

# Science and development in Africa.

The greatest challenge to science and technological innovation of our generation?

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DFID/LSHTM

## Baconian view of science

The highest form of science:

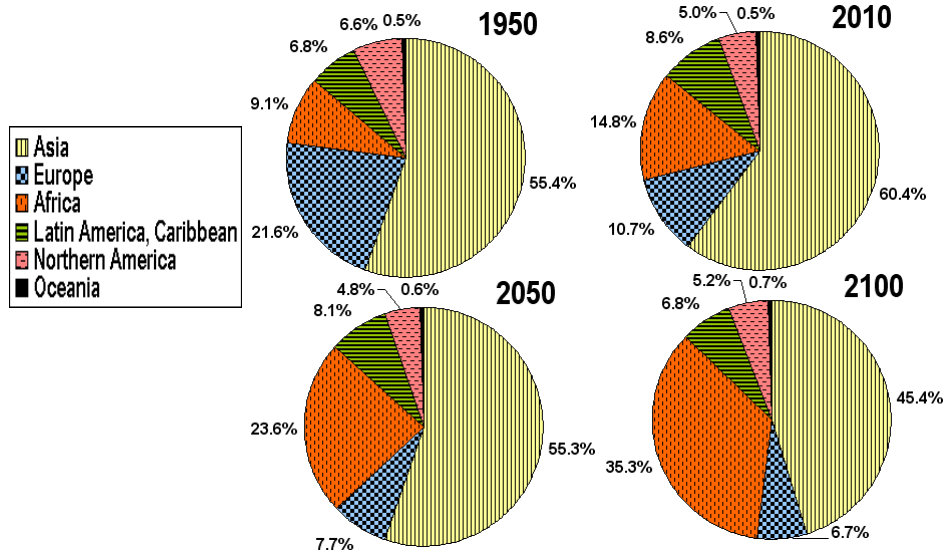
“Not either for pleasure of the mind, or for contention, or for superiority to others, or for profit, or fame, or power, or any of these inferior things; but *for the benefit and use of life*”

The Idols of the Cave:

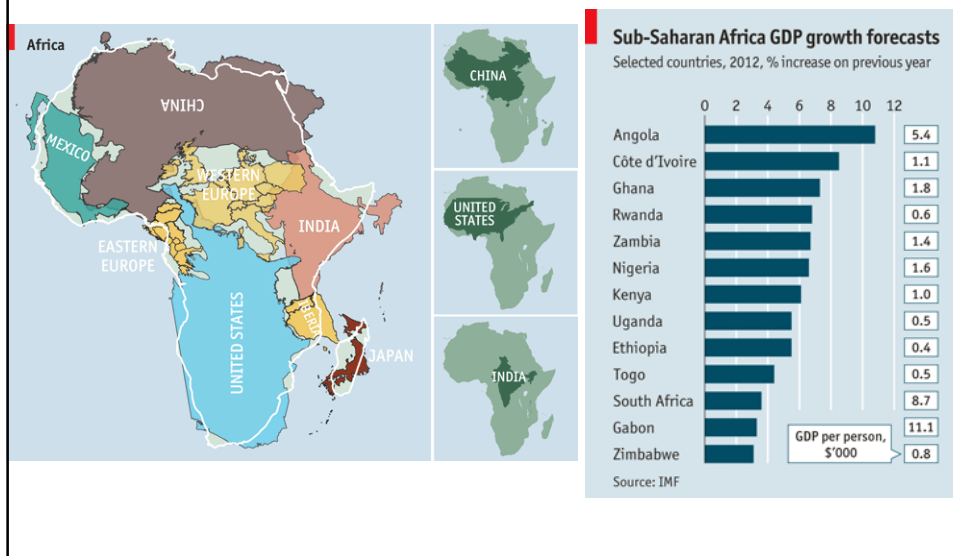
Allegiance to a particular discipline or theory.



