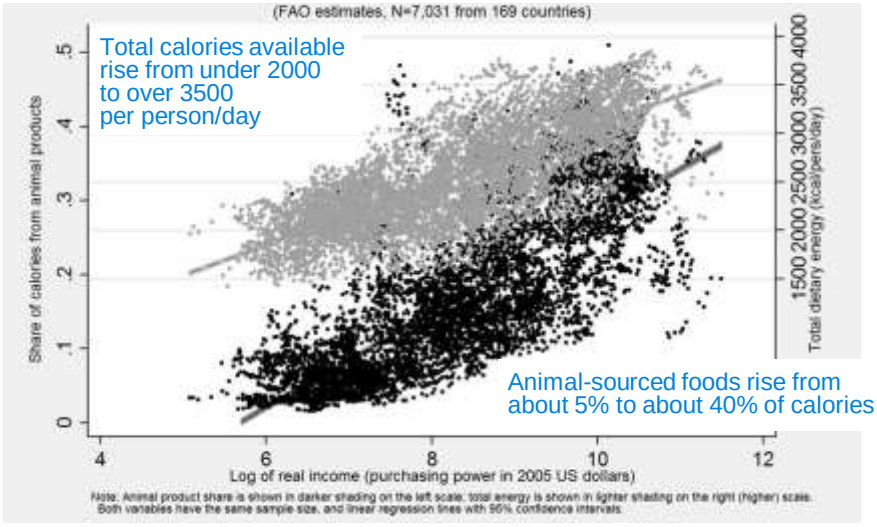


Most poverty

S.A. Block, W.A. Masters & P. Bhagowalia, 2012. "Does Child Undernutrition Persist Despite Poverty Reduction in Developing Countries? Quantile Regression Results", *Journal of Development Studies* 48(12):1699-1715.

# Higher income generally improves diet quality as well as quantity

Share of calories from animal sources, total food supply and income, 1961-2009

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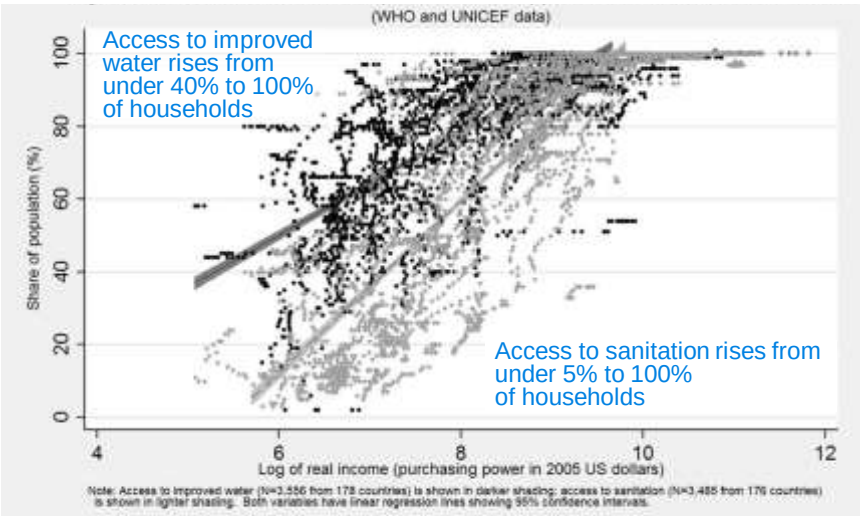
# Higher income also buys sanitation and clean water (among other things)

Access to sanitation, improved water and income, 1990-2010

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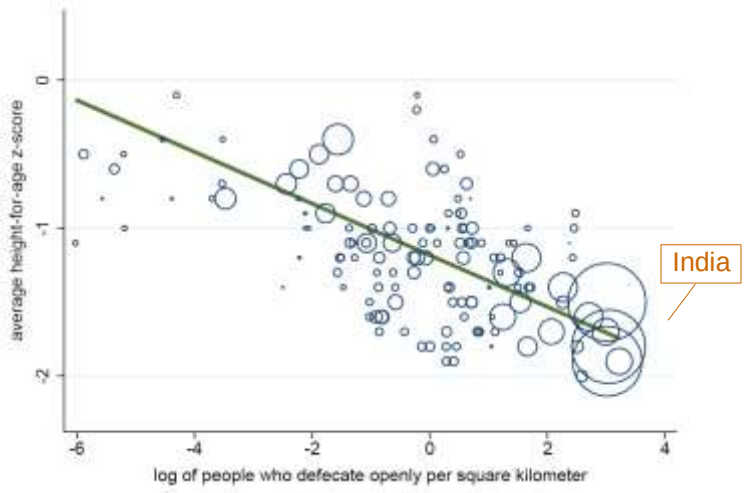
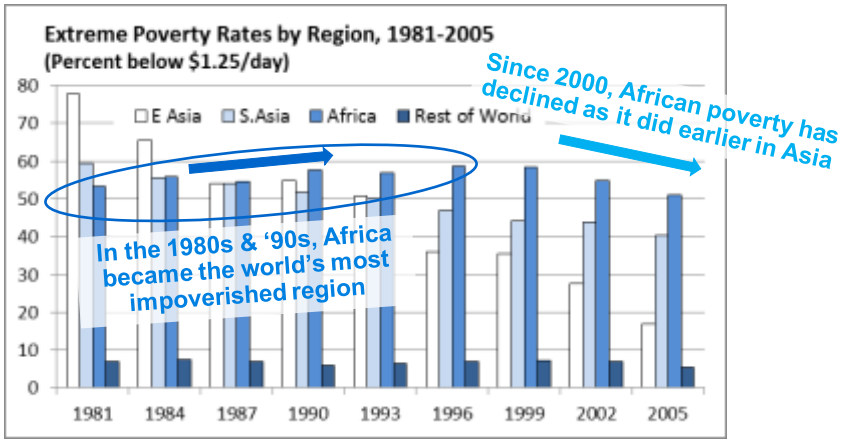
# Sanitation may be especially important

