Thoughts on Assessing the Impact of Improved Agricultural Technology on Poverty

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Plan of the presentation

- Some Questions
- Thoughts on why it is “hard” to answer the questions
- Survey of 5 studies addressing impact
- Attempted summary

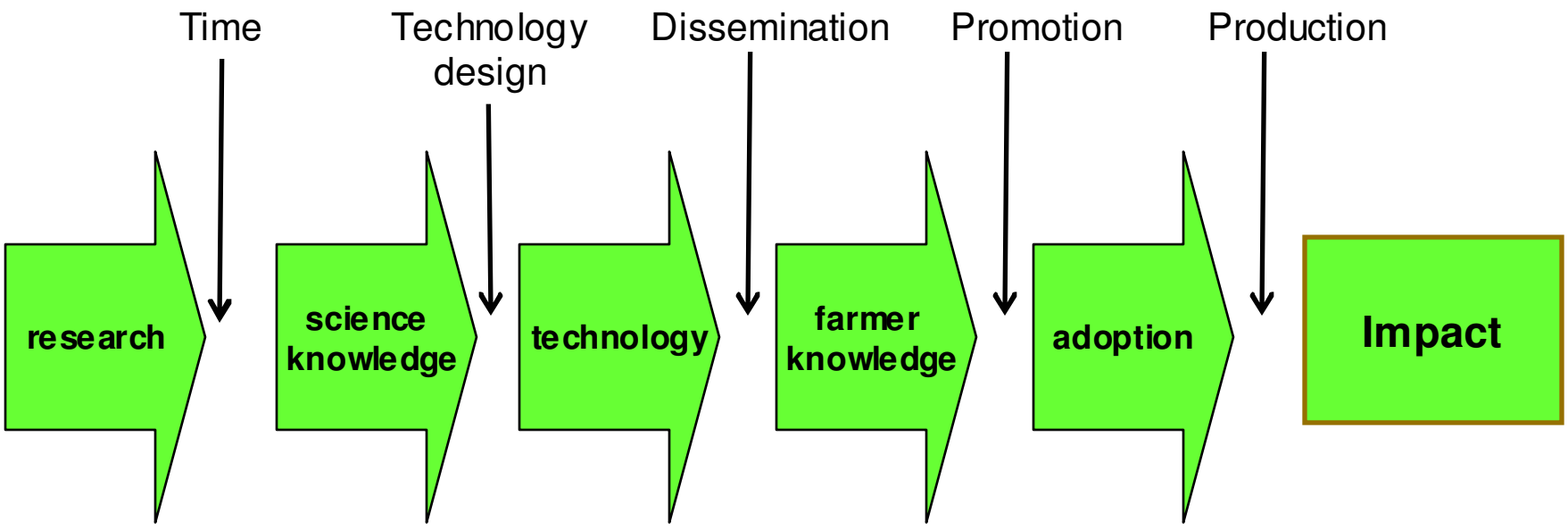
What is the Goal of Impact Assessment?

- To determine which research best contributes
  - to poverty reduction?
  - to food production?

....so as to "reward" success, assist management or direct investment ?

- To satisfy the demand of donor representatives or DG for impact studies?
- To advance professionally?

Can one actually measure the "impact of research?"



Does improved technology reduce or increase rural poverty?

- China, India, Bangladesh >1980:
  - Dynamic technology, rising yields, declining poverty
- SS Africa:
  - Stagnant technology, increasing poverty
- Mexico, many other LA:
  - Dynamic technology, rising poverty
- United States:
  - Dynamic technology, rising incomes, declining rural sector, rising farm incomes

Why is it hard to understand the role of improved agricultural technology in overcoming poverty?

- We are interested in the effect of changes in technology on changes in poverty
- Poverty is complicated to measure
  - Number of people 'in poverty'
  - % of people in poverty
  - 'How poor' the poor are
- => There are few measures of poverty
- Technology is complicated to measure
  - Yield is not technology; 'total productivity' is better
  - Productivity = f (inputs, weather, technology, prices)
  - Subject to short-term fluctuations
- => there are few measures of technology

