Innovative Finance for Agricultural R&D

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The problem: Regions vary greatly in ag technology



Source: calculated from FAO data, at http://faostat.fao.org.

There are diminishing returns to inputs, e.g. simply adding more fertilizer

Total fertilizer use, N+P+K (kg/ha of arable land)



Sustaining growth requires new technologies, e.g. new varieties

Adoption of new varieties (pct. of cropped area)



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

New technologies often
involve multiple innovationsGeneticAgronomic
improvement



(by researchers, using controlled trials)

(by farmers, using land & labor)

Successful innovations are often surprising traditional labor-intensive "flat" planting "Zai" microcatchments





For these fields, the workers are:



New finance mechanisms can help

- Agricultural R&D has distinctive characteristics

 value creation is dispersed among the poor, even with IPRs
 ...so private investment is limited by value capture
 research success is difficult to monitor and predict
 ...so public investment is limited to trusted institutions
- The traditional remedy is a third-party "prize"
 - paid by a public or philanthropic donor
 - to reward success after it is observed

Only a few kinds of technology and R&D are best funded with ex-post, third party prizes

Value capture is feasible: users can be made to pay, perhaps with IPRs

is private

Value capture is costly: benefits spill over to consumers or imitators

Funding is public

or philanthropic

Funders can observe quality of RD&D before results are known

Funders cannot observe quality of RD&D until results are visible

Research contests by private firms (e.g. Innnocentive,	and competitive grants) Prize contests funded by public or philanthropic donors (e.g. X Prizes, AMCs)	
Direct funding	Direct funding	
by private firms	by government or	
principals, employees,	philanthropic donors	
br research contracts)	(public labs, contracts	

Payment is ex-ante

Payment is ex-post

Prizes are an old financing mechanism



Prizes are increasingly widespread

	_{rs,} A visual history of major prizes,1930-2007				
ot to scale)		Advance	e market Commitment for pneumococcal di	sease vaccine up to \$1.5 billion	
or Innovative Research		S	Super Efficient Refrigerator Program for	\$37,682,243	
\$165,755,396		ł	highly efficient CFC free refrigerator		
			Virain Earth Challenge for removal o	f areenhouse aases \$25,000,000	
		European I	nformation and Communication Technolog	y Prize	
		Ansari X F	Prize for private manned space flight \$10 Archon X Prize for sequencing the Millennium Math Prizes for seven unsolv	human genome \$ 10,000,000	
			DARPA Grand Challenge for roboti	cs in vehicles \$6,660,406	
		Lemelson-MIT I	Prize for invention of a patented product us	eful to society \$6,000,000	
		Methuselah Mouse Pri	ze for demonstration of slowing of ageing p	process on mouse +\$4,300,000	
		NASA C	entennial Challenges for Improvements in	space exploration — \$2,000,00	
		Schweig	ghofer Prize for Europe's forest industry co		
			International Computer Go Championsh	ip \$1,600,000 ↓ \$1,210,084	
		6	first non-stop balloon flight around the glo	be \$1,210,084	
Across the English Chanı Kremer Priz Powered Fli Polytechnische Gesellscaft Prize			tion Prize for Rapid STD Diagnostic Test - for development of economical filtration dev	s1,210,08	
			m well water in developing countries		
	emer Prize for Human Powered Flight	\$588,092	Goldcorp Challenge for prospecting methods or		
	Kremer Prize for Human	\$290,153	CATS Prize for inexpensive of cial launch of payload into sp	ace 🛶	
	Powered Flight (Figure 8) —		Electronic Frontier Foundation C	\$250,000 \$250,000	
	rize		puting Challenge for new large p		
for Human Powered Flight		Fredkin Prize for Chess Compute	Program\$120,409 Loebner Prize for Computer that	\$100,000 Conjecture Pi	
\$59,240			can pass the Turing Test	\$100,000	

Prizes are an increasingly popular but problematic financing mechanism

- Successful prizes are inherently temporary
 - by revealing what works best, they attract other investment in successful strategies:
 - private investment when innovation is marketable
 - public grants and contracts when it is a public service
- The prize contest itself can be very wasteful
 - fixed awards give nothing for incremental achievements
 - prespecified criteria give nothing for other achievements

