The Economic Impacts of IPM Adoption: Review of the Empirical Evidence

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Objectives

♦ Discuss the methodological issues involved in the economic evaluation of the impacts of integrated pest management (IPM).

♦ Review empirical results that evaluate the economic impact of IPM at the farm level.

Economic Effects of IPM

♦ Farm Level Effects: Usually includes changes in net returns (revenues minus costs).

♦ Societal Effects: Include changes in economic welfare of consumers and producers resulting from market level changes in prices. Distributional issues have also been analyzed, e.g., impact on poverty.

♦ This presentation will focus on farm level effects.

User (Farm) Level Effects Include:

- Changes in pesticide use and costs.
- Changes in pest management practices (and costs), such as scouting, use of beneficial insects, etc.
- Changes in other input costs, e.g., machinery, labor.
- Changes in revenues resulting from changes in yields and product prices (e.g., due to changes in product quality).
- This information is often summarized in “partial budget forms.”

Data can be obtained from:

- Field trials.
- Farm surveys.
- Enterprise budgets (e.g., having farmers collect the information on all inputs by operation).
- Obtaining enterprise budgets from secondary sources and the help of experts.

Methodological Issues

♦A problem with field trials is that costs and yields for farm–scale adoption may differ those of the trials.

♦ A problem with the farm surveys and some of the other methods is that comparison of means may be misleading.

Comparison of means between adopters and nonadopters ignores:

♦ Factors other than adoption that influence yields and pesticide use, such as:

- Input and output prices
- Weather/Infestation levels
- Farm size
- Other practices and choices of production system

♦ Simultaneity and self-selection

Simultaneity and Self-selection Issues

1. Farmers' adoption and pesticide use decisions may be simultaneous.

2. Farmers are not assigned randomly to the two groups (adopters and nonadopters) but they make the adoption choices themselves. Therefore, adopters and nonadopters may be systematically different (e.g., adopters may be more educated and their land more productive). Differences may manifest themselves in farm performance and could be confounded with differences due to adoption. This self-selectivity may bias the results, unless corrected.

A Theoretical Modeling Framework

To account for simultaneity and self-selectivity one can use a two-stage econometric model:

- The first stage consists of the *decision model* --for the adoption of IPM, estimated by probit analysis.

- The second stage is the *impact model* that provides estimates of the impact of using IPM on pesticide use, yields, and net returns after controlling for other factors.

Results

Assessing and comparing results on the effects of IPM programs is difficult because of:

♦ Heterogeneity across regions, time, and types of crops grown. For example, it is difficult to compare IPM adoption in hot, humid climates, which are more favorable to the development of pests, to IPM adoption in more moderate climates.

♦ IPM involves an assortment of techniques which have developed to different degrees for different crops, and different farmers may adopt IPM to various degrees.

♦ The methodologies used to assess the effects of IPM on pesticide use, yields, and profits vary widely, from simple comparisons of sample averages of adopters and nonadopters, to advanced econometric techniques.

The impact of IPM on Pesticide Use, Yields, and Net Returns in the U.S. Field Crops

Commodity	IPM Techniques	Pesticide Use		Yield	Net Returns	Number of
		Most common Effect	Range Percent		Per Acre	Studies
Cotton	Scouting only	Increase	-64 to +92	Increase	Increase	10
Cotton	Scouting and others	Decrease	-98 to +34	Increase	Increase	11
Soybeans	Scouting	Decrease	-21 to +83	Increase	Increase	5
Soybeans	Scouting and others	Decrease	-100 to -85	na	Increase	2
Corn	Scouting	Increase	+15 to +47	Increase	Increase	1
Corn	Scouting and others	Decrease	-15 to +67	Increase	na	2
Peanuts	Scouting and others	Decrease	-81 to +177	Increase	Increase	6

Sources: Norton and Mullen, Fernandez-Cornejo et al.