## Africa's population- will double to around 2Bn by 2100 (UN population division)



## Economic growth and size (Economist).

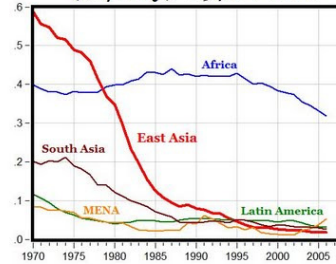


Yet Africa has not benefited from science and technology as other continents have.

Include:

- Health
- Food security and nutrition
- Water
- Power
- Communication
- Natural disasters
- Economic growth
- Increasingly climate change

**Regional Poverty Rates  
(\$1/Day) 1970-2006**



Science can help provide solutions, improve lives and boost economies in at least three ways

- New technologies and methods, reducing costs and adapting older technologies.
- Better ways of delivering existing technologies and services.
- Understanding the environment to allow better decision-making.

## Improving yield, drought and flood resistance.

- Semi-dwarf wheat and rice
- Traditional African rice (*Oryza glaberrima*) yields of about one tonne per hectare, Asian species (*Oryza sativa*) five tonnes.
- New rices for Africa (NERICAs)
- 4 tonnes / hectare, drought and pest resistant, ready for harvesting 30-50 days sooner.



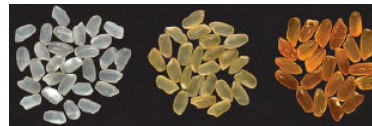
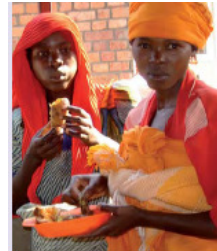
## Disease and pest resistant plants

- Wheat rust
- Striga (witchweed) IR
- Banana wilt.



## Better nutritional value- biofortification

- Pro-vitamin-A enriched sweet potato and rice
- Iron-fortified beans
- Above all improve the diversity of diet

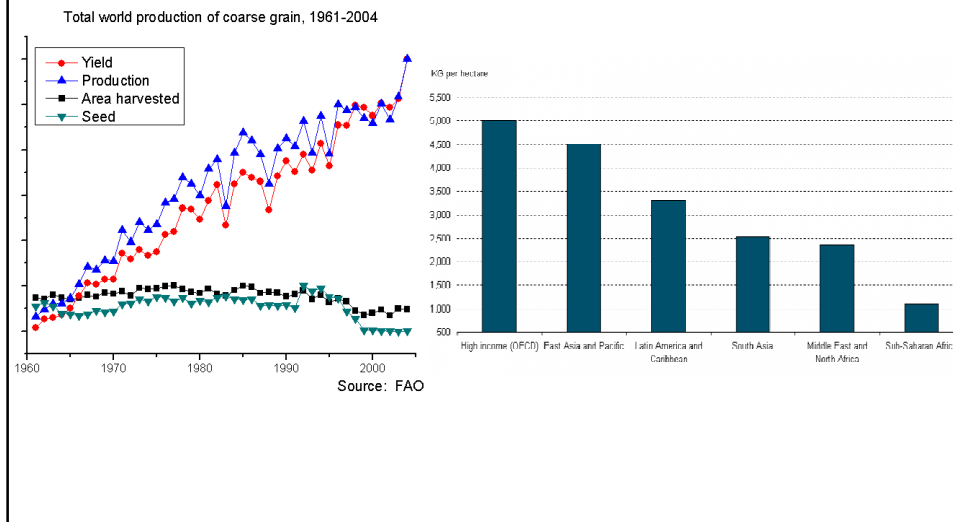


## Better agricultural practice, post-harvest loss

- Use of water, nitrogen and phosphates.
- Africa typically has v low nitrogen soils- 20-40kg N/ha v 2,800kg N/ha in much of Asia.
- Adding nutrients can increase yield by 5x. But expensive- need to be targeted.
- Nitrogen-fixing?
- Better storage & transport.