*Lack of sanitation + dense population = what diseases?*



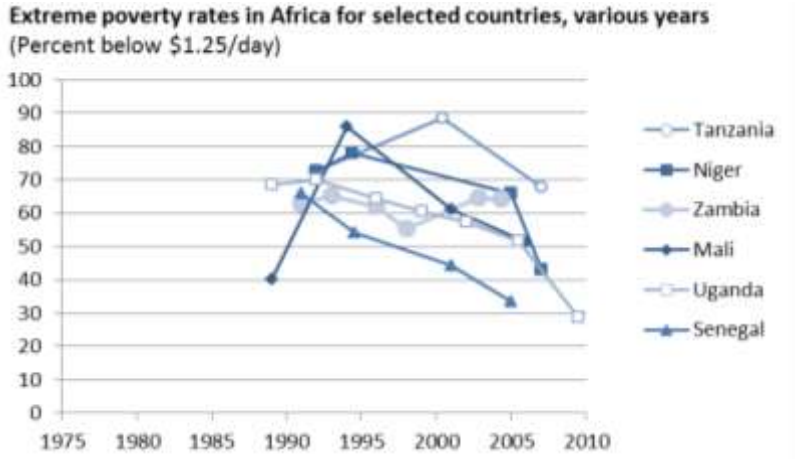

Note: Observations are nationally representative country totals from 130 DHS surveys in 65 countries, 1990-2010, with circles are proportional to population.
Source: Dean Spears (2013), http://riceinstitute.org.

# Africa's impoverishment is relatively recent and is already receding




Source: Calculated from World Bank (2011), PovcalNet (http://iresearch.worldbank.org/PovcalNet/), updated 11 April 2011. Estimates are based on over 700 household surveys from more than 120 countries, and refer to per-capita expenditure at purchasing-power parity prices for 2005.

# There are limited data and wide variation but many signs of improvement

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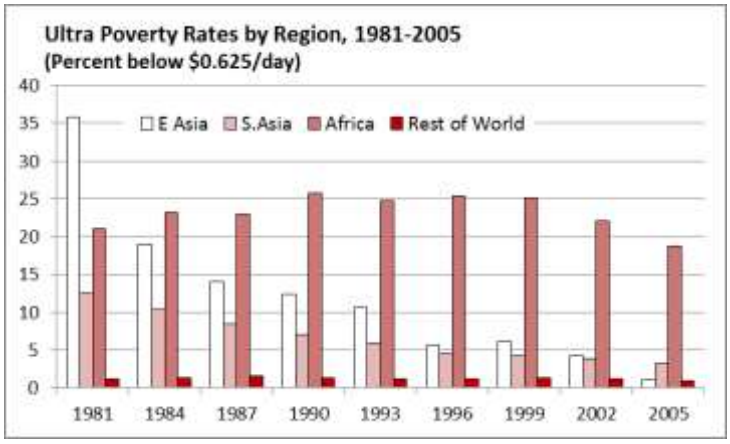
## Despite the recent turnaround, Africa is the last frontier of *ultra* poverty (<$0.625/day)

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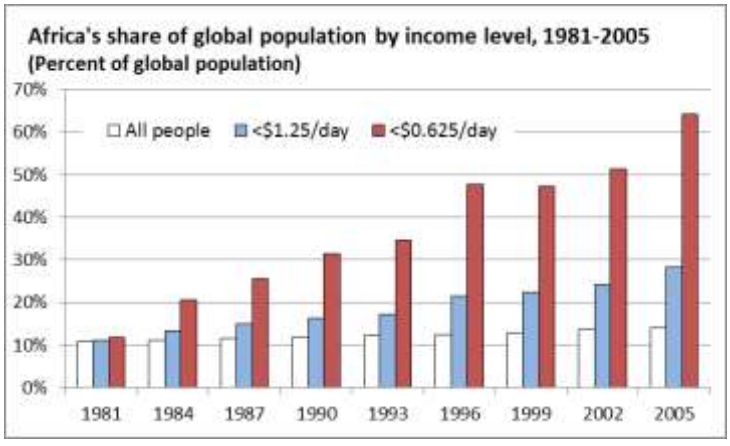
## Africa now has 1/8th of the world's people, but 2/3rds of the ultra-poor

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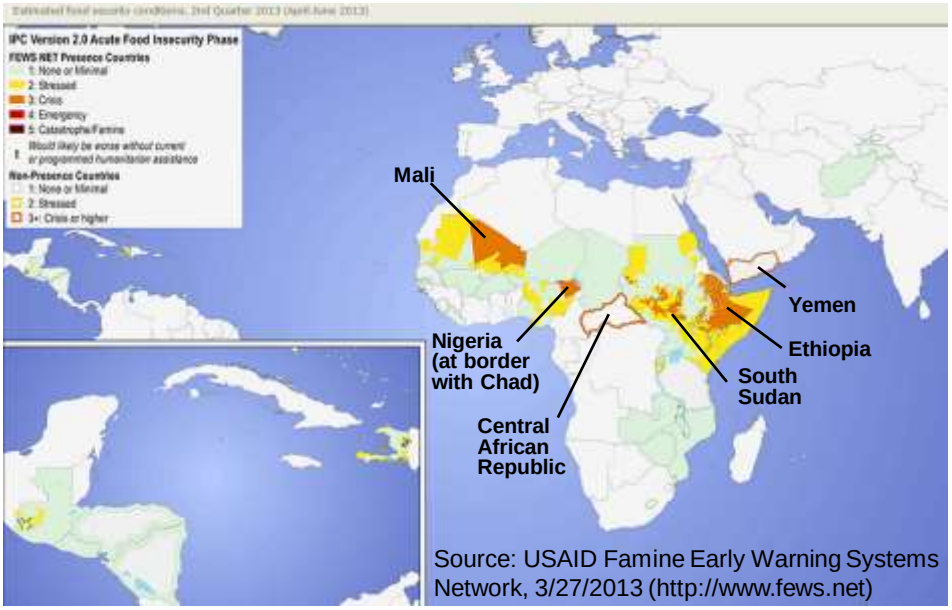
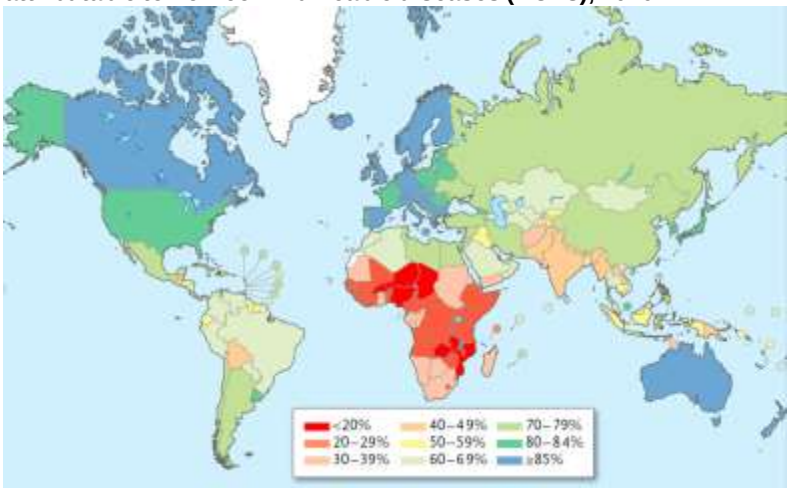
# Africa has almost all of the world's food crises and emergencies