The impact of technological change on poverty

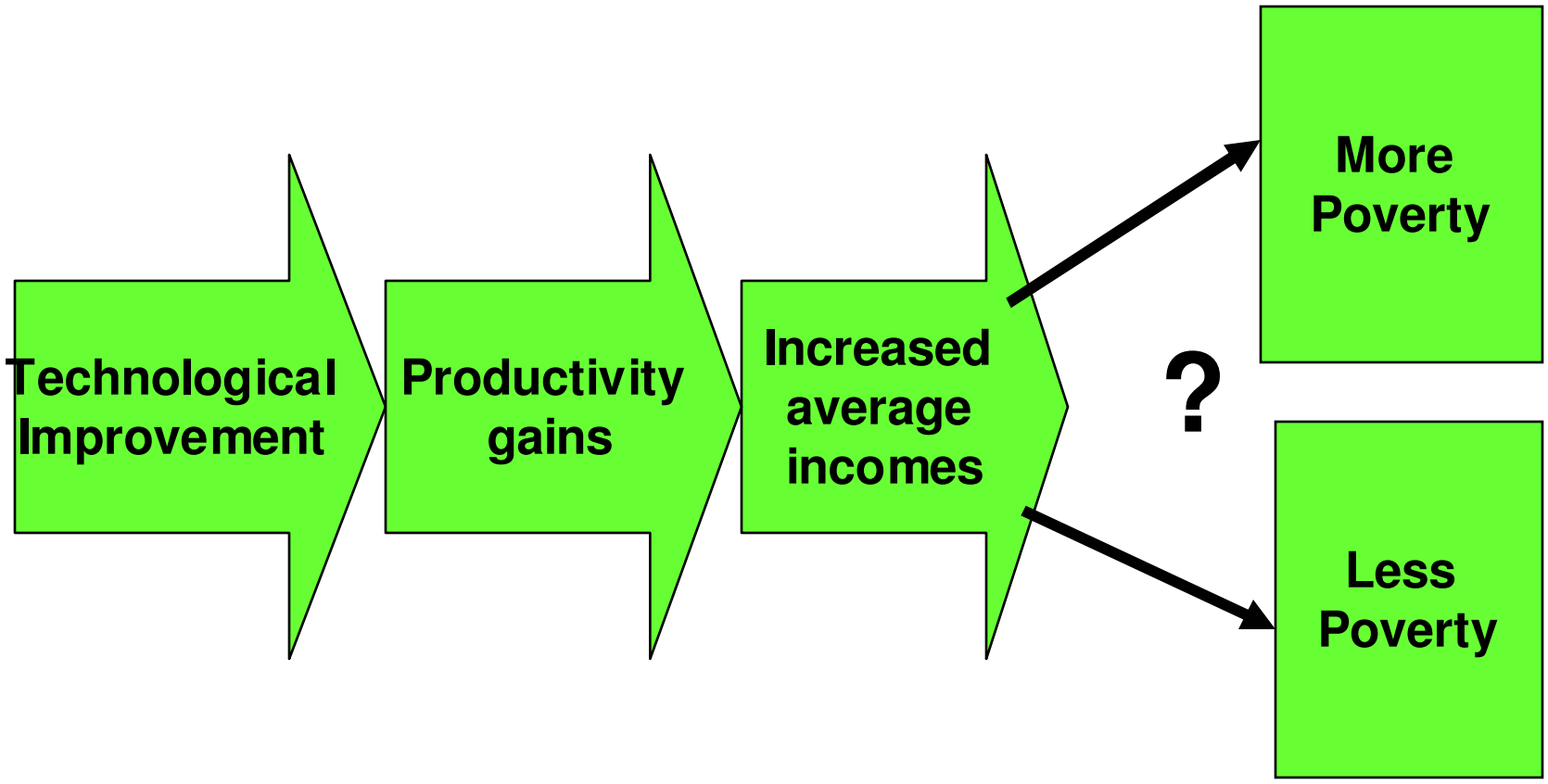
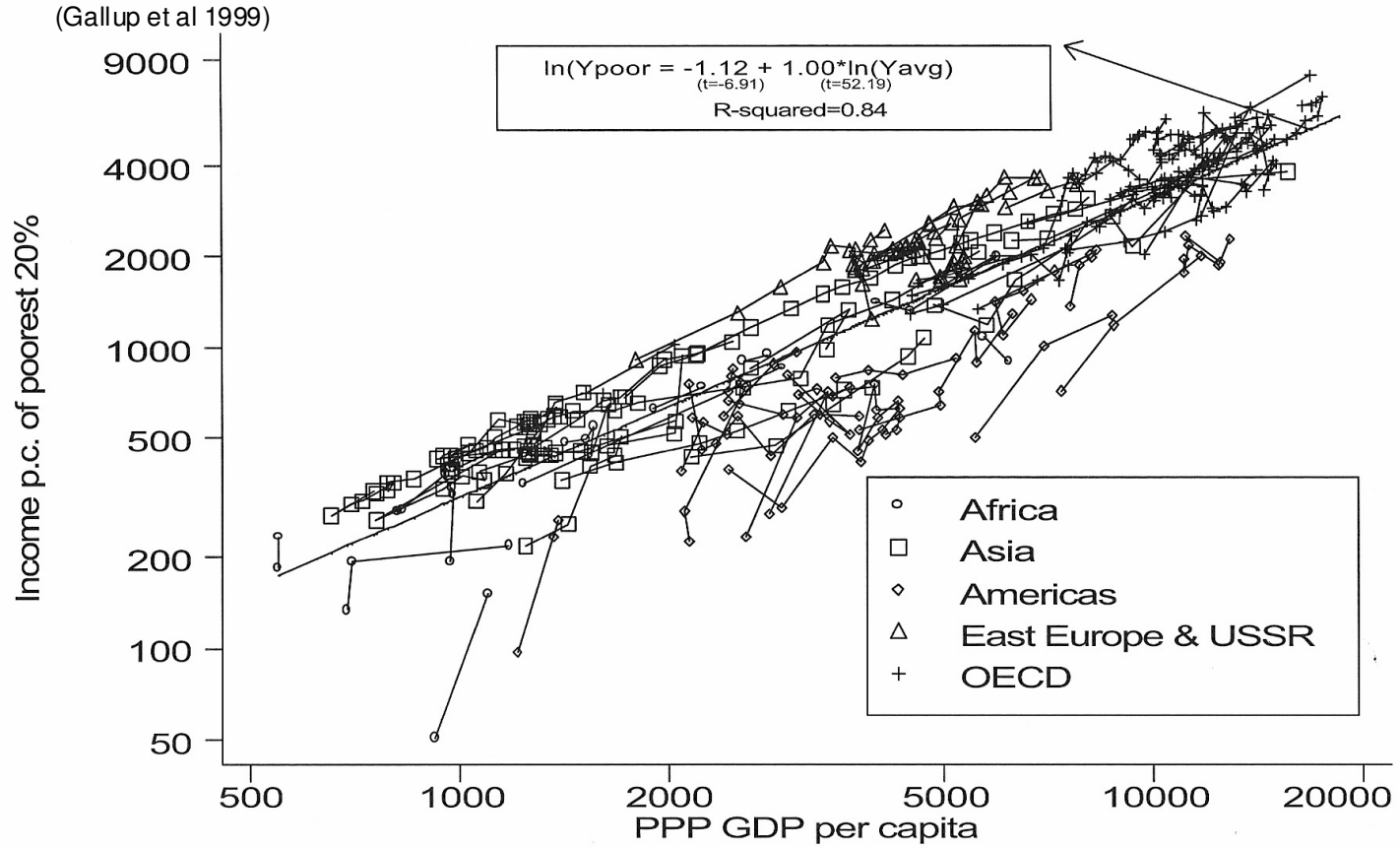