Yield can improve dramatically with modern technology and methods- but only if applied



## Animal diseases

- Rinderpest
- East coast fever
- Trypanosomiasis
  
- Zoonoses:  
brucellosis, bovine tuberculosis



## Human health

- Prevention technologies (vaccines, bednets, HIV)
- Infrastructure
- Diagnostics
- Drugs
- Health systems
- Behaviour
- Economic development
- Nutrition
- Sanitation



## Vaccines

*Technology good-  
deployment the issue.*

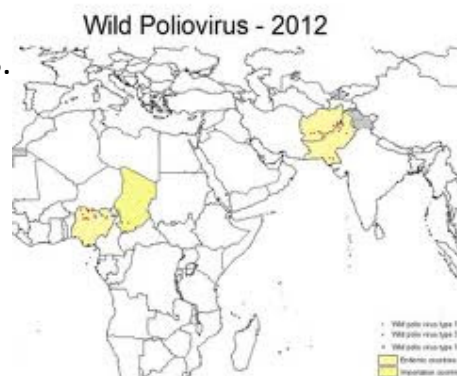
- Polio, measles, Hepatitis B.

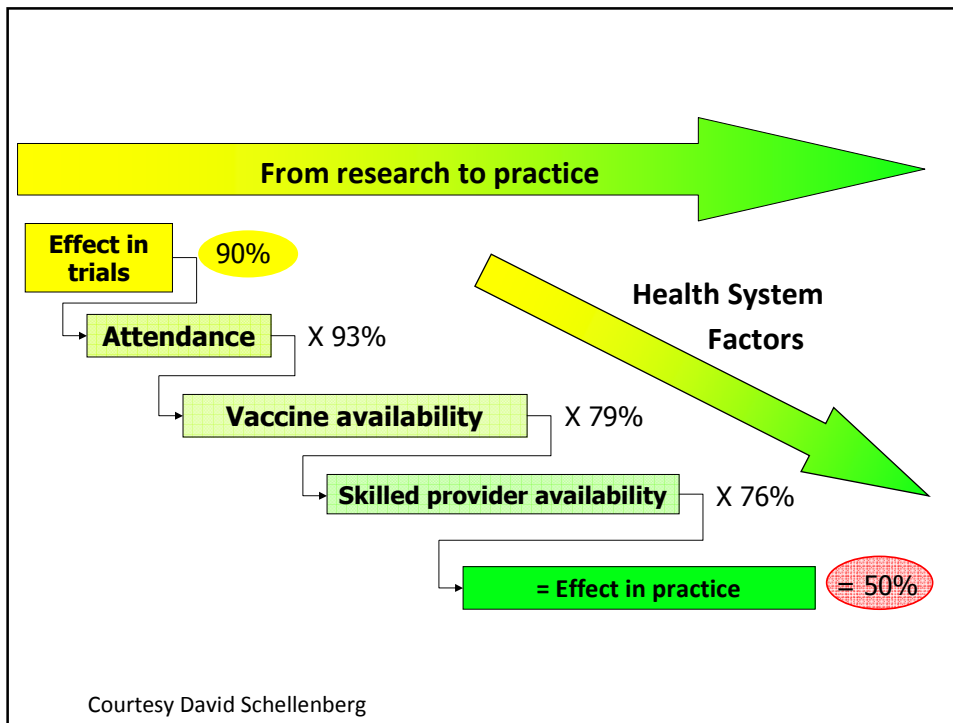
*Basic science strong,  
development ongoing*