Source: USAID Famine Early Warning Systems Network, 3/27/2013 (http://www.fews.net)

# Africa's burden of disease appears still to be principally infectious, rather than NCDs

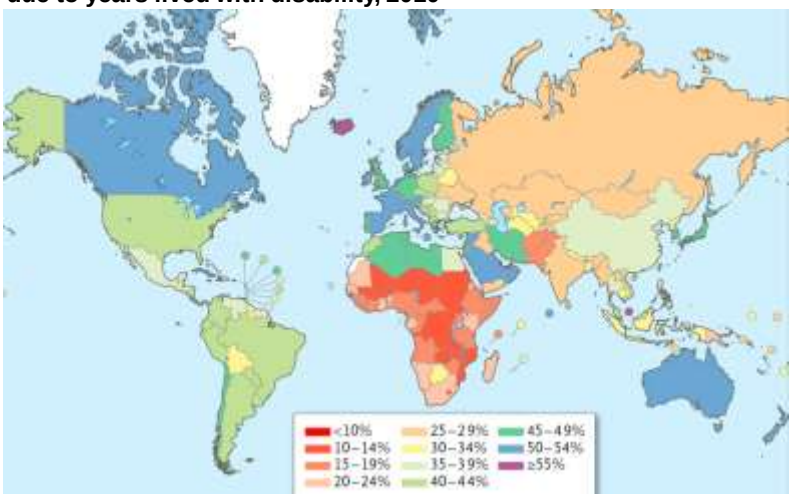
**Percentage of total Disability-Adjusted Life-Years lost attributable to non-communicable diseases (NCDs), 2010**




Source: C.J.L. Murray and A.D. Lopez, Measuring the Global Burden of Disease. *New England Journal of Medicine,* 369 (August, 2013):448-57.

# Africa's burden of disease appears still to be principally mortality, rather than disability

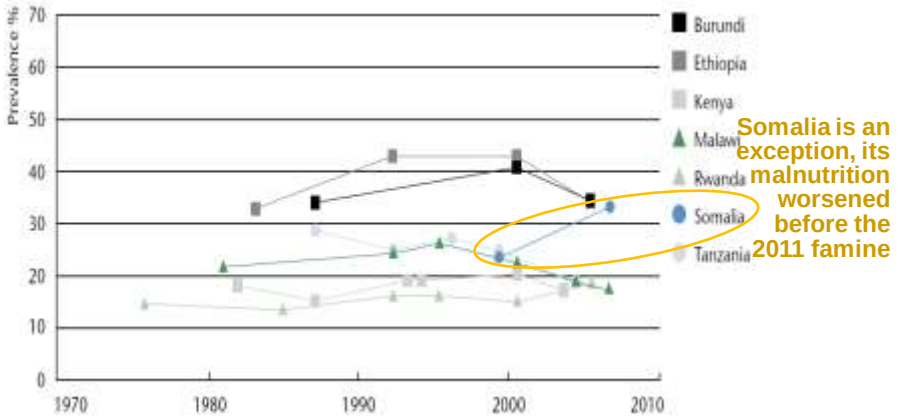
**Percentage of total Disability-Adjusted Life-Years (DALYs) due to years lived with disability, 2010**




Source: C.J.L. Murray and A.D. Lopez, Measuring the Global Burden of Disease. *New England Journal of Medicine,* 369 (August, 2013):448-57.

# Undernutrition has begun to improve in some African countries

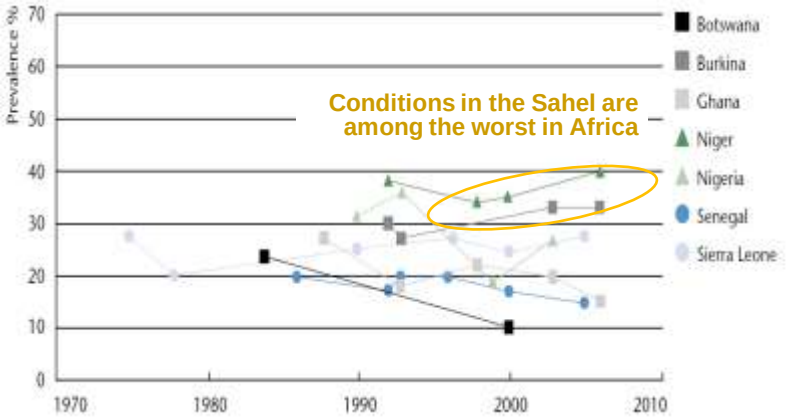
**National trends in prevalence of underweight children (0-5 years)**
**Selected countries with repeated national surveys**




Source: UN SCN. Sixth Report on the World Nutrition Situation. Released October 2010, at http://www.unscn.org.

