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

IPM Training Methods	IPM Technologies: Simple ⟷ Complex		
Less Intense ↕	B_1-C_{11}	B_2-C_{12}	B_3-C_{13}
	B_1-C_{21}	B_2-C_{22}	B_3-C_{23}
More Intense	B_1-C_{31}	B_2-C_{32}	B_3-C_{33}

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)

$$B_{hectare} = \{(Q_{new} - Q_{old}) \text{ X } P_{rice}\} - (C_{new} - C_{old})$$

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:

(1) $P_i = X_i \beta_p + \varepsilon_i$

(2) $Y_{IPMi} = X_{IPMi}\beta_{IPM} + \alpha P_i + \varepsilon_{IPMi}$

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)

β, α = model parameters

Participation in the FFS cannot be treated as exogenous if
$Cov(\varepsilon_i, \varepsilon_{IPMi}) \neq 0$, 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)

Dependent var. = No. practices adopted	Simple IPM Practices	Intermediate IPM Practices	Complex IPM Practices
	F = 6.47 Prob > F = 0	F = 4.06 Prob > F = 0	F = 5.12 Prob > F = 0
	Dep. Var (0-5)	Dep. Var (0-9)	Dep. Var (0-3)
Field day	-0.166	0.615**	0.308*
Agent visit	0.233	0.401**	0.06
Predicted FFS	3.870***	4.454***	1.609**
Age	0.028	-0.035	0.041*
Family members	0.063**	0.055	0.02
Farm size	-0.001***	-0.001**	0
Distance to mkt	-0.04	-0.260***	0.021

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

	FEXP1	FEXP4	FEXP5	Cost Ratios	
	(Attend FFS)	(field days)	(pamphlets)	FFS/ field days	FFS/ pamphlets
Implementation Costs (per farmer)	$30	$1.50	$0.50	20:1	60:1
Farmer-to-farmer diffusion (No. of other farmers they shared IPM information with)	11	2.7	0.33		
Marginal Impacts on Adoption	.564	.383	.277		
Taking into account diffusion	($30/12)	($1.50/3.7)	($.50/1.33)		
Cost/Total no. of farmers affected	$2.50	$0.40	$.38	6.25:1	6.58:1
Total effect on adoption (= marginal effect +contacts*marginal effect)	3.26	0.84	0.33	3.88:1	9.88:1

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