- Dengue, meningococcus,  
rotavirus

*Some way to go on the  
fundamental science*

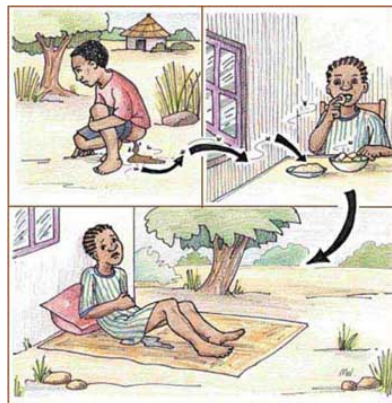
- HIV, malaria, tuberculosis





Prevention: vaccines do not provide a complete solution, even in theory

- Malaria
- Trachoma, onchocerciasis
- Diarrhoea
- HIV





The technological endpoint of outstanding science may be very simple



## Drugs

*Good drugs, but deployment and targeting weak.*

- Malaria, pneumonia

*Resistance eroding the drugs we have- back to the basic science*

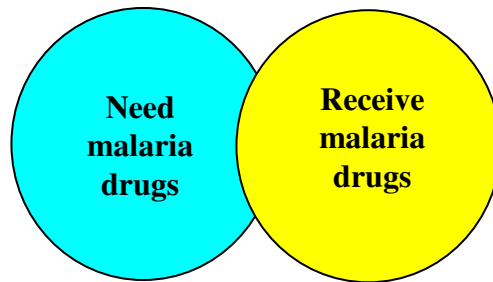
- Malaria, HIV, typhoid

*Drugs still poor/toxic/expensive*

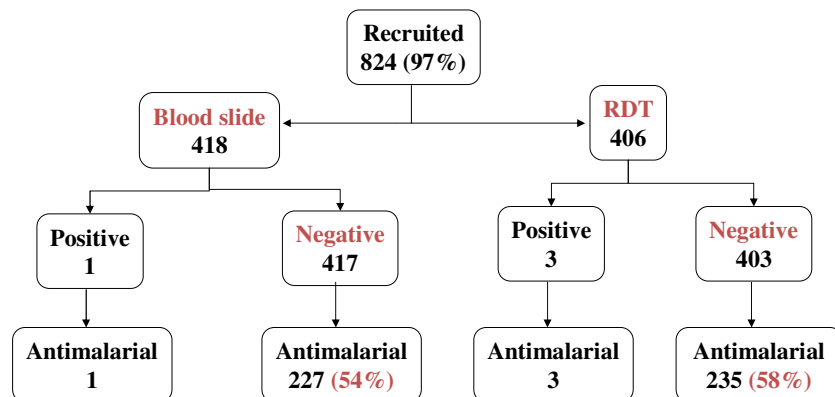
- Sleeping sickness, leishmaniasis



Good technology needs improved systems.  
An example is malaria.



Providing a technology at an appropriate cost is  
necessary, not sufficient

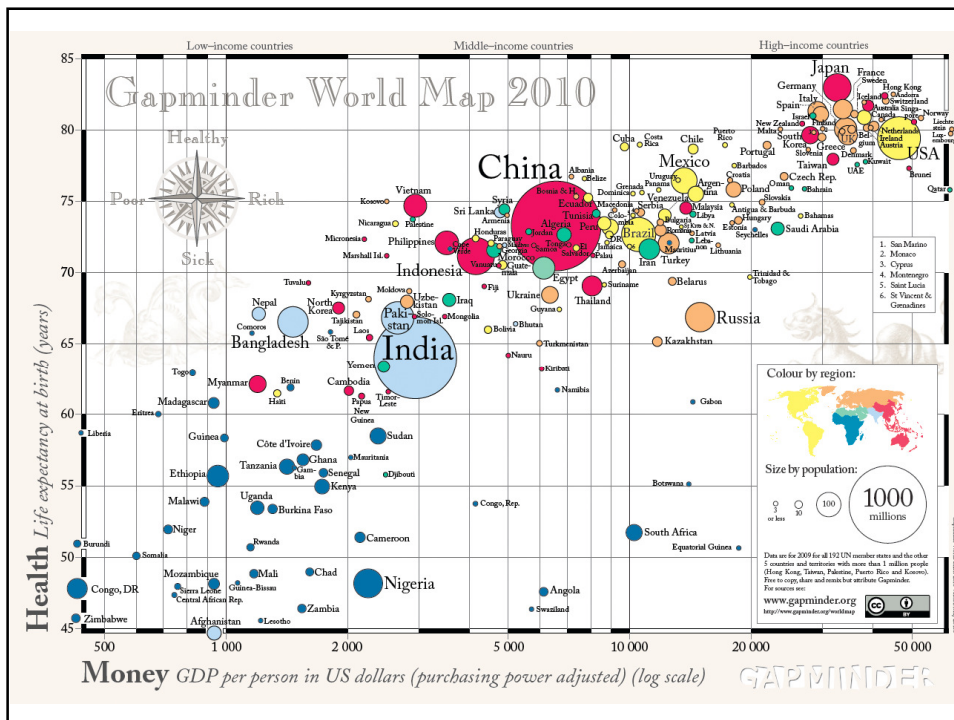
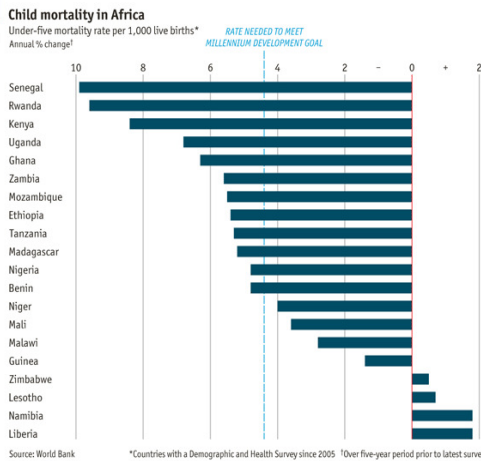


