Reorienting Agricultural Research to meet the MDGs

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Professor of International Development, Imperial College
The Benefits of Agricultural Growth (1)

• For most Low Income Countries Economic Growth is crucial to all the MDGs
  
  e.g. Malawi Government Expenditure
  $750 million + $500 million from donors
  $100 per head for everything

• Economic Growth in medium term
  = Rural Economic Growth
  = Growth in Agriculture, Forestry and Fisheries
The Benefits of Agricultural Growth (2)

• Key to halving poverty
  - it can provide increases in incomes for both farmers and farm labourers.
  - it has a significant multiplier effect on other economic activities (Every additional $1 of farm income generated creates a further $1 - 2 of income outside agriculture).
The Benefits of Agricultural Growth (3)

Key to halving hunger

• directly for small farmers from their own production
• by reducing prices of staple foods and improving their availability
• by increasing government and private food stocks for times of shortage
MDG 1 (between 1990 ad 2015)

• ERADICATE EXTREME POVERTY AND HUNGER
  - Halve the proportion of people whose income is less than one dollar a day
  - Halve the proportion of people who suffer from hunger

• Agricultural Growth is key to MDG 1
The Role of Agricultural Research and Development
Past Successes

The Green Revolution was one of the most successful technologies of the 21st century.
The Green Revolution

- At its heart
  - lodging

- Wheat
  - Short-strawed Norin 10 from Japan

- Rice
  - Dee-geo-woo-gen, a short, stiff-strawed variety with a single recessive gene for dwarfing.
  - IR8 the "miracle rice".
  - China - similar to IR8 - Guang-chai-ai.
Growth in average wheat yields during the Green Revolution

![Graph showing the growth in average wheat yields in India and Pakistan from 1961 to 1981, with data from FAO.]
Real Cereal Prices (1990 US$)

The Limitations

- Focused on ‘ideal’ environments
- Over-reliance on synthetic pesticides and fertilisers
- Not all the poor benefited
- Passed Africa by
Today there are:

- **Over 800 million chronically undernourished**
- **180 million children severely underweight for their age**
- **400 million women of child bearing age anemic**
- **Over 200 million children vitamin A deficient**
Global Food Deprivation

Source: FAO
Average Cereal Yields

(FAO 2006)
Average annual increase in developing country cereal yields

(FAO, 2006)
Agricultural Growth in India
Montek Ahluwalia

- **1960s** – reliant on PL480

- **1970s** Green Revolution
  - Food self sufficiency - Ag GDP 1.4%

- **1980s** Ag Growth policy – Ag GDP 4.6%

- **Since mid 1990s** – Ag GDP 2%
  - 2002-2003 – Ag GDP 1.1%
World Grain Stocks

Grain Consumption Outstrips Production Again

Consumption

Production

World Grain Stocks Fall

Note: Includes Coarse Grains and Wheat

Source: USDA
Some Recent Successes
The New Rices for Africa

Monty Jones
2004
Eradication of Rinderpest

A Vaccine in the 1960s

Dr. Walter Plowright
1999 World Food Prize Laureate

United Kingdom
Immediate Needs for MDG1

• Higher yielding, resilient varieties and breeds
• Integrated pest and nutrient management
• Efficient small scale water management
• Accessible input markets, with low price inputs
• Accessible output markets with fair prices
We need Appropriate Technologies

- Traditional Technologies
- Intermediate Technologies
- Conventional Technologies
- Advanced Technologies

In a Mix that is Appropriate
Treadle Pump
Coconut Harvester
Kerala, India
Mr Joseph - Honeybee

Biodegradable Plastic Mulch
Loess Plateau - China
Wamalwa Farm, Siritanyi FFS, Kanduyi. Maize-groundnut intercrop providing 5330 kg maize and 1203 kg groundnut per ha. These results indicate that MBILI can produce significant food surpluses.

Rasike Farm, Chililila WG. MBILI maize-soyabean intercrop providing 1215 kg maize and 545 kg soyabean per ha when conventional intercrops failed. These results indicate that MBILI is a means toward greater food security.
Conventional Technologies
Quality Protein Maize

opaque   yellow   white
kernel   vitreous QPM

The Millennium World Food Prize Laureates

Dr. Evangeline Villegas
Mexico

Dr. Surinder Vasal
India
But often

- Labour intensive to use
- Require relatively high level skills to use
- Difficult to solve many problems
- Time consuming and expensive to produce
- Poorly available
Advanced & Platform Technologies

- Information & Communication Technologies
- Biotechnology
- Nanotechnology
- New Materials
Sustainable Agriculture in the Seed

Tissue Culture

Marker-aided Selection

Recombinant DNA
African X Asian Rices

Oryza sativa
Progeny
Oryza glaberrima
Marker- Aided Selection

- Locating and tagging the genes for drought tolerance
Recombinant DNA

(Genetic Engineering or Modification – GM)
GLOBAL AREA OF BIOTECH CROPS
Million Hectares (1996 to 2005)

Increase of 11%, 9.0 million hectares or 22 million acres, between 2004 and 2005.