A new type of prize can help

- Kremer (2001) pioneered a new economics of prizes
 - payment is an "advance market commitment" (AMC) for a vaccine, so award is proportional to number of doses sold
 - donor defines effectiveness criteria and price per dose
- But agricultural technology is not like medicine
 - more difficult because don't have "one disease, one cure"
 - instead, we have many localized problems & solutions
 - easier because the value of improvement is measurable
 - product is sold at observable prices
 - gains are measurable using experiments and surveys
- For agriculture, we need royalty-like "prize rewards"
 - donors would pay a lump sum, divided among winners in proportion to value of gains from their innovations

"Prize rewards" could be paid for *any* technology whose gains can be measured

New technology's characteristics are predictable

New technology could have various characteristics

Success is a matter of opinion

Success is a discrete, yes/no achievement

Increments of success can be measured

predictable	Characteristics	
	Achievement awards (e.g. Nobel Prizes, etc.)	
Traditional prizes (e.g. X Prizes)		
AMC for medicines (fixed price per dose times no. of doses)	Prize Reward (fixed sum divided in proportion to impact)	

Payment is proportional to success

Payment is

a fixed sum

Type of technology Type of technology is pre-specified

How prize rewards would work to accelerate innovation

- Donors offer a fixed sum (e.g. \$10 m./year), to be divided among all successful new technologies
- Innovators assemble data on their technologies
 - controlled experiments for output/input change
 - farm surveys for extent of adoption
 - input and output prices
- Secretariat audits the data and computes awards
- Donors disburse payments to the winning portfolio of techniques, in proportion to each one's impact
- Investors, innovators and adopters use prize information to scale up spread of winning techniques

Implementing Prizes: Schematic overview

Step 1: donors specify lines of credit for target domains (e.g. \$1 m. for food crops) **Step 2:** innovators submit data on gains from new techniques after adoption (e.g. \$36 m. over 7 submissions)

Prizes would be a small fraction of total activity, but a key market-like signal of value

Impact: other donors, investors and innovators imitate successes

Step 3: secretariat verifies data and computes reward payments (e.g. 1/36th of measured gains)

Prize rewards can stimulate any kind of innovation whose value is measurable





improved fish-drying in Senegal

using hermetic bags to store crops

Implementing Prizes: Data requirements

Data needed to compute each year's economic gain from technology adoption



Variables and data sources

Market data *P*,*Q* National ag. stats.

Field data

S"

- Yield change × adoption rate
- Input change per unit

Economic parameters

- Supply elasticity (=1 to omit) K
- **Demand elasticity** (=0 to omit) ΔQ

Implementing Prizes: Data requirements

Data needed to estimate adoption rates across years



Implementing Prizes: Data requirements

Computation of cumulative economic gains



Implementing Prizes: An example using case study data

Example technology	Measured Social Gains (NPV in US\$)	Measured Social Gains (Pct. of total)	Reward Payment (US\$)
1. Cotton in Senegal	14,109,528	39.2%	392,087
2. Cotton in Chad	6,676,421	18.6%	185,530
3. Rice in Sierra Leone	6,564,255	18.2%	182,413
4. Rice in Guinea Bissau	4,399,644	12.2%	122,261
5. "Zai" in Burkina Faso	2,695,489	7.5%	74,904
6. Cowpea storage in Benin	1,308,558	3.6%	36,363
7. Fish processing in Senegal	231,810	0.6%	6,442
Total	\$35.99 m.	100%	\$1 m.

Note: With payment of \$1 m. for measured gains of about \$36 m., the implied royalty rate is approximately 1/36 = 2.78% of measured gains.

Implementing prize rewards: What's done, what's next

- Refinement and endorsement of the initiative
 - 3 journal articles, 20 seminar meetings since 2003
 - 9-member Advisory Board formed October 2004
 - FARA as potential Africa secretariat since Sept. 2005
- Funding for project development
 - Adelson Family Foundation (New York), 2004-06
 - IFPRI (Washington and Addis Ababa), 2006-08
- Funding for prize rewards
 - significant interest from various donors
 - could be funded through FARA or other secretariats

For more information...

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www.agecon.purdue.edu/staff/masters www.agecon.purdue.edu/prizes www.fara-africa.org