# Undernutrition levels and trends vary widely across Africa

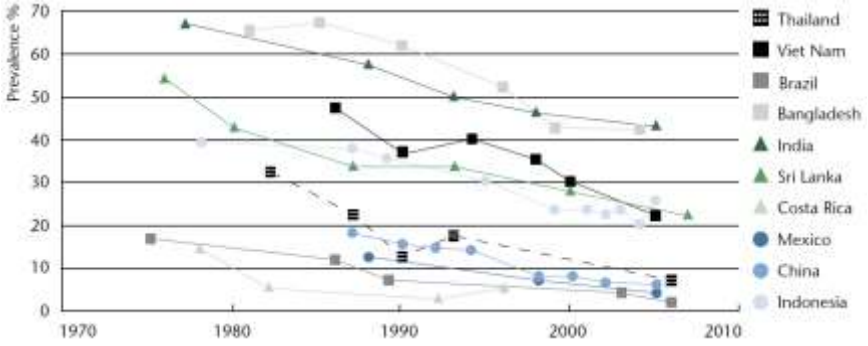
**National trends in prevalence of underweight children (0-5 years)**
**Selected countries with repeated national surveys**




Source: UN SCN. Sixth Report on the World Nutrition Situation. Released October 2010, at http://www.unscn.org.

# In Asia, where undernutrition was worst, we've seen >20 years of improvement

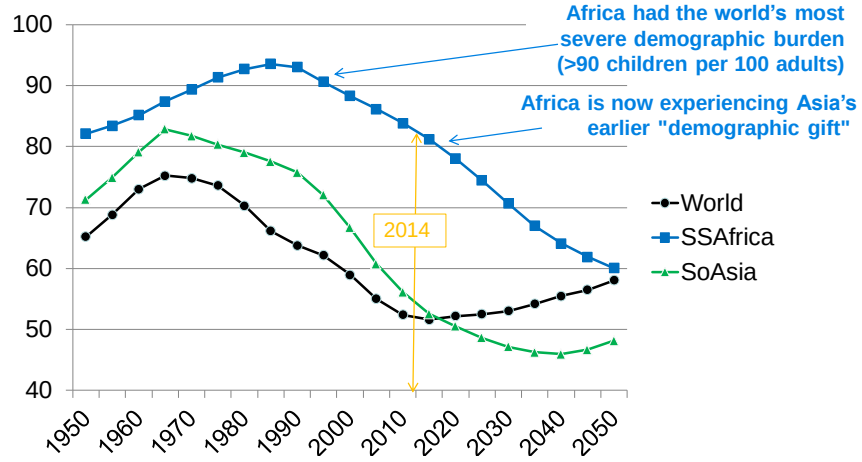
**National trends in prevalence of underweight children (0-5 years)**
**Selected countries with repeated national surveys**




Source: UN SCN. Sixth Report on the World Nutrition Situation. Released October 2010, at http://www.unscn.org.

# An underlying cause of Africa's impoverishment has been its child-survival baby boom, roughly 20 years behind Asia's

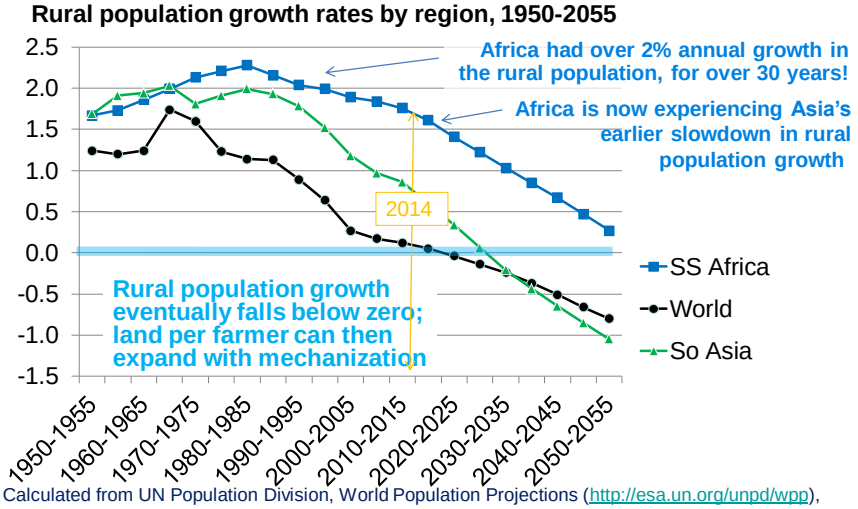
**Child and elderly dependency rates by region (0-15 and 65+), 1950-2055**




Source: Calculated from UN Population Division, World Population Projections (http://esa.un.org/unpd/wpp), accessed 11 Aug 2012, based on UN Population Prospects: The 2010 Revision (April 2011).

# A related cause of Africa's impoverishment is fast, sustained rural population growth

**Rural population growth rates by region, 1950-2055**

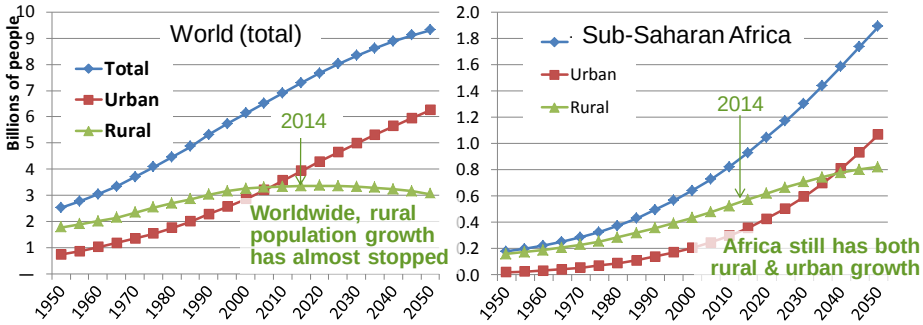



Source: Calculated from UN Population Division, World Population Projections (http://esa.un.org/unpd/wpp), accessed 11 Aug 2012, based on UN Population Prospects: The 2010 Revision (April 2011).