Figure 1: Income of average vs. poorest



When overall incomes grow >2.8%, incomes of poor grow faster than 2.8%

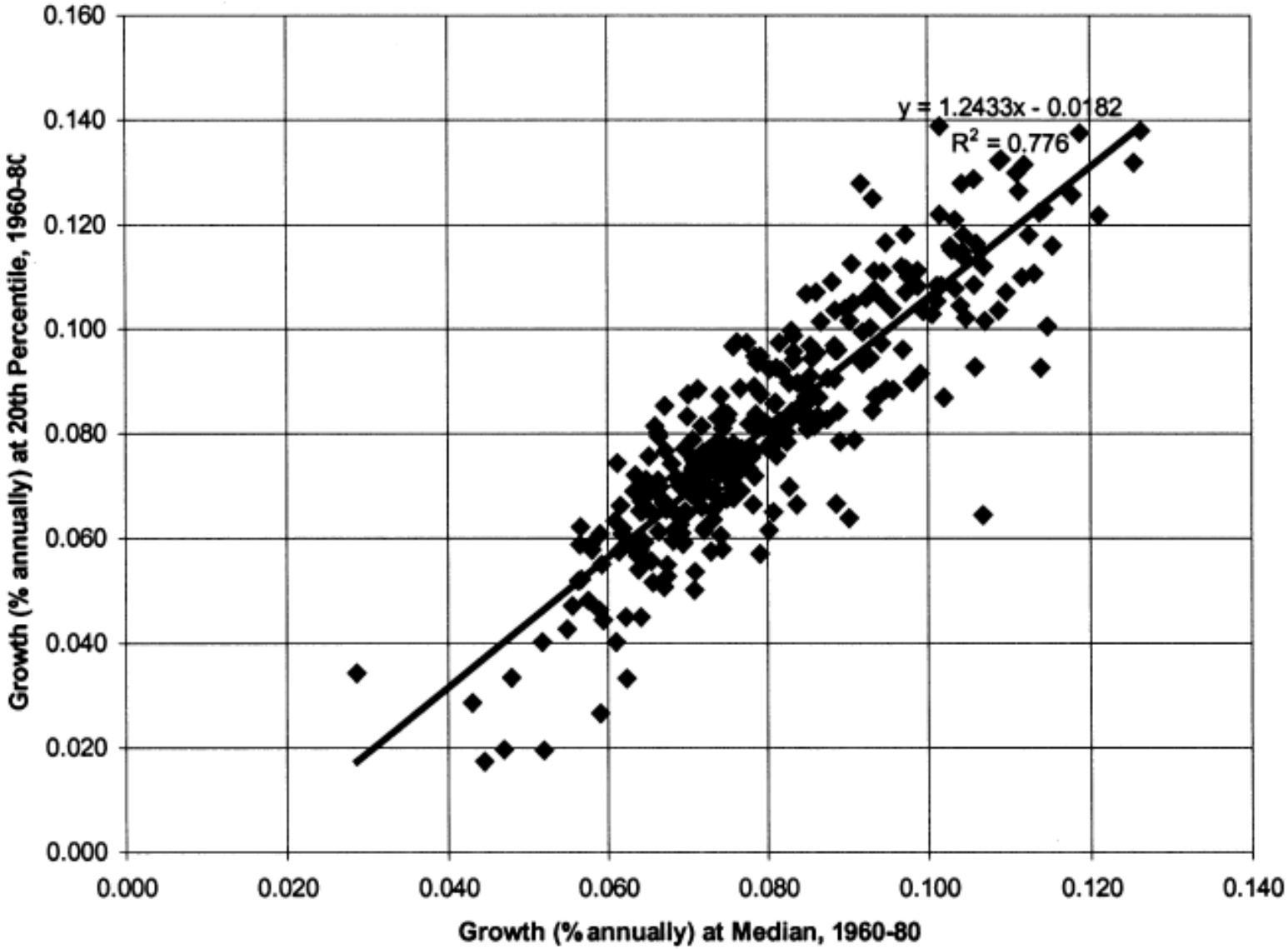
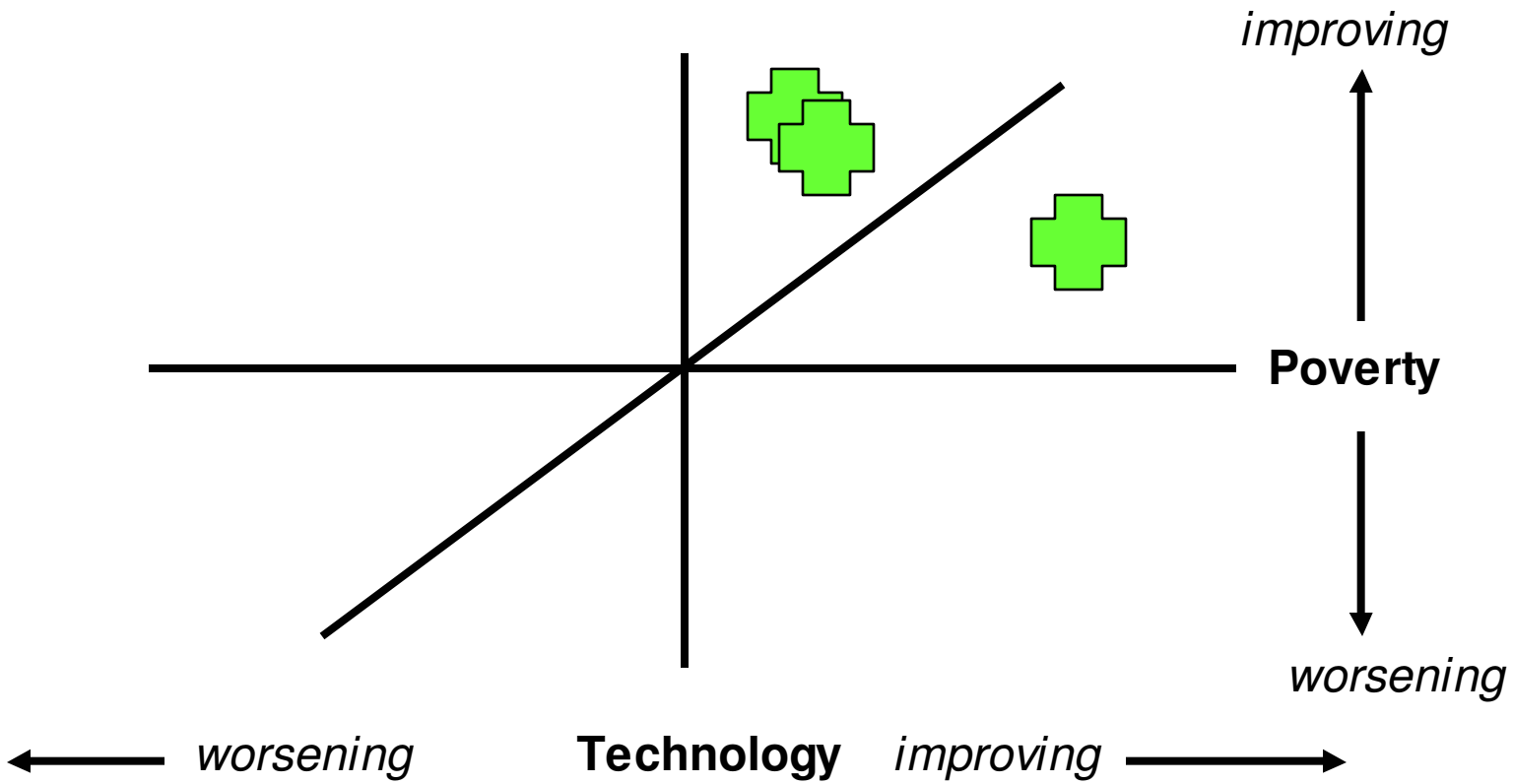


