Cost-Effectiveness of Alternative IPM Technology Transfer Methods

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Introduction

- Many types of agricultural technology diffusion methods exist and they can vary greatly in effectiveness and cost
  - Farmer field schools, field days, mass media, extension farm visits, farmer-to-farmer spread
- In IPM, there is a heated debate over most appropriate diffusion methods to maximize IPM spread
Why is there a debate?

- Many diffusion methods exist, some are better for certain types of information.
- IPM information ranges from simple messages to complex management practices.
- Intensive training methods cost more but budgets are limited.
- Some training methods are less participatory than others.
- Some methods take time, and speed of transfer is important for certain types of IPM information.
- Information technologies change rapidly.
- Some organizations promote one diffusion method as the only useful one.
- Selection bias in assessment surveys is often poorly addressed.
Most common IPM diffusion methods

- Mass Media – bulletins, newspapers, and electronic messages
- Extension agent visits -- periodic visits by agents to farmers or farm groups to address pest mgt. issues, often in conjunction with other issues
- Field days – single- or multiple-day presentations by IPM scientists or extension to provide training in farm fields about IPM
- Farmer field schools -- participatory learning in regular small group training sessions on IPM over a whole crop season. FFS stresses need to observe fields regularly, conserving natural enemies, farmer experiments, relevant, science-based knowledge, IPM philosophy and agro-ecology
- Farmer-to-farmer spread—least costly, but also least certain
Three components of cost-benefit in case of IPM diffusion

- Effectiveness of diffusion: several dimensions
- Net benefits of adoption: depend on the yield impacts of the IPM technology and the cost of implementation relative to alternative pest-control methods
- Costs of the diffusion method: include fixed and variable costs associated with program delivery
Effectiveness of IPM diffusion methods can be measured in several dimensions:

- # of farmers reached
- # of farmers who adopt and # of practices adopted
- Correct use of information
- Information retention
- # who can use information in a new situation
- # of targeted (e.g. limited resource) farmers reached
- Speed of information spread
Figure 1. Continuum of IPM Technologies and Training Methods

<table>
<thead>
<tr>
<th>IPM Training Methods</th>
<th>IPM Technologies</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Simple</td>
</tr>
<tr>
<td>Less Intense</td>
<td>$B_1-C_{11}$</td>
</tr>
<tr>
<td></td>
<td>$B_1-C_{21}$</td>
</tr>
<tr>
<td>More Intense</td>
<td>$B_1-C_{31}$</td>
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</tbody>
</table>
Costs of diffusion vary depending on the method used and degree of complexity of the IPM practice
Net benefits from adoption of each practice (to farmer)

\[ B_{\text{hectare}} = \{(Q_{\text{new}} - Q_{\text{old}}) \times \text{Price}\} - (C_{\text{new}} - C_{\text{old}}) \]

Where: \( Q \) is the quantity produced under the new (IPM) and old technology; \( C \) is the production cost

Benefits to each farmer would be the per-land area benefit times the total land area allocated to the new technology

Note:
External benefits are not included
Health costs are not included
Main issue: How to determine effect of each diffusion method on net benefits to farmers?

- Who participates in or is exposed to diffusion programs?
- What is the impact of participation on on-farm practices? Specifically, how does exposure or participation affect dimensions of adoption?
- What are the net benefits associated with each of these dimensions?
Methods

- Survey data (farm-level observations)
  - Best-case: before and after exposure to diffusion method
  - More frequent case: cross-sectional observations

- Major issues:
  - Treatment effects not observed (unless we have observations before and after)
  - Assignment to the treatment is not random
    - Cannot compare outcomes for participants to those for non-participants without addressing this problem
    - Numerous solutions including selectivity models, propensity score matching, etc.
Methods

Analysis of outcomes:
- Determinants of binary adoption (probit, logit)
- Determinants of IPM continuum adopted:
  - Number or percentage of practices adopted
  - “Correct” use
- Determinants of yields, per-unit costs, profits
- Determinants of farmer knowledge of IPM
Methods

- **Outcome analysis:**
  - Duration of use of practices
  - Spread to other farmers

- **Evaluation technique used depends on data:**
  - If data show before and after effects and treatment is randomly assigned: could do a comparison of means
  - Otherwise, need to control for determinants of participation and separate participation effects from others, such as wealth, etc.
Methods

Typical case: estimate a model of the following sort:

\[ P_i = X_i \beta_p + \varepsilon_i \]
\[ Y_{IPM_i} = X_{IPM_i} \beta_{IPM} + \alpha P_i + \varepsilon_{IPM_i} \]

- \( P \) = participation in the diffusion mechanism (a binary decision)
- \( Y_{IPM} \) = IPM outcome (knowledge, adoption, yield, etc.)
- \( X \) = vector of determinants of participation in diffusion
- \( X_{IPM} \) = determinants of knowledge about, adoption of, or adaptability of IPM (depending on model used)
- \( \beta, \alpha \) = model parameters

Participation in the FFS cannot be treated as exogenous if \( \text{Cov}(\varepsilon_i, \varepsilon_{IPM_i}) \neq 0 \), if unobserved factors affect both participation and the outcome
Evidence from previous studies: FFS

Selection bias issues in some studies over estimated effects of FFS training: Studies that do not control for selection bias find higher yields and less pesticide use among FFS farmers (Larson et al. 2002).