# “Africa is experiencing some of the biggest falls in child mortality ever seen, anywhere” *Economist*

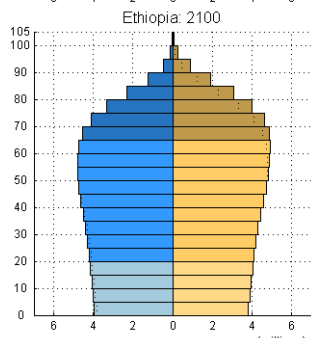
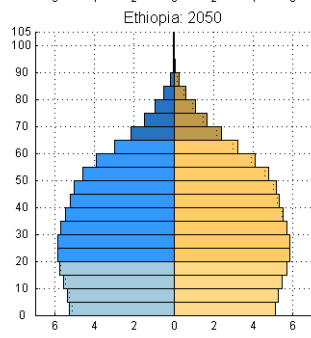
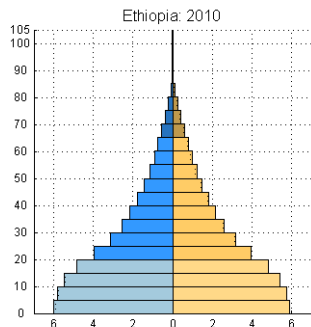
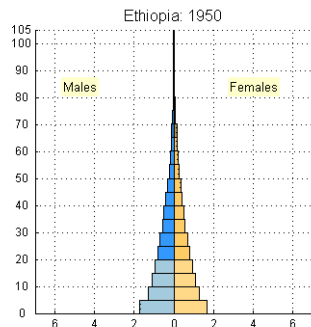
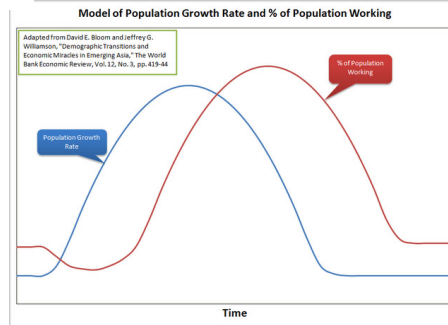
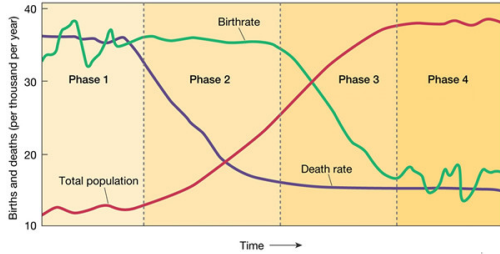
2012

“Results [in Niger]... show that about 59,000 lives were saved in children younger than 5 years in 2009, attributable to -the introduction of insecticide-treated bednets (25%); improvements in nutritional status (19%); vitamin A supplementation (9%); treatment of diarrhoea with oral rehydration salts and zinc, and careseeking for fever, malaria, or childhood pneumonia (22%); and vaccinations (11%).”