The impact of IPM on Pesticide Use, Yields, and Net Returns in the U.S.
Fruits and Vegetables

Commodity	IPM Techniques	Pesticide Use		Yield	Net Returns Per Acre	Number of Studies
		Most common Effect	Range Percent			
Fruits/Nuts	Scouting only	Decrease	-43 to +24	Increase	Increase	7
Fruits/Nuts	Scouting and others	Decrease	-41 to +37	Same or increase	Same or increase	8
Vegetables	Scouting and others	Decrease	-67 to +13	Same	Increase	9

Sources: Norton and Mullen; Greene and Cuperus; Fernandez-Cornejo et al., Rakshit.

Fruits and Vegetables (II) - Econometric Results

Elasticity with respect to probability of adoption of IPM[1]

	Tomatoes	Strawberries		Grapes	Oranges	
	Fresh market	Fresh market	Processed	All	Fresh	Processed
Elasticity of pesticide use with respect to						
IPM for insects	-0.40	ns	+0.67	-0.26	ns	ns
IPM for diseases	-0.11	+0.46	+1.15	-0.10		
Elasticity of yields with respect to						
IPM for insects	ns	ns	ns	ns	+	-
IPM for diseases	ns	+0.30	+0.56	+0.30		
Elasticity of farm profits with respect to						
IPM for insects	0.01	ns	ns	ns	+	ns
IPM for diseases	0.27	0.03-0.17	+0.39			

1 Elasticities are relative changes; e.g., there is a 4 percent reduction in pesticide use associated with a 10 percent increase in IPM adoption for tomatoes.

ns: Not significant (underlying regression coefficient was insignificant).

Sources: Fernandez-Cornejo (1996, 1998); Fernandez-Cornejo and Jans (1996).

The impact of IPM on Pesticide Use, Yields, and Net Returns – Outside the U.S.

Commodity	Country	IPM Techniques	Pesticide Use	Yield	Net Returns Per Acre	Number of Studies
Rice	China	Scouting and Host plant resistance	Decrease	Same	Increase	2
Rice	India	Multiple	Decrease	Increase	Increase	1
Rice	Sri Lanka	Multiple	Decrease	Increase	Increase	1
Fruits/Nuts	New Zealand	Scouting and others	Decrease	na	Increase	1
Vegetables	Philippines	Multiple	Decrease	na	Increase	1

Sources: A. Rakshit (2006), compiled from various sources.

Conclusions - Cotton

♦ **Cotton** is the commodity most studied in relation to the effects of IPM in U.S. agriculture with more than 20 studies having been published over the past 25 years.

♦ **IPM and pesticide use.** The findings are mixed. When the effect of scouting is examined separately, higher pesticide use is associated with adoption in many cases. When scouting is considered in combination with other IPM techniques, lower pesticide use is associated with adoption in most of the cases.

♦ **Yields and net returns:** Higher yields and net returns are generally associated with IPM adoption in cotton.

Conclusions - Other Field Crops

♦ Other field crops studied in relation to the effects of IPM in the U.S. include **soybeans** with 7 studies published over the past 25 years and **peanuts** with 6 studies.

♦ Lower pesticide use and higher yields and returns are related to the use IPM techniques in most of the cases. A similar effect is shown for **corn**, although only three studies have reported IPM impacts for this commodity.

Conclusions - Fruits and Vegetables

♦ Most IPM studies for **vegetable** production were carried out in the 1980s and do not use econometric techniques but rather compare sample averages for adopters and nonadopters. These studies show that IPM adopters used fewer applications and had lower pesticide expenditures in the majority of the cases.

♦ Most early studies on IPM for **fruits** focused on apples and pears. Like the case of vegetables, the majority of those fruit studies report less pesticide use by IPM adopters, in particular when IPM is defined more broadly than just scouting for pests.

♦ Results of more recent F&V econometric studies controlling for self-selection are more mixed and show in some cases there is no significant difference in net returns for adopters and non-adopters.

Conclusions - Selected Studies Outside the U.S.

♦ Four studies in China, India, and Sri Lanka showed that farms using IPM in rice production used less pesticide use and had higher net returns than farms not adopting.

♦ Fruit (apples) and vegetable (onion) studies in New Zealand and the Philippines showed that farm using IPM used less pesticide and had increased net returns.