FARMER AND FARM CONCEPTS IN MEASURING ADOPTION LAGS

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Conventional definitions of the time to adoption of an innovation do not consider whether a potential adopter already had decision-making responsibilities at the time the innovation became available. Data from a pest management survey conducted in India are used to evaluate empirically an alternative definition that takes into account when farmers assumed decision-making responsibilities.

1. Introduction

Agricultural technology transfer and extension activities should accelerate adoption, avoid loss of potential returns to research, and reduce undesirable distribution effects of differential adoption. These activities are likely to be the more effective the better farmers' past adoption behaviour can be explained.

A recent review of the literature on adoption of agricultural innovations by Feder *et al* (1985) indicates that most of the research on adoption behaviour has concentrated on the factors that contribute to an explanation of adoption. Measurement of the level of adoption or the time to adoption, in contrast, appears not to have received much attention.

The definition of adoption lag deserves close attention when policies for shortening adoption lags attempt to affect farmers' adoption decisions. Such policies may be justified by intentional explanations that involve a relation between actions, goals, and expectations (Elster, 1983). The elements of this triad can only be ascribed to individuals. In an intentional explanation, adoption lag must therefore be defined and measured as an act of an individual farmer. When defined as a characteristic of farms, adoption lag is not amenable to intentional explanation.

In this paper we first compare two measures of the adoption lag. One measure uses the farm as the unit of observation. The farmer, or decision-maker, is the unit of observation for the second measure. We then report a comparison of alternate empirical models of the adoption lag.

2. Operational Definitions of Farmer's and Farm's Adoption Lags

The adoption lag has been defined as the time from availability of an innovation to its adoption (Lindner *et al*, 1979). We consider an indivisible technology that is adopted when it is first used on the farm of its adopter, irrespective of the intensity of its use. The first use of an innovation on any farm

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from some group of farms is an observable indicator of availability. We can then define the adoption lag of a particular *farm* as the period from the time when the innovation was first used on any one farm of that group of farms and the time when the innovation was first used on that particular farm.

This definition refers only to farms but not to farmers and is unsuitable for intentional explanations. Simply substituting 'farmer' for 'farm' is no remedy because some individuals may not have been farmers with decision-making responsibilities when the innovation was adopted by the first farmer. Simple substitution would then lead to an upwardly biased measure of the adoption lags for these farmers. This bias would be equal to the time from the innovation's first adoption in the group to the time when the particular individual became head of a farm. Hence, we define the adoption lag for a particular *farmer* as the period from the time the innovation was available, or the time the individual assumed headship of a farm, whatever event occurred last, and the time that farmer used the innovation for the first time.

3. An Example: Adoption Lags of High-Volume Sprayers

Different measurement of adoption lags is useful when it allows better empirical explanations of adoption that may lead to more effective adoption policies. Regression analysis is frequently used to explain observed adoption behaviour. We now compare results from three regression models. In one model information on when adopters became heads of their farm is not incorporated. In the other models this information is either contained in the dependent variable or in the independent variables.

4. Data

We obtained data on adoption of high-volume (HV) spraying of an insect pest by 67 pigeonpea growers from a sample survey in a village in India (Mueller *et al* 1986). The diffusion processes for HV-spraying can be regarded as completed because controlled-droplet applicators are quickly replacing HV-spraying.

Adoption of HV-spraying began in 1968 when 33 farmers were already managers of their farms. Average time to adoption of HV-spraying is 10 years when farms are the unit of observation and 7.7 years for farmers.

5. Modelling Adoption Lags

Based on experience from adoption studies reported in the literature and acquaintance with the social and economic environment in the study village, we selected variables that could explain the time to adoption of HV-sprayers. Age at the time of adoption and school attendance reflect personal characteristics of adopters. Ownership of a pair of bullocks and a bullock cart is an indicator for farmers' endowments with production capital. The importance of pests in pigeonpea is captured by two variables. The first is the proportion of sole-cropped pigeonpea in total cultivated area of a farm and may indicate farmers' concern with pest management in this crop. Perceived percentage yield loss in treated sole-cropped pigeonpea is an indicator of the severity of the pest problem. Because dusting and spraying are close technical substitutes, we included two variables that express whether and how dust had been applied before the adoption of HV-spraying. The means and coefficients of variation (CV) of these variables are given in Table 1 which also contains the regression results.