*Amouzou et al, Lancet Sept 2012.*



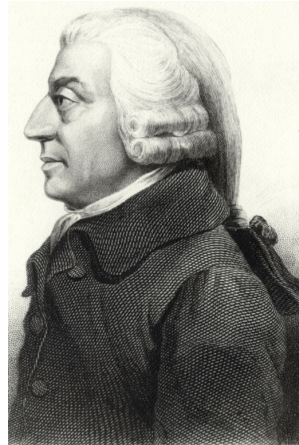
## Demographic transition, demographic dividend, second demographic dividend



(millions)

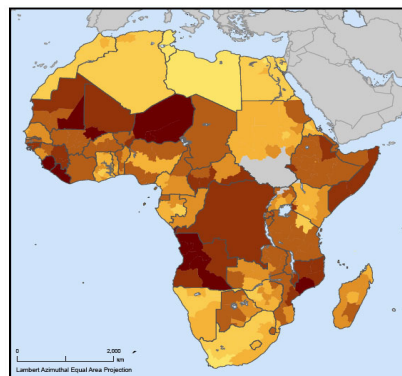
## The central place of economics

- A lot of science is undertaken ostensibly for development in Africa but with no economic analysis. It is likely to fail.
- Cost-effectiveness, willingness-to-pay, elasticity of demand etc central.



Africa is likely to suffer more from climate change than any other continent. Reasons include:

- **Poverty** meaning many fewer choices
- High reliance on rain-fed agriculture
- Water scarcity
- Cold seldom a constraint



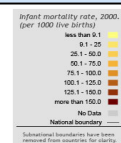
Africa  
By Subnational Administrative Level

Measures of Poverty

### Infant Mortality Rates [IMR]

Subnational mortality rates are adjusted to 2000 using national trend data.

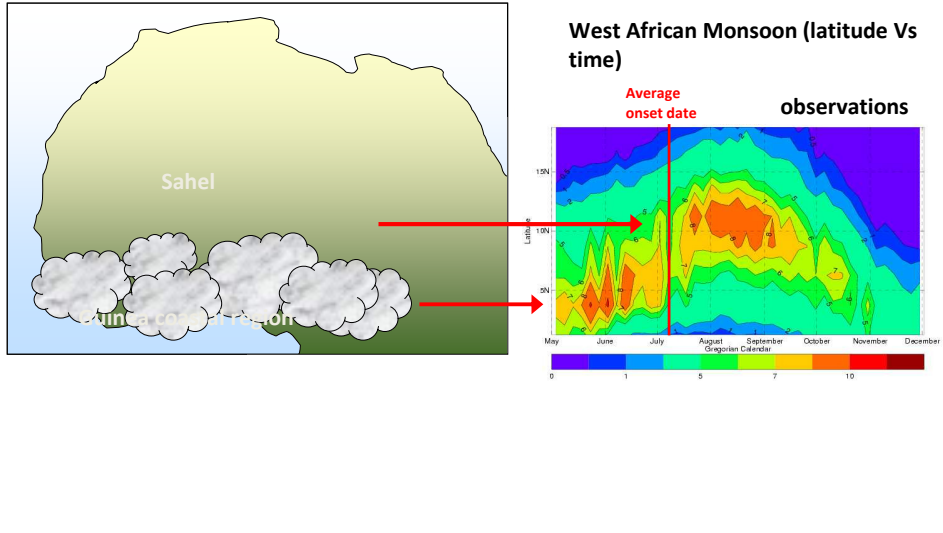
Original data for 99% of countries are from 1990 or later. All data are from 1990 or later.



Copyright 2005, The Trustees of Columbia University in the City of New York.  
Source: Center for International Earth Science Information Systems (CIESIS)  
Columbia University Global e-mail: [global@earth.columbia.edu](mailto:global@earth.columbia.edu), and  
Earth Observatory URL: <http://earthobservatory.nasa.gov>