# The rural population stops growing and farm sizes can rise when urbanization employs all new workers

…in Africa that won't happen until the 2050s

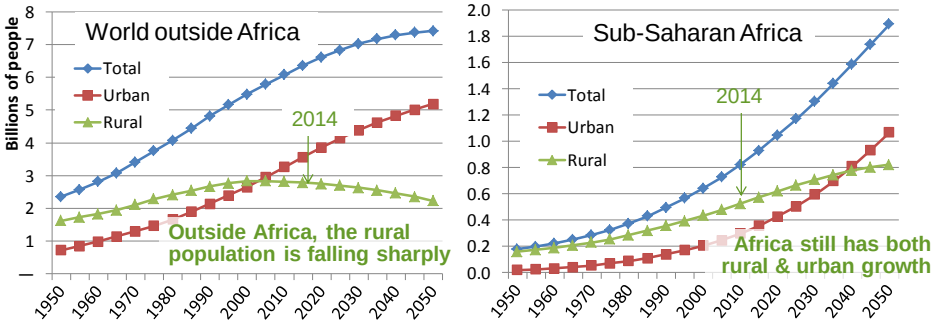
**Population by principal residence, 1950-2050**




Source: Calculated from UN World Urbanization Prospects, 2011 Revision , released October 2012 at http://esa.un.org/unpd/wup. Downloaded 18 April 2013.

# Africa's continued rising rural population is in sharp contrast to the rest of the world

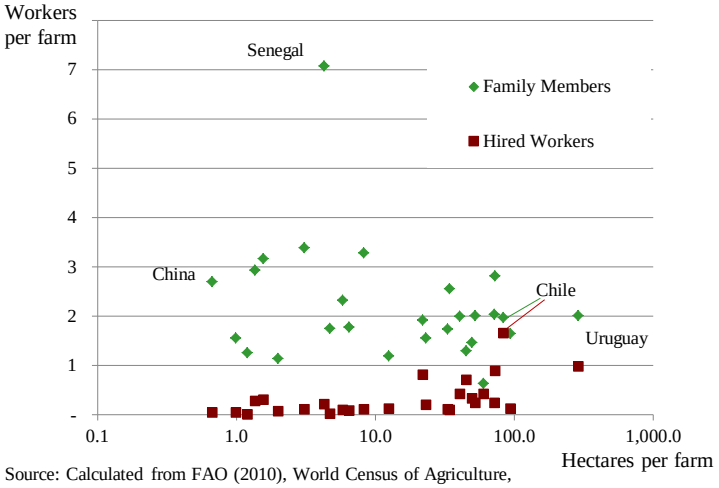
**Population by principal residence, 1950-2050**




Source: Calculated from UN World Urbanization Prospects, 2011 Revision , released October 2012 at http://esa.un.org/unpd/wup. Downloaded 18 April 2013.

# How many people work on each farm?

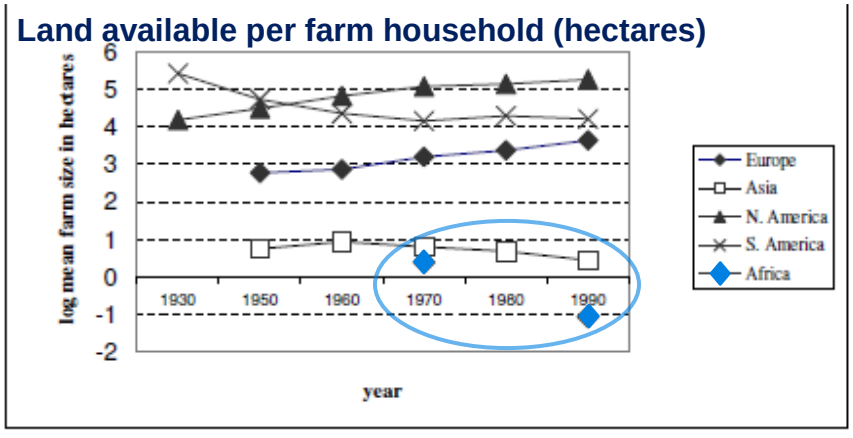
Farm family and hired workers per farm, latest census (1996-2003)




Source: Calculated from FAO (2010), World Census of Agriculture, Main Results and Metadata by Country (1960-2005). Rome: FAO.

Note: Countries shown are, from left to right: China, Cape Verde, Japan, Yemen, Lao P.D.R., Philippines, Pakistan, Senegal, Greece, Morocco, French Guiana, Algeria, Portugal, Netherlands, Belgium, Ireland, Austria, Germany, France, Denmark, Luxembourg, Venezuela, Finland, Brazil, Chile, Sweden, Uruguay.

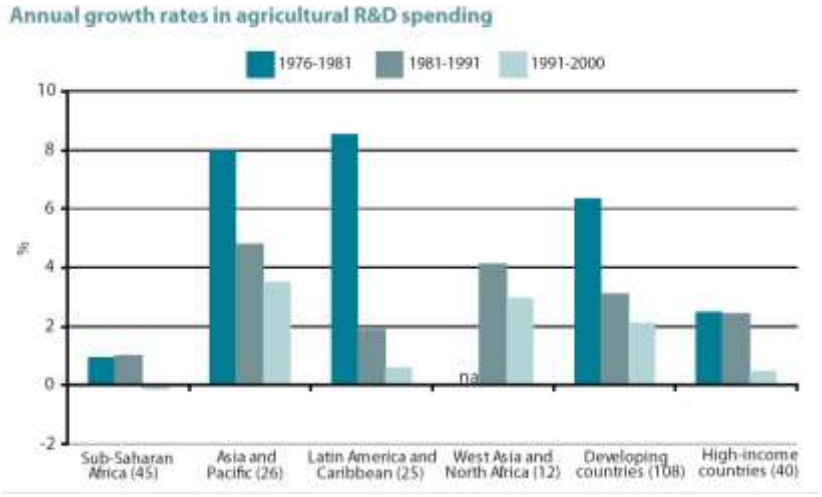
# Africa's burst of rural population growth drove a sharp fall in land per farmer