Participants have higher IPM knowledge than non-FFS farmers. (Feder et al. 2004; Godtland et al. 2004)

Participants retain IPM knowledge over time

Mixed results on impacts on yields and income and in lowering pesticide use

- Lower pesticide use, but no impact on gross margin (Thailand: Praneetvatakul and Waibel, 2005)
- No significant impact on economic performance (Feder, et al.)
- Positive impact on productivity (Godtland, et al.)
Evidence from previous studies: FFS

- IPM knowledge not shared by FFS participants to other farmers (Feder et al.; Rola et al. 2002)
- FFS groups not sustainable (Tripp, et al. 2004)
- Critical mass of participants needed for diffusion to take place: clustering of FFS may improve diffusion process (Waibel, 2006)
- Cost per person trained high: US$ 47.50 in Indonesia and US$ 62.00 in the Philippines (Quizon, et al)
Issue: FFS compared to other techniques

- Recent studies from Bangladesh (Ricker-Gilbert, et al.) and Ecuador (Mauceri, et al.) conducted under IPM CRSP, funded by USAID
- Examined impacts on farmer knowledge, adoption, and diffusion of IPM-related information associated with different technology transfer mechanisms
- Controlled for selection into these transfer mechanisms and the costs of each
Findings: Bangladesh

- FFS participants more likely to adopt IPM, but other methods also have positive impact on adoption of multiple practices
- FFS participants do not diffuse results; IPM knowledge is more widespread in non-FFS villages where other methods (field days, agent visits, mass media) were used
- Agent visits most strongly associated with adaptability of IPM to other crops
- Different methods are better at diffusing, depending on the dimension of effectiveness we examined
## Adoption Results (Bangladesh)

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<tbody>
<tr>
<td></td>
<td>F = 6.47</td>
<td>F = 4.06</td>
<td>F = 5.12</td>
</tr>
<tr>
<td></td>
<td>Prob &gt; F = 0</td>
<td>Prob &gt; F = 0</td>
<td>Prob &gt; F = 0</td>
</tr>
<tr>
<td></td>
<td>Dep. Var (0-5)</td>
<td>Dep. Var (0-9)</td>
<td>Dep. Var (0-3)</td>
</tr>
<tr>
<td>Field day</td>
<td>-0.166</td>
<td>0.615**</td>
<td>0.308*</td>
</tr>
<tr>
<td>Agent visit</td>
<td>0.233</td>
<td>0.401**</td>
<td>0.06</td>
</tr>
<tr>
<td>Predicted FFS</td>
<td>3.870***</td>
<td>4.454***</td>
<td>1.609**</td>
</tr>
<tr>
<td>Age</td>
<td>0.028</td>
<td>-0.035</td>
<td>0.041*</td>
</tr>
<tr>
<td>Family members</td>
<td>0.063**</td>
<td>0.055</td>
<td>0.02</td>
</tr>
<tr>
<td>Farm size</td>
<td>-0.001***</td>
<td>-0.001**</td>
<td>0</td>
</tr>
<tr>
<td>Distance to mkt</td>
<td>-0.04</td>
<td>-0.260***</td>
<td>0.021</td>
</tr>
</tbody>
</table>
Findings: Ecuador

- FFS and field day participation had strongest impacts on farmer IPM knowledge
- Some farmer-to-farmer knowledge spread was observed, especially in intensive FFS villages
- FFS and field day participation had a positive impact on intensity of IPM adoption
- Magnitude and significance of the diffusion mechanism depends on the dimension of effectiveness
<table>
<thead>
<tr>
<th></th>
<th>FEXP1 (Attend FFS)</th>
<th>FEXP4 (field days)</th>
<th>FEXP5 (pamphlets)</th>
<th>Cost Ratios</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implementation Costs (per farmer)</td>
<td>$30</td>
<td>$1.50</td>
<td>$0.50</td>
<td>20:1</td>
</tr>
<tr>
<td>Farmer-to-farmer diffusion (No. of other farmers they shared IPM information with)</td>
<td>11</td>
<td>2.7</td>
<td>0.33</td>
<td></td>
</tr>
<tr>
<td>Marginal Impacts on Adoption</td>
<td>.564</td>
<td>.383</td>
<td>.277</td>
<td></td>
</tr>
<tr>
<td>Taking into account diffusion</td>
<td>($30/12)</td>
<td>($1.50/3.7)</td>
<td>($0.50/1.33)</td>
<td></td>
</tr>
<tr>
<td>Cost/Total no. of farmers affected</td>
<td>$2.50</td>
<td>$0.40</td>
<td>$.38</td>
<td>6.25:1</td>
</tr>
<tr>
<td>Total effect on adoption (= marginal effect + contacts*marginal effect)</td>
<td>3.26</td>
<td>0.84</td>
<td>0.33</td>
<td>3.88:1</td>
</tr>
</tbody>
</table>
Findings: Bangladesh and Ecuador

- Participation in training methods is not random
- FFS participants are more knowledgeable about IPM techniques, but other methods are effective at spreading information (especially field days in Ecuador)
- Costs of field schools make them a relatively expensive means of spreading IPM (especially in Ecuador)
Summary

- Cost-effective means of spreading IPM knowledge are needed
- Evidence gradually accumulating that different dissemination techniques are successful at spreading knowledge
- FFS tend to be effective, but costly and with questionable impacts on spread to non-participants
- Use of combinations of techniques is a promising approach