In regression model 1, farmer-based adoption lag is the dependent variable, whereas farm-based adoption lag is explained in models 2 and 3. Models 1 and 2 have the same independent variables. In model 3 the time from availability of HV-sprayers to the time when farmers became heads of their farms is reflected by an independent variable. This variable was set to zero for all farmers who were already farm heads before availability of HV-sprayers. Otherwise, model 3 is identical to model 2.

Table 1 Regression Results for Farmer- and Farm-Based HV-Sprayer Adoption Lags, Farhatabad, India (N=67)

			Farmer-based lag		*Farm-based lag*			
			Model 1		*Model 2*		*Model 3*	
Variable	*Mean*	*CV*	*Coeff.*	*SE*	*Coeff.*	*SE*	*Coeff.*	*SE*
Farmers' age at time of adoption (years)	42	0.32	0.17†	0.03	0.00	0.03	0.06†	0.03
School attendance for more than 4 years (binary)	0.48	—	−2.3†	0.87	−2.1†	0.72	−2.2†	0.66
Ownership of bullocks and cart (binary)	0.81	—	−0.42	1.2	0.4	0.99	0.11	0.91
Perceived yield loss (%)	20.0	0.28	0.12	0.08	0.1	0.06	0.11*	0.06
Proportion of sole-cropped pigeonpea in cultivated area (%)	52.0	0.41	−0.01	0.02	0.03	0.02	0.02	0.02
Experience with dusting before HV-sprayer adoption (binary)	0.85	—	4.1†	1.4	4.2†	1.2	4.2†	1.1
Dusting by hand before HV-sprayer adoption (binary)	0.60	—	−1.8*	0.99	−2.0†	0.83	−2.0†	0.76
Lag between HV-sprayer availability and assuming headship (years)	3.0	1.3	—	—	—	—	0.35†	0.10
Intercept	—	—	−2.2	3.1	5.6	2.6	2.9	2.5
$\bar{R}^2$			0.45		0.32		0.43	
F			8.56†		5.37†		7.20†	

* Significant at .1 level
† Significant at .05 level

6. Results

The parameters of the independent variables are, as a group, significantly different from zero in all models (Table 1). The $\bar{R}^2$ may not be legitimately used to compare the performance of model 1 with the performances of models 2 or 3 because the dependent variables are different (Rao and Miller, 1971). Model 1 may, however, be regarded as empirically preferable to model 2 because it fits the data better and because the coefficient of farmer's age at time of adoption is statistically significant in model 1.

The estimates of the farm-based adoption lag model are clearly improved by introducing the lag between HV-sprayer availability and assuming headship as an independent variable. This is indicated by the higher $\bar{R}^2$ and the smaller standard errors of model 3. In addition, in model 3, as in model 1, the coefficient of the variable farmer's age at time of adoption is statistically significant.

Model 3 may be empirically preferred to model 1 because all the coefficients that are statistically significant in model 1 are also significant in model 3 but have standard errors that are not larger than in model 1. Furthermore, perceived yield loss is significant in model 3 but not in model 1.

Seen together, we interpret the regression results as supporting our hypothesis that adoption lags can be better explained when the lag between availability of an innovation and the time when farmers became heads of their farms is taken into account. The results provide empirical evidence that this should be done by introducing this lag as an independent variable in a model explaining farm-based adoption lags.

7. Summary and Conclusions

In this note, we have argued and demonstrated that the time when farmers became the decision-makers of their farm-households should be taken into account when explaining adoption lags. However, we cannot provide a clear indication how this information is best incorporated, either in the measure of the adoption lag or as a factor explaining conventionally measured, farm-based adoption lags. That is, however, of secondary importance. More importantly, we suggest that adoption analysts will be better able to explain adoption lags when they spend some additional effort on collecting data when farmers became decision makers.

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