Source: FAO Statistics division at http://www.fao.org/es/ess/index_en.asp

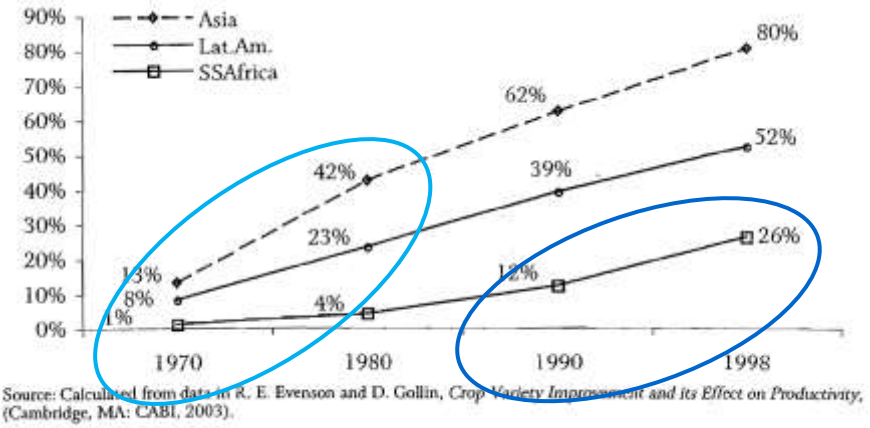
Reprinted from Robert Eastwood, Michael Lipton and Andrew Newell (2010), "Farm Size", chapter 65 in Prabhu Pingali and Robert Evenson, eds., *Handbook of Agricultural Economics*, Volume 4, Pages 3323-3397. Elsevier.

# Africa's rural population grew during a period of worldwide slowdown in agricultural R&D




Reprinted from Nienke Beintema and Howard Elliott (2011), "Setting meaningful investment targets in agricultural research and development: Challenges, opportunities and fiscal realities." Chapter 9 in Piero Conforti, ed., *Looking Ahead in World Food and Agriculture: Perspectives to 2050.* Rome: FAO.

# Africa's green revolution did eventually arrive, roughly 20 years behind Asia's



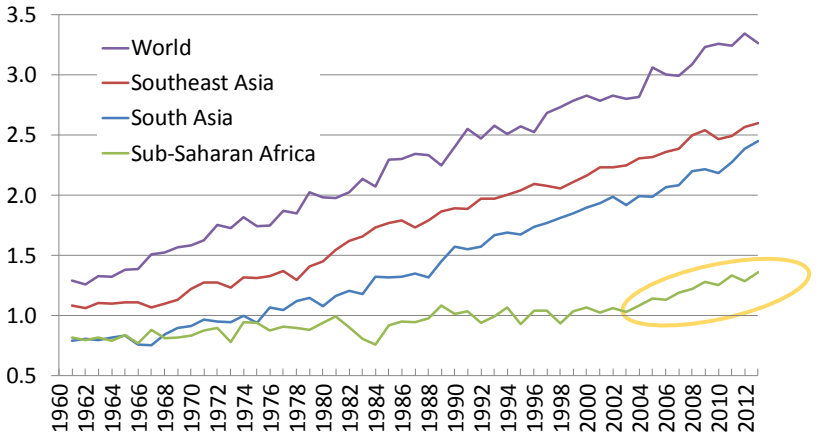

Source: Calculated from data in R. E. Evenson and D. Gollin, *Crop Variety Improvement and its Effect on Productivity*, (Cambridge, MA: CABI, 2003).

**Figure 16.** Adoption of new varieties (percentage of cropped area).

Source: Reprinted from W.A. Masters, "Paying for Prosperity: How and Why to Invest in Agricultural Research and Development in Africa" (2005), *Journal of International Affairs*, 58(2): 35-64.

# Africa's green revolution has finally taken hold

**USDA estimates of average cereal grain yields (mt/ha), 1961-2013**




Source: Calculated from USDA, PS&D data (www.fas.usda.gov/psdonline), downloaded 2 August 2013. Results shown are each region's total production per harvested area in barley, corn, millet, mixed grains, oats, rice, rye, sorghum and wheat.

# What else might influence diet quality?

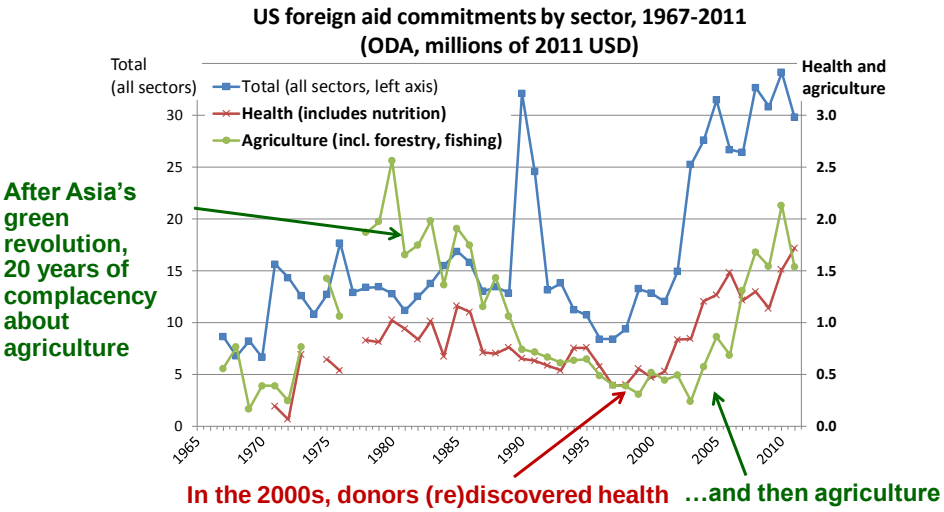
**Association between diet diversity (# of items) and household characteristics in the China Health and Nutrition Survey (CHNS).**