Figure 3. Growth of farm-household income at median and at 20th percentile, 1960–80

Relationship of technology to poverty



Research on agricultural "productivity" gains and poverty in India (1950s-90s)

- Agricultural economic growth did *not worsen* poverty *(Bell and Rich, 1994)*
- Rural growth reduces rural *and* urban poverty, urban growth does not (*Datt & Ravallion 1996*)
- Higher ag wages and higher yields reduce rural poverty (*Datt & Ravallion, 1998*)
  - 1% crop yield => -.4% poverty in short run, -1.9% in long run
- States with low farm productivity, low rural living standards, and low literacy => more poverty (*Ravallion & Datt, 1999)*
- Ag R&D and roads had biggest impact on productivity growth and poverty reduction (*Fan, Hazell & Thorat, 1999*)
- But, some still question the conclusion for India

Why is it hard to understand the role of improved agricultural technology in overcoming poverty?

- We are interested in the effect of changes in technology on changes in poverty
- Poverty is complicated to measure
  - Number of people 'in poverty', % of people in poverty
  - 'How poor' are the poor ? Or the poorest 20%, 25%, etc?
  - How poor compare to others (relatively)
  - => There are limited data on poverty
- Technology is complicated to measure
  - Yield is not technology; 'total productivity' is better
  - Productivity = f (inputs, weather, technology, prices)
  - Subject to short-term fluctuations
  - => => Technology is poorly measured

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  - Productivity = f (inputs, weather, technology, prices)
  - Subject to short-term fluctuations
  - Often use 'proxy' indicator like new crop varieties
  - => Technology is poorly measured

Technology: rotations, varieties, fertilizer

Improved soybeans with hugely better performance on poor soils

Maize + P-inefficient soybean

Maize + P-efficient soybean

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- => Technology is poorly measured
- The impact of technology on income is complex

Different views on the role of technology

- Byerlee; Alston, Norton and Pardey
  - The major effects of technological change are through higher output and **lower food prices**
  - To reduce poverty, focus technology on crops consumed by poor farmers and consumers
- Altieri; Fan and Hazell
  - Major effects of technology are indirect, on input use -- **wages and employment**
  - To reduce poverty, focus technology on neglected regions neglected commodities, and labor-using innovations

Five studies that examine the effects of technological change on poverty

- Before and after the 'green revolution' in one village in India
- Before and after the 'green revolution' in several villages in India
- Calculated/estimated effect on "all villages," Madagascar
- Modeled effects on Asia, Africa, LA economies
- Modeled effects including international trade

Before and after the 'green revolution' Palanpur, India

(Lanjouw and Stern 1998) **1962-63 to 1974-75**

- HYV wheat: 0% to 45%
- Irrigated land: 60% to 100%
- Wheat yields: 41 to 114 (+178%)
- Rice Yields: 26 to 103 (+ 296%)
- Per capita income: 149 to 1025
- Real/capita income: 152 to 275
- Poverty rate: 54% to 11%

"Real income" reflects relative changes of wages/income and food/consumer goods prices

Before and after the 'green revolution' Palanpur, India (Lanjouw and Stern 1998)

