An Overview of Economic Evaluation of Agricultural Research

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Objectives

- Economic evaluation issues
- Economic evaluation methods
- Economic evaluation results
- Observations and suggestions
Economic Evaluation Issues

- Multiple objectives
- Long term investment
- Level of aggregation
- Counterfactual
- Retrospective versus prospective
Issue: Multiple objectives

- Productivity
- Environment
- Health/nutrition
- Security

Tradeoffs among objectives; effects on some are more difficult to measure and value than on others.
Research knowledge pays off over a long period of time, depreciates, and requires maintenance.

Estimating lags is crucial in research evaluation.
Issue: Level of aggregation

- Project, program, portfolio
- Parallel, serial, unrelated projects
- Field, farm, market
- Research Spillovers
Issue: Counterfactual

☐ Isolating what would (have) occur(red) without the research

☐ Attribution – Isolating effect of ARS research from other public and private research
Retrospective versus Prospective

- Evaluation methods can be similar, but data will differ
- Often the analysis is both R and P
- Probabilities are key in prospective case

\[(\text{Probability of research success}) \times E(\text{Cost change per unit}) \times E(\text{Adoption rate}_t)\]
Economic Evaluation: **Methods**

- **Econometric (and B/C analysis)**
  - Good for estimating aggregate benefits with historical data
  - Considers effects of other investments
  - Considers both failures & successes

- **Economic surplus (and B/C analysis)**
  - Can disaggregate benefits by group
  - Can measure ex post or ex ante benefits
  - Good for measuring effects of technologies
Econometric (regression-based)

Example:
Production function approach

\[ Y = (L, N, K, R) \]

\[ R = \text{research expenditures} \]

Research is included with a lag and the resulting marginal product is discounted over time
Economic surplus

\[ B_t = P_1 Q_1 K \left(1 + 0.5 \frac{\Delta P}{P_1} \right) \frac{\Delta K}{(e + n)} = \]

Where: (1) \( K = \frac{\Delta P}{P_1} \) reflects yield and cost changes, Tech adoption, prob of success, (2) \( e \) and \( n \) = supply and demand elasticities (reflect slopes of D and S)
Economic surplus

\[ \Delta TS = + \]
\[ \Delta CS = + \]
\[ \Delta PS = - \]
Present value

Discounting Benefits and costs

\[ NPV = \sum_{t=0}^{T} \frac{(B_t - C_t)}{(1+r)^t} \]

\[ IRR: \sum_{t=0}^{T} \frac{(B_t - C_t)}{(1+IRR)^t} = 0 \]
Steps in economic surplus analysis

- Define technology domain
- Define markets
- Estimate yield and cost changes
- Define research and adoption lags
- Apply economic surplus formulas
- Identify R&D costs
- Discount benefits and costs
Methods for assessing impacts on environment, health, nutrition

- Assess research-induced physical or biological changes first
- Can require a technique for valuing changes not priced in a market
  - Cost of averting or repairing damage
  - Inferring demand from other behavior
  - Stated values from survey or experiment
Economic Evaluation: **Results**

- Griliches: 1958 hybrid corn study found 35-40% rate of return (first study)
- Since then, dozens of aggregate studies in U.S., with mean rate of return around 50% and most falling in 20-60% range
- Hundreds of project or “technology” impact studies with a much wider range of estimated benefits (winners and dry holes)
- See **Fuglie and Heisey (2007)** for a recent summary of rates of return
Results: Non-market impacts

- Fewer quantitative studies but some

One Example:

- Mullen et al (1997) used a stated preference technique to value reduction in pesticide risk due to IPM program on peanuts. $844,000 estimated annual benefit in Virginia.
Observations and suggestions

- Useful to periodically measure aggregate economic impacts of agricultural research to help justify overall budget (GAO)
- Not feasible to quantify impacts of all projects, but useful to have examples
- Portfolio analysis should be kept simple because of difficulty in disaggregating benefits across all projects
- Economic principles can help guide portfolio selection even if impacts not all quantified
  
  \[(\text{Probability of Success} \times \text{Potential Benefits} \times \text{Projected Adoption})\]