| | 2004 | | | | 2006 | | | |
|---|---|---|---|---|---|---|---|---|
| | Urban | | Rural | | Urban | | Rural | |
| HHINC (thousand CNY) | 0.018*** (3.62) | 0.015** (3.14) | 0.019*** (3.90) | 0.013*** (3.82) | 0.016*** (4.05) | 0.016*** (4.12) | 0.0096*** (3.88) | 0.0098*** (3.92) |
| HHINC2 | -0.00010*** (-3.34) | -0.000089** (-2.94) | -0.00007[2] (-1.78) | -0.000064 (-1.59) | -0.000076*** (-3.59) | -0.000075** (-3.68) | -0.000035*** (-4.71) | -0.000031*** (-4.75) |
| HHSIZE | 0.18*** (3.97) | 0.19*** (4.33) | 0.10*** (3.32) | 0.11*** (3.75) | -0.0051 (-0.12) | 0.0051 (0.13) | 0.15*** (4.87) | 0.14*** (4.88) |
| Refrigerator | 0.83*** (8.66) | 0.80*** (8.48) | 0.42*** (4.80) | 0.24** (2.68) | 0.90*** (7.06) | 0.81*** (6.36) | 0.45*** (4.47) | 0.43*** (4.28) |
| Transportation Tool | 0.30* (2.46) | 0.27* (2.20) | 0.28** (2.91) | 0.27** (2.82) | 0.67*** (4.91) | 0.59*** (5.10) | 0.42*** (3.84) | 0.42*** (3.87) |
| Home Farming | -0.39* (-2.49) | -0.016 (-0.09) | -0.79*** (-8.00) | -0.29** (-3.09) | -0.23 (-1.32) | 0.33 (1.78) | -0.43*** (-4.07) | -0.14 (-1.20) |
| Population Density (1000/km$^2$) | | 0.00041 (0.18) | | 0.024*** (3.40) | | 0.059** (5.20) | | 0.052* (2.10) |
| Restaurants (per 1000 people) | | 0.0068 (1.17) | | 0.014** (3.16) | | 0.021*** (7.24) | | 0.021*** (4.08) |
| Bus Stop | | 0.21 (1.47) | | 0.29** (3.02) | | 0.77*** (3.84) | | 0.24* (2.40) |
| Distance to Market (km) | | -0.019*** (-4.87) | | -0.030*** (-7.16) | | -0.14** (-2.81) | | -0.014*** (-4.07) |
| Constant | 6.64*** (19.25) | 6.46*** (17.39) | 4.26*** (14.58) | 4.18*** (14.48) | 7.19*** (16.18) | 6.32*** (10.22) | 5.86*** (16.19) | 5.82*** (14.75) |
| Observations | 3485 | 3485 | 2837 | 2837 | 2212 | 2212 | 2664 | 2664 |
| Adjusted $R^2$ | 0.222 | 0.228 | 0.220 | 0.254 | 0.196 | 0.228 | 0.243 | 0.285 |

t statistics in parentheses

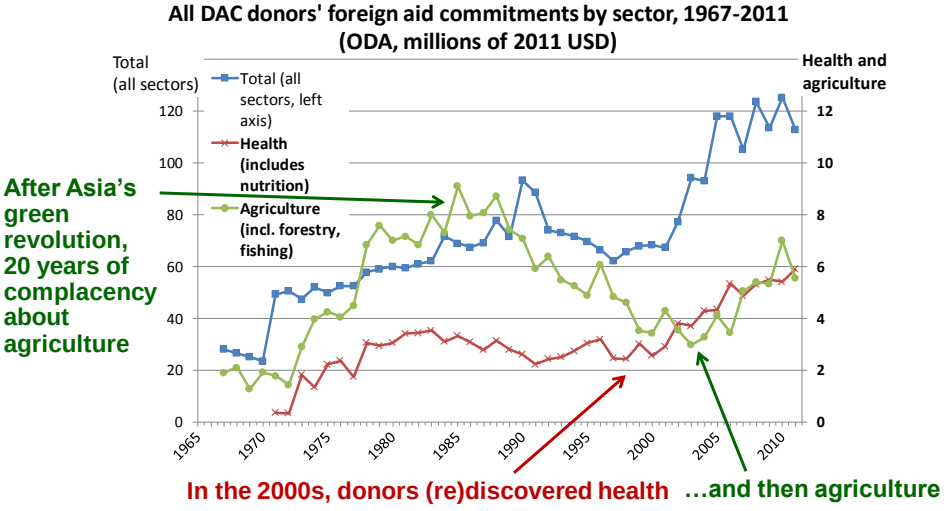
Source: J. Liu, G. Shively and J. Binkley (2013), "Dietary Diversity in Urban and Rural China: An Endogenous Variety Approach". Agricultural and Applied Economics Association, August 4-6, 2013, Washington, D.C. http://purl.umn.edu/149624.
Note: Coefficients not shown for age, sex, education, marriage and timing of survey.

# U.S. aid for agriculture has just begun to recover after being sharply cut in 1980-99




Source: Author's calculations from OECD (2013), Official Bilateral Commitments by Sector, updated 15 April 2013 (http://stats.oecd.org/qwids).

# Global aid trends have been similar to the U.S. trends, magnified times four




Source: Author's calculations from OECD (2013), Official Bilateral Commitments by Sector, updated 15 April 2013 (http://stats.oecd.org/qwids).