	1957-8	1962-3	1974-5	1983-4
% HYV wheat	0	0	45	60
Yield of wheat	41	41	114	101
"Normal" yield of wheat	45	50	100	155
Real ag wages	2.5	2.3	3.1	5.0
Real income/ capita	161	152	275	194
Pop.	528	585	757	960
%poverty	47	54	11	34

Before and after the 'green revolution' in 11 villages in Tamil Nadu, India

(Hazell and Ramasamy, 1991)

	1973-74	1983-84
Regional rice price	100	140
Regional rainfall	100	115
Small farm HYV adoption	little	widely
Large farm " "	widely	widely

Before and after the 'green revolution' in 11 villages in Tamil Nadu, India

(Hazell and Ramasamy, 1991)

	1973-74	1983-84
Small farms rice area	0.55	0.64
Large farms " "	0.75	2.11
Small farms rice yield	1773	2777
Large Farms " "	2524	2176
Small farms yield index	100	156
Large farms " "	100	86

Before and after the 'green revolution' 11 villages in Tamil Nadu, India

(Hazell and Ramasamy, 1991)

	1973-74	1983-84
Small farm crop output value	1426	2013
Large farm " " "	3854	6280
Small farm cultivation costs	700	908
Large farm " "	1534	3396
Small farm net income	726	1105 +54%
Large farm " "	2320	2884 +24%

Before and after the 'green revolution' 11 villages in Tamil Nadu, India

(Hazell and Ramasamy, 1991)

	1973-74	1983-84
Small farms: farm income + ag wages	1115	1845 + 65%
Large farms " "	2548	2931 + 15%
Landless laborers " "	827	1681 +103%
Small farms: Other income	84	441 +425%
Large farms: " "	216	337 +56%
Landless laborers: " "	108	421 +290%

But: no direct measures of poverty!

Calculated/estimated effect on "all villages" Madagascar (Minten and Barrett, 2006)

- Data from 1381 communes (>99%)
  - Survey in 2001, Census in 1993
- Rice: 50% agriculture value, 45% calories
- Three effects of technical change
  - Food prices => net food buyers
  - Output productivity => net sellers
  - Real wages => unskilled workers

Calculated/estimated effect on "all villages" Madagascar (Minten and Barrett, 2006)

- Doubling of rice yields
  - ⇒ 38% reduction in number food insecure
  - ⇒ 31-44% harvest price reduction (but farmers retain 10-60% of benefits from doubled yield)
  - ⇒ 65-89% increase in real agricultural wages
- Other observations:

  cash cropping reduces food insecurity

  most remote: 10% more food insecure vs least
- Higher yields come from intensification, irrigation livestock
- Intensification associated with irrigation, extension agents, non-remoteness (access)

Calculated/estimated effect of technological change Madagascar (Minten and Barrett, 2006)

Change	Rice price	Real wage	% food insecure
Increase rice yield 1 t/ha	-20	37	-19
Flood-resistant rice varieties	-9	11	-7
Drought escape (short duration) varieties	-9	9	-5
High altitude varieties	-3	6	-3
Improve access by 50%	6	11	-5

What is the impact on non-farmers and urban poor?

Modeled effects on entire economies (Social Accounting Matrix)

de Janvry and Sadoulet, J. of Development Studies, April 2002

- Economic sectors:
  - Agriculture: cereals, exports, other
  - Food processing, Trade and services
  - Administration
- Labor: rural, urban, public
- Households: rural landless, rural small, rural large, urban poor, urban non-poor

Modeled effects on entire economies

Parameters in "typical" household, by region

de Janvry and Sadoulet, J. of Development Studies, April 2002

	Africa	Asia	L Am.
% ag contribution to GDP	50	30	15
% total HH income that is rural	60	70	25
Rural poor:			
% total HH income from farm	70	25	15
% off-farm in total HH income	30	40	65
% ag in total consumption	70	40	15
Urban poor % ag consumption	45	35	10

Modeled effects on entire economies

10% crop productivity gain de Janvry and Sadoulet 2002

Resulting % change in…	Africa	Asia	L. Am.
National income (GDP)	6.8	5.3	3.8
Agricultural production	10.0	8.8	8.0
Consumer food crop price	-6.0	-1.5	-7.0
Real income of urban poor	4.3	6.2	5.1
Real income of poor farmers	7.6	5.0*	4.3
Share of direct effect (%) (home consumption and self-employment on farm)	77	45	26
* 3.4 if chemical use increased 40% w/tech.			

