Funding International Agricultural Research for Development (R4D)
A GSP’s Perspective on the Changing Roles
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> **The Problem**: A potential under-supply of agricultural R&D to meet future food demand

> **The Question**: Across sectors and crops, who should fund Ag R&D?

> **Model**: Optimal allocations based on differences in sector objectives & constraints/opportunities (by commodity)

> **Data**: Current allocations based on what data are available

> **Discussion**: Do the current allocations look optimal?
The Problem: increasing population & decreasing food security, Ag R&D as ONE possible solution

> The FAO projects that agricultural production needs to increase by over 70% by 2050 as world population surpasses 9 billion

  • Several studies have shown evidence of a slowdown in agricultural productivity growth in the U.S. (Fuglie, 2008; Alston et al., 2010; Andersen et al., 2018) and a yield plateau for rice in E. Asia and wheat in N.W. Europe (Grassini et al., 2013)

> In most low and middle income countries (LMICs), particularly those in Sub-Saharan Africa (SSA), agricultural productivity remains low

  • The negative prospect of climate change (Schlenker and Roberts, 2009; Urban et al., 2012; Nelson et al., 2014) multiplies these concerns

> Increasing food supply by substantially investing in Ag R&D targeting a broad range of crops and agricultural activities relevant to LMICs could be an important means of increasing food security
The shared problem of too little agricultural R&D as a global public good

> As a public good, the provision of Ag R&D by the private sector is likely socially sub-optimal (Samuelson, 1954; Nelson, 1971).

> Agricultural R&D is largely funded by the public sector (Pardey et al., 2016; ASTI, 2012; Beintema et al., 2012)

> The global landscape of Ag R&D funding is changing (Pardy, 2016):
  • Middle-income countries have surpassed rich countries in public sector food and Ag R&D funding.
  • Low-income countries are losing ground (and their global share is small).
  • The global share of private sector investment is rising (Fuglie, 2016)
What is the optimal distribution of funding across sectors and across crops?

Our question:

If you were a **Global Social Planner**, how would you allocate society’s R&D budget across the private, public and private not-for-profit sectors to ensure a socially optimal quantity of R&D directed toward commercial and “orphan” crops?

The answer would depend in part on what is different across sector missions (preferences) and sector comparative advantage (constraints). That is, what do these different funders try to maximize, and to whom are they accountable?
Optimal allocations based on objective and cost

\[ E(\text{NPV}_i) = \left[ m_i \left( \frac{e_i (P_M \times Q_i) + s_i \times \text{loc}^s_i \times \text{SOC}_i}{(1 + r_i)^{t_i}} \right) - \text{loc}^c_i \times C_i \right] \]

- **Financial returns**: Function of excludability \( e_i \), market size, market share, probability of R&D reaching the market \( m_i \) & consumer willingness-to-pay
- **Social benefits**: \( \text{SOC} \) e.g., food security. Affected by importance given to social benefits \( s_i \) and location \( \text{loc}^s_i \)
- **Location of $ flows**: location of consumers, employment, and investment \( \text{loc}^c_i \)
- **Estimated time to market**: \( t \) and \( r \) (discounting)
- **Costs of R&D**: \( C_i \)
Current Ag R&D funding: What can we patch together by sector and by crop?

- Private data from publicly-traded company financial statements from U.S. SEC 10-K filings
- Public funding data from CGIAR Agricultural Science and Technology Indicators (ASTI)
  - Aggregate data over the period 1981-2014
  - Crop-level detail for 2008-2014
- Philanthropic data from specific foundation reports and CGIAR annual reports
- Reviews and estimates from the literature (e.g., Fuglie et al., 2016; Pardey et al., 2016)
Private funding for Ag R&D

> Data on private investments are limited and focused on large-acre market-oriented crops and small-acre cash crops like fruit and vegetables (Fuglie et al., 2016)

> Subsistence crops like cassava, pearl millet, and sorghum are characterized by substantially lower levels of private research intensity (CGIAR, 2011; Naseem et al., 2001)

Private sector R&D spending by crop, 2014

Source both figures: Fuglie, 2016
E.g. Private firms’ research by crop (count of firms by U.S. SEC 10K filing)
Public funding across crops