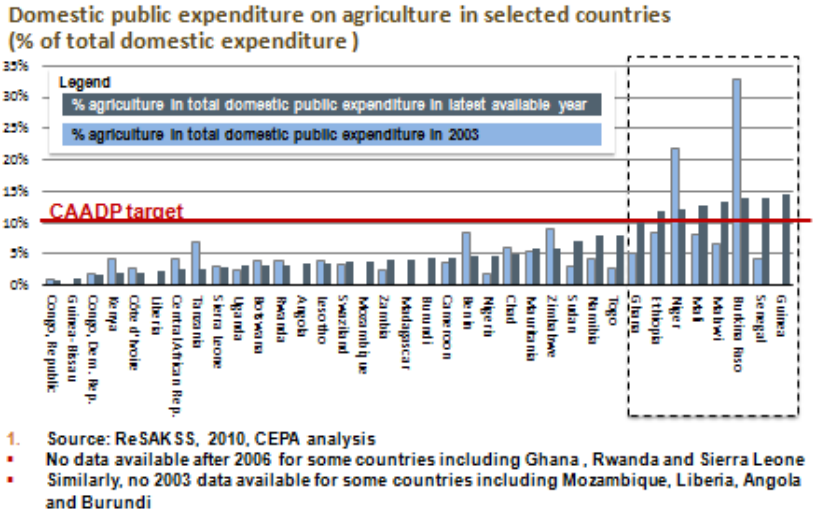
# The wake-up of external aid for agriculture has been led by the Gates Foundation

**Top 15 donors' foreign aid commitments to African agriculture, 2005-2008**

| Rank | 2005 | | 2006 | | 2007 | | 2008 | |
|---|---|---|---|---|---|---|---|---|
| 1 | IDA | 300.72 | IDA | 538.88 | United States | 463.07 | IDA | 867.01 |
| 2 | AfDF | 152.04 | AfDF | 226.81 | IDA | 399.16 | **BMGF** | |
| 3 | Denmark | 114.98 | France | 141.80 | **BMGF** | | United States | 323.58 |
| 4 | United States | 102.30 | EU Institutions | 114.79 | France | 342.42 | EU Institutions | 181.73 |
| 5 | IFAD | 80.72 | **BMGF** | | AfDF | 235.65 | Canada | 155.20 |
| 6 | Germany | 66.88 | IFAD | 87.50 | EU Institutions | 186.30 | IFAD | 129.49 |
| 7 | Belgium | 66.43 | United States | 84.78 | IFAD | 122.76 | France | 95.13 |
| 8 | EU Institutions | 65.75 | Japan | 66.12 | Japan | 73.36 | Germany | 87.25 |
| 9 | Japan | 58.42 | Sweden | 60.58 | Korea | 56.63 | Belgium | 77.42 |
| 10 | United Kingdom | 45.06 | Germany | 54.31 | Germany | 56.33 | Japan | 75.13 |
| 11 | Canada | 43.48 | Belgium | 53.48 | Belgium | 53.20 | Ireland | 41.81 |
| 12 | Netherlands | 36.19 | Norway | 50.34 | Canada | 41.40 | Norway | 35.39 |
| 13 | France | 32.14 | United Kingdom | 30.70 | Norway | 40.64 | Italy | 32.36 |
| 14 | **BMGF** | | Ireland | 22.56 | Denmark | 31.46 | Denmark | 29.17 |
| 15 | Norway | 20.80 | Netherlands | 19.01 | Ireland | 24.79 | Spain | 19.31 |

Note: Exact amounts for BMGF have been obscured because methodology differs from that used by the DAC.
Source: P. Pingali, G. Traxler and T. Nguyen (2011), "Changing Trends in the Demand and Supply of Aid for Agriculture Development and the Quest for Coordination." Annual Meetings of the AAEA, July 24–26, 2011.

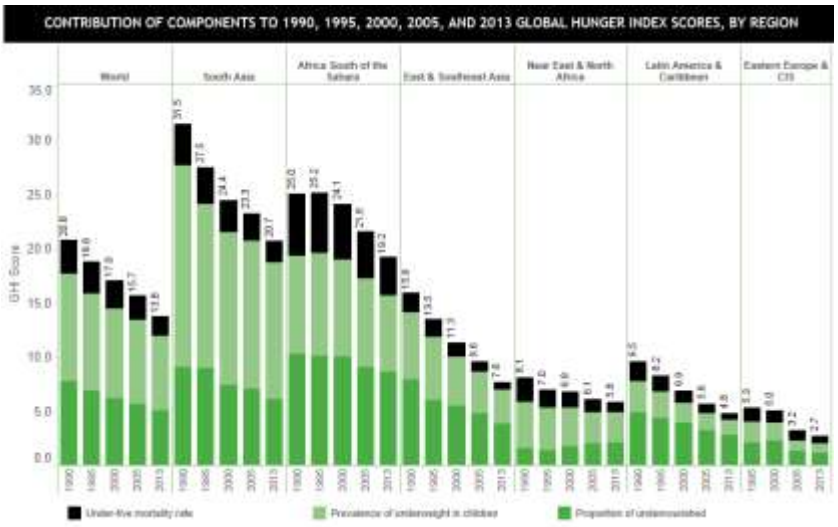
# Many African governments are now focusing more on agriculture




1. Source: ReSAKSS, 2010, CEPA analysis
   - No data available after 2006 for some countries including Ghana, Rwanda and Sierra Leone
   - Similarly, no 2003 data available for some countries including Mozambique, Liberia, Angola and Burundi

Slide is courtesy of Prabhu Pingali, Greg Traxler and Tuu-Van Nguyen (2011), "Changing Trends in the Demand and Supply of Aid for Agriculture Development and the Quest for Coordination," at the AAEA, July 24–26, 2011.

# Agriculture is one of the many factors contributing to global nutrition trends




Source: International Food Policy Research Institute, Global Food Policy Report 2013, launched 12 March 2014 (http://www.ifpri.org/gfpr/2013).

Friedman School of Nutrition Science and Policy

## Agriculture, Nutrition and Health in International Development

### In conclusion, from all the data

**(on a few aspects of this huge topic)**

- Global trends
  - The end of scarcity?
  - The search for just-right nutrition
- Regional trends
  - Malnutrition as a disease of poverty
  - Africa fell into extreme poverty recently, and is now emerging
    - Trends are closely tied to demographic change,
    - worsened by Africa's delayed green revolution

...and external aid can help!

Tufts University