Modeled effects on Africa economies

10% productivity gain de Janvry and Sadoulet, 2002

Resulting % change in…	All Crops	Food crops	Live-stock
National income (GDP)	6.8	2.9	2.0
Agricultural production	10.0	3.9	2.8
Consumer food crop price	-6.0	-12.0	-1.2
Real income of urban poor	4.3	1.7	1.5
Real income of poor farmers	7.6	3.9	0.5
Share of direct effect (%) (home consumption and self-employment on farm)	77	72	-30

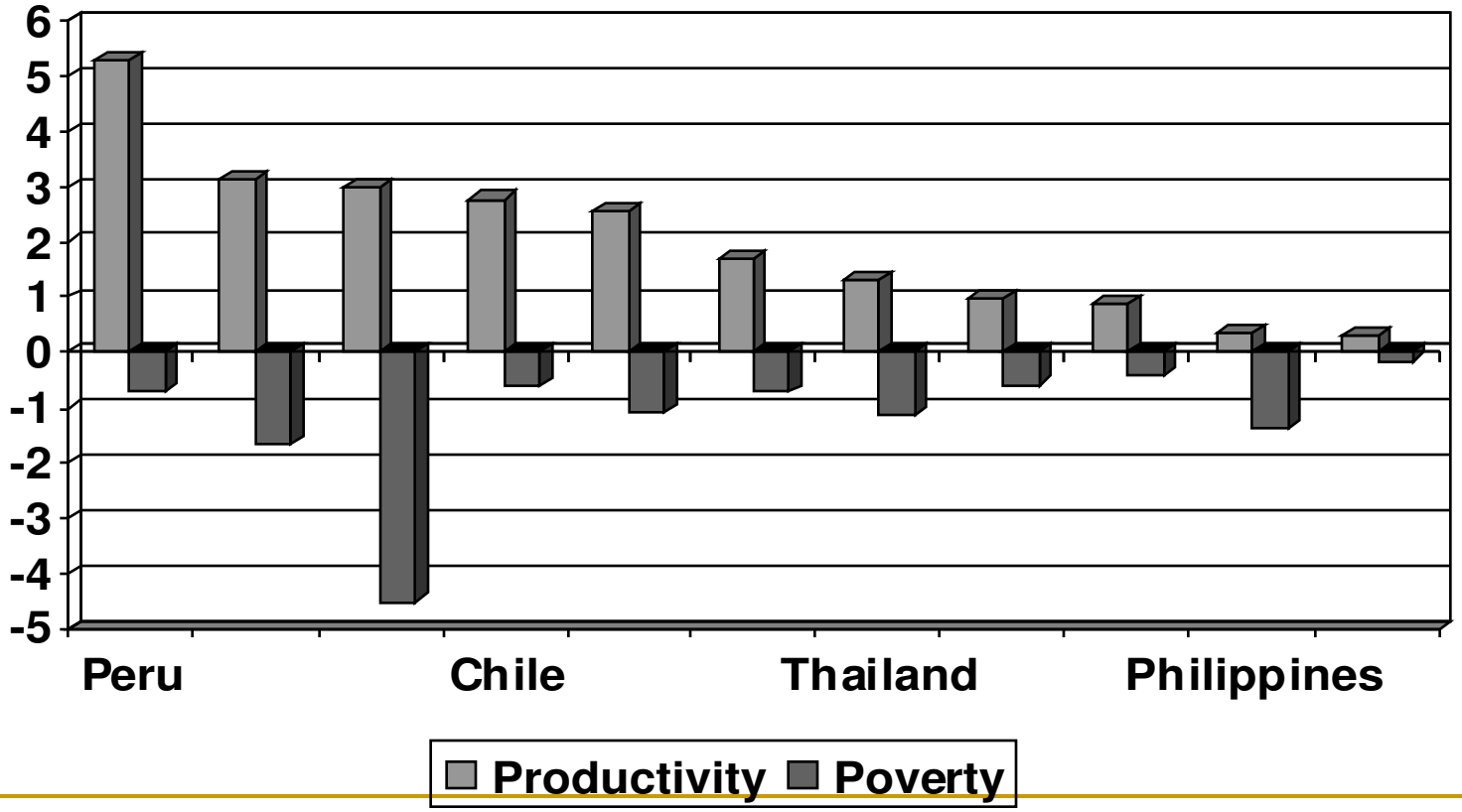
Modeled effects of crop productivity gains, including international trade

(Valenzuela, Ivanic, Ludena and Hertel, 2005)

- Rural, urban, inputs, products with trade
- Staple crops, food crops, cash crops, livestock
- Historic data on productivity growth
- Data on earnings of land, labor, capital
- Historic data on consumption and prices