Source: Clive James, 2005.
Uganda
Golden Rice
Diamond Back Moth

Source: CIMBAA
Translational Research

• Takes the knowledge and products of basic science and translates them into forms that can be turned into practical products, e.g.

  • Genomic discoveries – Advanced labs
  • Packages of tested traits - CGIAR
  • Commercial crop varieties – NARS & Private
Farmers need access to Technologies
Input Markets
Output Markets
Cereal Bank in Western Kenya
Farmers need to participate in the process of technology identification and development
Farmers as Ecologists
Into and Out of Poverty

- **Into Poverty**
  - Poor health and health-related expenses
  - Heavy funeral expenses
  - Large family size and land subdivision.

- **Out of Poverty**
  - Diversification of income by establishing links with the urban economy.
  - A job, mostly in the private sector.
  - A craft or trade in a city,
  - A small business in the neighbourhood.
  - Diversified on-farm income through production of cash crops
  - Livestock acquisition.
  - Significantly acquisition of education did not, by itself, appear enough to escape from poverty.

The Benefits of Agricultural Growth (4)

It will also have an indirect positive effect on other MDGs, including those concerned with education, health, water and the environment.

But is this real or imagined?

Millennium Development Goals (by 2015)

- Halve poverty and hunger
- Halve population without access to safe drinking water
- Universal primary education
- Gender equality in primary education
- 3/4ths decline in maternal mortality
- 2/3rds decline in under-5 mortality
- Halting and reversing HIV/AIDS
- Special assistance to AIDS orphans
- Improving lives of 100 million slum dwellers
### Goals and Targets

<table>
<thead>
<tr>
<th>GOAL 1</th>
<th>Eradicate extreme poverty and hunger</th>
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<tr>
<td>Reduce extreme poverty by half</td>
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<tr>
<td>Reduce hunger by half</td>
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<thead>
<tr>
<th>GOAL 2</th>
<th>Achieve universal primary education</th>
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<tr>
<td>Universal primary schooling</td>
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<th>GOAL 3</th>
<th>Promote gender equality and empower women</th>
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<tr>
<td>Equal girls' enrolment in primary school</td>
<td></td>
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<tr>
<td>Women's share of paid employment</td>
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<td>Women's representation in national parliaments</td>
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<th>GOAL 4</th>
<th>Reduce child mortality</th>
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<tr>
<td>Reduce mortality of under-five-year-olds by two thirds</td>
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<td>Measles immunisation</td>
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<th>GOAL 5</th>
<th>Improve maternal health</th>
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<td>Reduce maternal mortality by three quarters</td>
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<th>GOAL 6</th>
<th>Combat HIV/AIDS, malaria and other diseases</th>
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<tr>
<td>Halt and reverse spread of HIV/AIDS</td>
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<tr>
<td>Halt and reverse spread of malaria</td>
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</tr>
<tr>
<td>Halt and reverse spread of tuberculosis</td>
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<th>GOAL 7</th>
<th>Ensure environmental sustainability</th>
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<td>Reverse loss of forests</td>
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<tr>
<td>Halve proportion without improved drinking water</td>
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<td>Halve proportion without sanitation</td>
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<tr>
<td>Improve the lives of slum-dwellers</td>
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**Target already met (or very close)**
- Target will be met by 2015 or little progress/stabilisation around very low levels (not an issue in the region)

**On track**
- Target will be met by 2015 or little progress/stabilisation around very low levels (not an issue in the region)

**Lagging**
- Progress insufficient to meet target by 2015

**Off track**
- Deterioration, change in the wrong direction or no progress at all

**Insufficient data**
Primary Education

- Food insecure families
  - Cannot afford school expenses
  - Need children to work on farm

- Attendance and completion low in rural areas

- Hunger and malnutrition impair performance
  - Low birth weight leading to stunting, protein, iodine and iron deficiency
The Health Goals

- **Between 1990 and 2015**
  - 5. Reduce by two-thirds the under-five mortality rate
  - 6. Reduce by three-quarters the maternal mortality ratio

- **By 2015**
  - 7. Have halted and begun to reverse the spread of HIV/AIDS
  - 8. Have halted and begun to reverse the incidence of malaria and other major diseases
Infant Mortality

- Malnutrition
- Lack of Vitamin A
- Lack of Zinc

Together 1.5 m deaths a year
HIV/AIDS, Malaria and TB

- Hunger and malnutrition increase vulnerability
  - Reduce immunity
  - In AIDS increase likelihood of opportunistic infections
  - Vitamin A & zinc reduce malaria attacks

- Hunger drives
  - women to prostitution
  - men to be migrant labourers
Maternal Mortality Causes – Global Estimates

- Ectopic pregnancy, embolism and other direct causes – 8%
- Unsafe abortion – 13%
- Obstructed labour – 8%
  Risk greatly increased by stunting due to childhood undernutrition
- Eclampsia – 12%
  Links with deficiencies of calcium and other micronutrients have been suggested
- Sepsis – 15%
  Anaemia and vitamin A deficiency increase the risk of sepsis
- Anaemia, malaria, HIV/AIDS, heart disease and other indirect causes – 20%
- Haemorrhage – 25%
  Anaemia is a major risk factor for haemorrhage