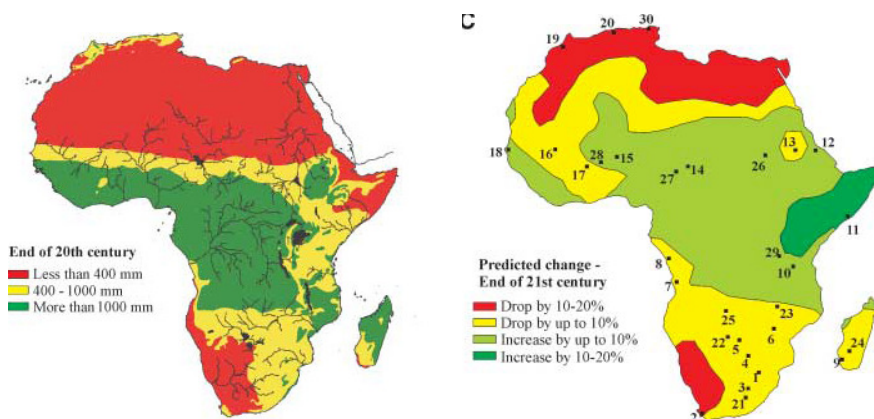
Subnational boundaries have been removed from countries for clarity.

## West African Monsoon Rainy season onset *(Met Office)*



## Impact of reduced precipitation on water runoff

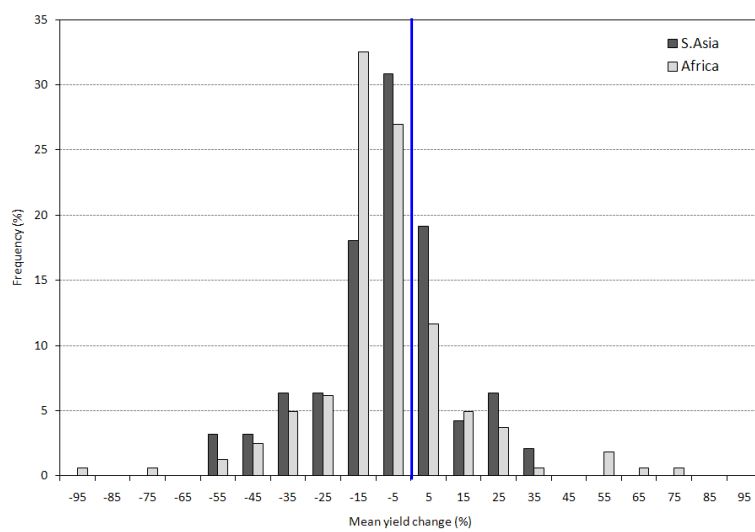
(de Wit & Stankiewicz, *Science* 2007)



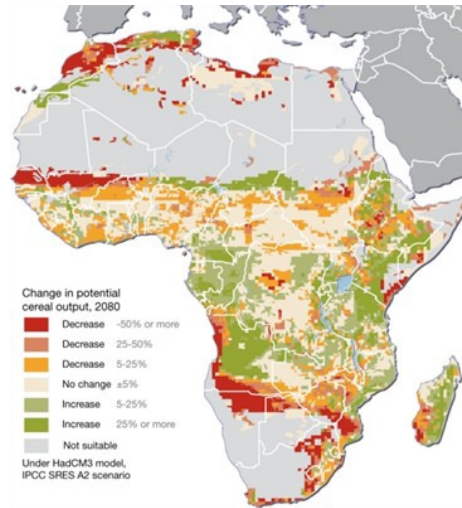
## Summary of % change by crop across Africa

(Knox, Hess, Daccache, Wheeler 2012)

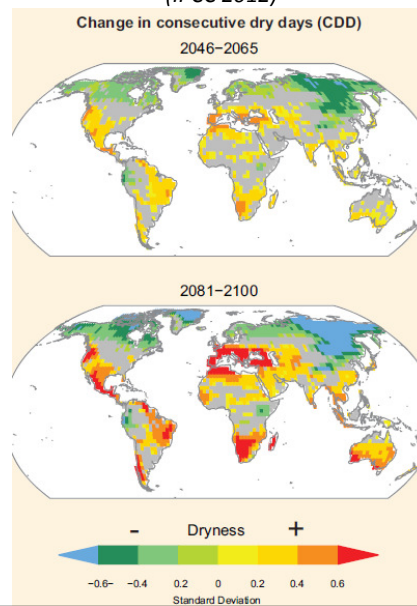
- 17% wheat
- 5% maize
- 15% sorghum
- 10% millet
- No change in yield detected for rice



