Agri-food R&D: Re-examining the Rewards and the Risks

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Benchmarking Global Agricultural Production

Where in the world does agriculture happen?
1961

$1.08 trillion (2014-16 PPP prices)

High Income, total 43.9%
  - Europe, 18.7%
  - USA, 14.4%
  - High income other, 9.4%
    - Australia, 1.4%
Asia & Pacific, total 23.9%
  - China, 9.0%
  - India, 8.0%
  - Asia & Pacific other, 7.0%
  - EE&FSU, 13.9%
LAC other, 5.7%
  - SSA, 5.7%
MENA, 3.9%

2020

$3.98 trillion (2014-16 PPP prices)

High Income, total 23.8%
  - USA, 9.5%
  - Europe, 7.9%
High income other, 5.4%
  - LAC other, 6.3%
Asia & Pacific, total 44.7%
  - China, 22.7%
  - India, 10.9%
  - SSA, 7.5%
Asia & Pacific other, 11.1%
  - EE&FSU, 6.3%
  - MENA, 5.2%

Source: Data from FAO (2022).
Benchmarking R&D Investments  (Preliminary estimates)
Global R&D Spending – Agri-Food vs Total R&D

Agricultural R&D/Total R&D Intensity (Global)

Agricultural R&D/Total R&D Intensity (By Income Class)

Low income

Upper middle income

Lower middle income

High income

percent

percent


7.4

4.4

20.2

3.3
Global Agri-Food R&D Spending, 1980 vs 2018

1980
- High income Europe: 25%
- High income other: 21%
- E. Europe & FSU: 14%
- LAC: 11%
- SSA: 4%
- MENA: 2%
- Asia & Pacific: 7%
- Australia: 3%

$41 billion (2020 PPP$)

2018
- High income Europe: 19%
- High income other: 17%
- LAC: 4%
- MENA: 7%
- SSA: 4%
- Asia & Pacific: 13%
- E. Europe & FSU: 1%

$101 billion (2020 PPP$)
Global (Agri-Food) R&D Spending – Public vs Private

2018

- Total R&D
  - Public: 32%
  - Private: 68%

- Ag R&D
  - Public: 49%
  - Private: 51%

$2,302 billion (2020 PPP)

$101 billion (2020 PPP)

Agri-Food R&D

- Public
- Private

Percent

<table>
<thead>
<tr>
<th>Year</th>
<th>Public</th>
<th>Private</th>
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<td>2016</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2018</td>
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High income: 56%
Low income: 11%

2018
Agri-Food R&D – A (still) Growing Global Divide

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>Amount (million 2020 PPP$)</th>
<th>Share (%)</th>
<th>Country</th>
<th>Amount (million 2020 PPP$)</th>
<th>Share (%)</th>
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<td>Brazil</td>
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<td>256</td>
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<td>Bottom 50</td>
<td>447</td>
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International Agri-Food R&D

CGIAR trend

- High income
- Low and middle income
- International Banks and others
- Foundations
- Low income

Donor 2020

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<tr>
<th>Donor</th>
<th>%</th>
<th>$</th>
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<tr>
<td>USA</td>
<td>14.8</td>
<td>104.9</td>
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<td>Bill &amp; Melinda Gates Fdn</td>
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<td>Top 10</td>
<td>63.0</td>
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<tr>
<td>Total</td>
<td>100</td>
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39% decline, 2014–20
Agri-Food R&D Investment Recap

Unprecedented structural shifts in the geography, research orientation and research performance of agri-food R&D worldwide
R&D Rewards

Does agriculture research pay?
- Have the easy gains been made?
- Has the ROI declined over time?

How do the R&D investment trends square with the economic evidence?
What We Did

• A hard-nosed, data-driven assessment of the past payoffs to CGIAR research investments

• To do so we

  • Compiled all available ROI evidence for National (and CGIAR-related) R&D
    • 430 (115) published studies, 2,600 (363) ROI estimates, spanning 1958-2015
  • Standardized ROIs into comparable benefit-cost ratio (BCR) estimates
  • Conducted a formal meta review of the ROIs
  • Benchmarked that ROI evidence against other relevant information
    • Identified 9 studies of CG-related R&D with payoffs in excess of one billion
What We Found

A wide dispersion in the *reported* BCRs

Our formal meta-regression analysis reveals *conditional predictions* of the returns to R&D after holding constant attributes of the studies that confound direct comparisons

- **CG predicted BCR = 12.0**  
  
  (95% CI 9.0 to 15.8)

- **Non-CG predicted BCR = 9.9**  
  
  (95% CI is 8.6 to 11.2)

A $600 billion return to the cumulative investments in the CG! (2010 prices)
Aspects of Our Findings

Agricultural research lags are long (often multiple years, decades)
- Realizing the full potential from agricultural R&D requires far-sighted, steady and sustained investments

Very high BCR indicates significant underinvestment
- A BCR of 10:1 indicates that agricultural R&D was more profitable than many other government investments

The main beneficiaries are the producers and consumers of staple crops targeted by CGIAR and NARS
- This means the lion’s share of the total benefits from CGIAR crop-improvement research has gone to the poor

The totality of the evidence in our report, and elsewhere, supports at least doubling the total public investment in agricultural R&D.
How Do R&D Payoffs Happen?

New Insights from New Research

- The value proposition of genetic gain (a century of US wheat improvement)

- Moving Matters (agriculture on the move!)
Genetic Gain in U.S. Wheat, 1918-2019

Consequences of Scientific Selection

Increased
- Spatio-temporal varietal diversity
- Yields
- Output
- Crop resilience

Reduced
- Cropped area
Multi-Peril Pest Risk – Biotic Risk Zones

Wheat, 13 pests

Maize, 11 pests
Production by Municipality, 2015

Production by County, 2007

~ + 2.36 C°

~ - 1.05 C°

432 Km W
422 Km N

279 Km W
157 Km N

Multi-pest risk severity
Risks

Risks of R&D underinvestment

- Climate change risks
- Plant and animal (and human) pest and disease risks
- Food security risks
- Biodiversity risks
- Regulatory risks
R&D Underinvestment Risk – The 21st Century Reality

Slowdown (possible declines) in growth of agricultural productivity
  • Failure to meet growth in demand at affordable prices (food accessibility)
  • Undercutting international competitiveness

Unmanaged risks: Changing climate and pest and disease pressure

Unresponsive to changing markets
  • Geographic location, rural-urban relocation
  • Regulatory restrictions
    • License to operate

Requires running even harder to stand still, let along achieve the global growth in food supply to meet the projected growth in demand
  • And to do that sustainably
  • Lower the footprint of agriculture on the environment
Take Home Messages

The payoffs to agri-food R&D are large, and show no signs of diminishing over time.

Arguable, the multitude of risks facing the world’s agri-food sector are much larger, and on the rise, relative to when the CGIAR and its antecedents were formed.

Instead of doubling down on investments in agri-food R&D, many trends are heading in the wrong direction.

Agri-food R&D is still Slow Magic, calling for an urgent revitalization of investments in agri-food R&D.