Calculated change in poverty and crop productivity and, 1991-01, including international trade

(Valenzuela, Ivanic, Ludena and Hertel, 2005)



The effect of technology depends on:

- **The extent & type of productivity gain**
- **Technology effects: (1) input-output ratios (2) amount of inputs bought (3) input prices**
- **Market income effects: (1) amount produced (2) amount consumed => amount sold (3) sale price**
- **Wage effects: (1) off-farm wage rates: (2) amount of off farm work**

Conclusions

- we have plenty of...
  - models and methodology
  - requests for studies
- but we also have...
  - poor, non-representative samples
  - lack of adoption time series
  - poorly defined “technology”
  - inability to aggregate from micro to macro
  - non-comparable representations of poverty
  - lack of “before” and “without” -- assume no alternatives
  - to little determination, funding, & imagination to fix the above
- Agriculture best reduces poverty by increasing income – impact studies should demonstrate it!

The impact of technology on incomes is complex

Real income of a household =

Own-produced food consumed +

Value of agricultural output sold +

Wages from off-farm work

Own-produced food requires inputs like labor, land, fertilizer, seeds, etc – these costs/unit of output are reduced by improved technology –

Critical variables: (1) amount output consumed/sold (2) amount of inputs bought (3) input prices (4) amount of labor

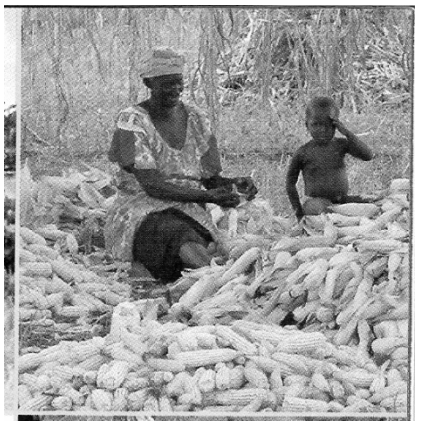
Critical variables for value of agricultural output sold: (1) amount produced (2) amount consumed (3) sale price

Critical variable for off-farm wages: (1) amt of off farm work (2) wage rate for off farm work

The only way to determine the impact is to calculate it!

What are important "existing conditions"?

- Location of poverty: rural vs urban
- Source of poor people's income: farm vs non-farm
- Optimum technologies vary across farms in direct proportion to:
  - Inequity in land distribution
  - Market failure, e.g. credit, knowledge
  - Unequal access to technology
- Tradable/non-tradable commodities
  - If non-tradable, technological gains to farmers are eroded by falling price => consumers gain
  - If tradable, technological change reduces costs but not sale price => farmers gain



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Is the CGIAR serious about reducing poverty?
The Consortium states:

- "The vision of the CGIAR is to reduce poverty and hunger, improve human health and nutrition, and enhance ecosystem resilience through high-quality international agricultural research, partnership and leadership."
- "Considerable evidence also points to large pro-poor impacts of international agricultural research."
- A review of evidence ... suggests that CGIAR research contributions ... have, in the aggregate, yielded strongly positive impacts relative to investment, and appear likely to continue doing so. (The Consortium page on Impact does not mention poverty).

Promotion/advocacy of program vs impact analysis

- Program promoted since 1996 by a coalition of stakeholders
- "Results from a survey of 125 farms in Central and Southern Provinces indicated that on average (adopting) farmers produced 1.5 tons more maize per hectare
- "The national program estimates that adoption now extends to over 300,000 ha.."
- "Over a 5-year cycle net profit was $269/ha with the technology compared to $130/ha without

Limitations of CG studies see Cheryl Doss CIMMYT paper

- Lousy sampling
  - not representative of low-income farmers
  - usually representativeness not specified
- One period – must assume basis of comparison
- Two periods – assume ceteris paribus
- Ignore displaced crops or other alternatives
- Inherent limitations of micro studies

Program feedback study

- 2 sites in each of 4 study areas; 13 hh directly involved in the program and 13 not involved; grouped together in analysis
- data on adoption and program participation
- “62.5% and 35% reported that their monthly net income from (adopting) had increased and remained constantly relative to their 1997 levels.”
- “qualitative impact assessment results showed that (adopting) households were largely better off..”

- Adoption
  - Extent of, relative to the population
    - What population is represented?

      (1) farmers in areas where technology has spread

      (2) farmers in areas where the crop is “important”

      (3) all farmers growing significant areas of the crop

      (4) farmers in “marginal” areas

      (5) “poor” farmers, female farmers, “all” farmers
  - At one point in time, or over time?
  - Contribution of, relative to ‘without”