## Various attempts to predict spatial effects on agriculture (UNEP/GRID-Arendal)



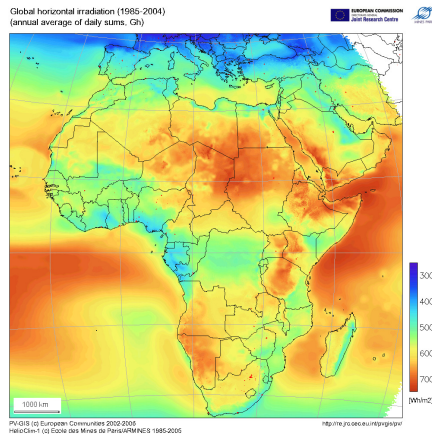
## Risk of drought- change consecutive dry days (IPCC 2012)





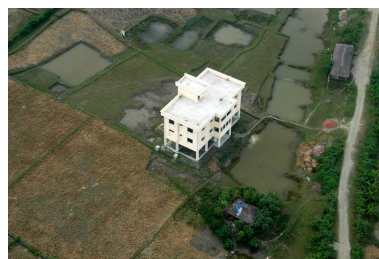
## Climate change - mitigation

- For Africa, with current technology low-carbon growth may mean slower growth.
- Nuclear, wave, tidal, electric vehicles pro-North.
- Theoretically, solar, biofuels. But a way to go before economically attractive at scale.
- Solar lanterns, off-grid electricity etc very pro-poor, but small impact on carbon.
- Little science of eg low-carbon building gets into infrastructure work



## Climate change - adaptation.

- Much (eg drought-resistant crops) is just an extension of improving resilience.
- Targeted programmes depend on better prediction esp. the effects on rainfall duration.
- Engineering for urban environment, for water and floods central.



## Innovation- *“Ex Africa semper aliquid novi”*

- Some advances come from innovations designed for Africa
- More come from adaptations of technology, including high-end technology, for local needs.
- Mobile banking, testing telemedicine, using phones to turn capital items into recurrent expenditure more advanced in much of Africa than UK.
- Innovation can cut both ways...



African nations are entering middle income status with far lower scientific capacity in depth than Asian and Latin American countries did.

- Individually outstanding African scientists, engineers, economists and technicians- but far too few.
- This may become one of the greatest blocks to growing out of LMI status.
- Physicians per 10,000 population (proxy indicator)
  - USA 24, UK 27
  - Brazil 18 Pakistan 8 Vietnam 12
  - Ghana 1 Uganda 1 Zambia 1

## Science can provide

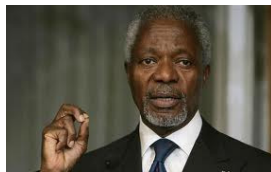
- New technologies and methods, reducing the costs of older technologies or innovating around them.
- Better ways of delivering existing technologies and services.
- Understanding the environment to allow better prediction and decision-making.

## It is not all plain sailing



- Hype causing unrealistic expectations.
- The supply of funding, and scientists in critical disciplines, falls well short of opportunity and need.
- The private sector is part of the solution. The public sector in development can be risk-averse and short-medium term.
- **Too often scientists find a solution by basic/translational research and then try to fit the problem to it.**
- Fashion and fad are common to science and development.
- Many areas in their scientific infancy. In some we have lost ground.
- Knowledge of Africa is poor in many critical areas of science outside the continent- opportunities are not spotted, unrealistic solutions are promoted.

## Africa has both scientific and political leadership



Wangari Maathai ; Monty Jones, Awa Coll-Seck, Kofi Annan, Tedros Ghebreyesus, Nelson Mandela

## A need for more science, of many types from most disciplines

- Our scientific generation globally could transform the outlook for most countries in Africa.
- Advances seldom comes from a single breakthrough, but rather a combination of steps from many disciplines.
- Basic research from almost every field, the D in R&D, field evaluation, anthropology, economics, engineering and many others are needed.
- There are many serious problems- but **they are problems which with good science, engineering and innovation are soluble.**