Allocation of public funding (FTE) for agricultural R&D in crops - SSA

Total public funding (FTE) allocated by type of crop

- Market-Oriented crops
- Other Fruits and Vegetables
- Orphan Crops

Source: ASTI, 2018

Share of public funding (FTE) allocated to each orphan crop - 2014
Public funding over time for Ag R&D in LMICs

(a) Total

Total agricultural R&D spending (million constant 2011 PPP dollars)

(b) Average per country

Average agricultural R&D spending (million constant 2011 PPP dollars)

Source: ASTI, 2018
E.g. Bilateral Public CGIAR Funding

United States

China

Maize  Rice  Grains & RTB
E.g. Research FTE and Export Value

Commodity
Grains
Non-Orphan Crops
Orphan Crops

Total Researchers, Sub-Saharan Africa
Export Value, Sub-Saharan Africa

Source: ASTI Database, 2017

Public R&D Researchers by Crop and Export Value
Sub-Saharan Africa, 2014
Philanthropic funding for Ag R&D

> Data on philanthropic investments are limited

> Estimates for total philanthropic funding in 2008 range from $245.6 million (Coppard, 2010) to $450 million (Morton, 2010)

> Between 2006 and 2013, the Bill & Melinda Gates Foundation (BMGF) invested $267.2M in Ag R&D (Pingali et al., 2016) while it has recently pledged $300M over the next three years (2018-2020) to fund research that helps farmers adapt to climate change (BMGF, 2017).
To solve a model of “optimal” funding shares, we need to understand

1. How do different funders weigh tradeoffs across high level outcomes in the agri-food system: profit, reduced poverty and hunger, nutrition, resilient eco-systems, access and inclusion...

2. What are the variables towards achieving these outcomes that differ across funders? E.g. scale, location, risk tolerance, accountability, cost of capital.

3. How does (crop) R&D itself rank as a strategy, relative to investment into entirely different technologies or data and the enabling environment?
## Assigning funder preferences and weighting

<table>
<thead>
<tr>
<th>Preferences</th>
<th>Private</th>
<th>Philanthropic</th>
<th>Public (National)</th>
<th>Public (Multilateral)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Financial Returns</strong></td>
<td>Necessary</td>
<td>Not necessary</td>
<td>Valued to large degree</td>
<td>Valued to some degree</td>
</tr>
<tr>
<td><strong>Social Benefits</strong></td>
<td>Not accounted for</td>
<td>Necessary</td>
<td>Valued to some degree</td>
<td>Valued to large degree</td>
</tr>
<tr>
<td><strong>Location of Returns</strong></td>
<td>indifferent</td>
<td>Some preference but below social benefits</td>
<td>Prefer domestic returns</td>
<td>Some preference but below social returns</td>
</tr>
<tr>
<td><strong>Location of Expenditures</strong></td>
<td>indifferent</td>
<td>Important</td>
<td>Prefer domestic expenditures</td>
<td>Indifferent</td>
</tr>
<tr>
<td><strong>Probability of Success (Risk)</strong></td>
<td>Very important</td>
<td>Less important</td>
<td>Important</td>
<td>Important</td>
</tr>
<tr>
<td><strong>Time to Market</strong></td>
<td>Very Important</td>
<td>Less Important</td>
<td>Important</td>
<td>Important</td>
</tr>
<tr>
<td><strong>Cost of Capital</strong></td>
<td>Very important</td>
<td>Important</td>
<td>Important</td>
<td>Less important</td>
</tr>
<tr>
<td><strong>Affordable price (access)</strong></td>
<td>No price subsidies provided</td>
<td>Willing to subsidize to large degree</td>
<td>Willing to subsidize to some degree</td>
<td>Willing to subsidize to some degree</td>
</tr>
</tbody>
</table>
Thank you
Evans School Policy Analysis & Research Group (EPAR)

Professor C. Leigh Anderson, Principal Investigator
Professor Travis Reynolds, co-Principal Investigator

EPAR uses an innovative student-faculty team model to provide rigorous, applied research and analysis to international development stakeholders. Established in 2008, the EPAR model has since been emulated by other UW schools and programs to further enrich the international development community and enhance student learning.
Public goods funding allocation (crowding out)
Coverage and quality: R&D expenditures
Evans School Policy Analysis and Research Group (EPAR)

Coverage and quality: Number of researchers

![Map showing the number of researchers worldwide, with color coding indicating different percentages of imputed data.](image-url)