Source: WHO
Main Contributions of ARD to other MDGs

- Often important but rarely a key

- Nevertheless important to use MDGs as a lens for viewing ARD

- Reduction in malnutrition and stunting

- Increased availability of Vitamin A, iron, zinc and other micronutrients
MDG 7: ENSURE ENVIRONMENTAL SUSTAINABILITY

• Growth in Agriculture, Forestry and Fisheries
  - Depends on Renewable Environmental Resources
    • Soils, Water, Enemies of pests, Trees, Fish

• Hence Agricultural Growth depends on Sustainable Environmental Development

• Which is furthered by Sustainable Agriculture
What do we mean by Sustainable Agriculture?
Marcus Terentius Varro

Agri cultura ...Non modo est ars, sed etiam necessaria ac magna, eaque est scientia, quae sint in quoque agro serenda ac facienda, quo terra maximos perpetuo reddat fructus’

Rerum rusticarum
Minimising the Trade-Offs

Productivity

Resilience

Stability

Equitability

Sustainable Agriculture
Doubly Green Revolution

• The aim
  • repeat the success of the Green Revolution
  • on a global scale
  • in many diverse localities

• and be
  • equitable
  • sustainable
  • and environmentally friendly
The Threat of Climate Change
Global mean temperatures are increasing

(Source: Met Office, UK)
Climate Change

Temperature & Water
Consequences of Global Climate Change

- Greater & more intense rainfall
- Higher temperatures
- Greater droughts
- River bank erosion
- Rising sea levels
- More intense cyclones
- Salt water incursions
Digital Elevation Model of Bangladesh

Legend:
- International Boundary
- River
- Railway
- Road

Elevation in meters (MGL):<br>
- 1 m  2 - 6 m  7 - 12 m  13 - 21 m  22 - 30 m  31 - 60 m  60 - 100 m  100 - 150 m  150 - 200 m  200 - 300 m  300 - 500 m
- No Data
Expected Change in Precipitation by end of 21st Century

De Wit & Stankiewicz 2006
Science, 311, 97-1921
Annual Losses to Drought

RICE

China: 4.4 MT or $880m
E. India: 2.9 MT or $580m
Global: 4% or 18 MT or $3.6b

TROPICAL MAIZE

Global: 17% or >20 MT or $2.2 b
Maize in Southern & Eastern Africa

Grain-filling stage

Risk of drought:
- High
- Low
- Medium
- Very High
- Very Low
- Default
Lodging

Drought
To Combat Drought

- Drought tolerant varieties and breeds
- Drought resilient cropping and farming systems
- Drought resilient livelihoods
- Small-scale sustainable water supplies
Message of Stern Report:

Need to start addressing these issues now
Resilience

A key component of sustainable development
Figure 1. Concept of resilience
Countermeasures

- **Breeding**
  - Drought and flood tolerant varieties
  - Heat tolerant varieties

- **Agronomy**
  - Minimum tillage, integrated pest control

- **Infrastructure**
  - Flood prevention

- **Environmental**
  - Mangrove belts, tree shelterbelts

- **Economic**
  - Crop insurance systems

- **Livelihood**
  - Income diversity, rural-urban linkages
Resilient Livelihoods
Viewed as a whole:

Complex Agenda
Technologies
Input Markets
Rural & Urban Economies
Health
Technologies
Output Markets
Education
Water & Environment

Policies
Markets
Trade
Credit
Land Reform
Science & Technology
Infrastructure
Environment
Etc, etc
MDG 8

DEVELOP A GLOBAL PARTNERSHIP FOR DEVELOPMENT
Agricultural Research as an International Partnership

- Reliance on private sector is not enough

- Importance of public sector
  - National research centres
    NARS
  - Regional research institutions
    FARA, ASERECA, APAARI
  - Global Research Institutions
    CIAR, GFAR

Role of BRICs
  - Brazil, India, China, etc

- Role of Not-for Profit
  - NGOs, Foundations
Public-Private-Community Partnerships

• Combine
  – innovation of private sector
  – political clout of public sector
  – articulated needs of communities

• Access to Proprietary Technologies

• Affordable products
The Three Legged Stool
Public-Private-Community Partnerships

Public

Civil Society

Private

Communities
African Agricultural Technology Foundation

African-led and based, freestanding, not-for-profit

Responsive to smallholder needs

- Licensing agreements for existing technologies
- Adaptive R & D
- Regulatory consent
- Delivery
- Stimulate new technologies
An Agricultural Research & Development System for the 21st Century

BRICS

Basic Science
Universities Advanced labs

Translational Research
PPCPs CGIAR

GFAR & Regional Research Centres

Product Development & Use
NARS Farmers

Bilateral Donors & NGOs

Multilateral Donors

Foundations & UN System

INSTITUTIONS
TEAMS
NETWORKS