Multi-institutional implementation of farmer field schools among Nicaraguan bean growers. Do different NGOs perform differently?

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The reduction of the public agricultural extension in many developing countries has induced the entrance of new extension providers. Among these new providers, non-governmental organizations (NGO) have received special support from international donor agencies (Wallace 1997) and have increased their participation in the delivery of agricultural technologies. Often, NGOs are seen as more efficient and cost-effective extension providers than governmental entities and as a better means to reaching poor farmers (Edwards & Hulme 1996). The increasing participation of NGOs in extension systems has also increased the pluralism of providers, usually highlighted as a desirable condition for increasing the extension supply (Qamar 2002). However, many other papers have warned that pluralism also introduces a variety of organizational characteristics and could affect the extension performance (Hassan 1993).

Studies of agricultural extension services impacts have concentrated on farmers' knowledge, technology adoption or farm productivity (Birkhaeusen et al 1991, Owens et al 2003). It has been recognized that impact assessment usually ignores the institutional framework of the extension process and the characteristics of the actors who facilitate this process (Raina 2003). The issue of how an increasing diversity of NGOs engaging in extension activities affects extension outputs has received no attention in the literature.

This paper analyzes how the characteristics of NGOs operating farmer field schools (FFS) for disseminating integrated pest management (IPM) among bean growers in Nicaragua.

NGOs as extension providers in developing countries

Public agricultural extension in developing countries has been criticized for being irrelevant and ineffectual (Rivera & Gustafson 1991). The recent wave of structural adjustment programs has produced severe budget cuts to national extension services (Farrington 1994). The resulting gap has come new providers including NGOs and private institutions (Qamar 2002).

Given their perceived strengths in cost-effectiveness and ability to reach the poor, NGOs have been encouraged to initiate extension services. A pluralism of extension providers has been considered desirable for national extension systems (Qamar 2002). However, this pluralism has also introduced a diversity of institutional characteristics (Bebbington & Thiele 1993). Some NGO characteristics favor successful extension outcomes but others produce an ambiguous effect on extension performance or to even impede it. Larger NGOs are expected to perform better because they have more resources and extension agents to deliver technologies (Hassan 1993). However, smaller NGOs tend to have better local knowledge and a better relationship with farmer communities that are necessary for a successful extension program (Garforth & Lawrence 1997). NGOs are more likely to succeed when they manage few and simple extension projects (Christopolos 1996). However, the temptation of increased funding sometimes lures NGOs to overreach, undermining their ability to capitalize on historic strengths, including hiring staff with inadequate scientific training (Garforth & Lawrence 1997). Finally, a broad number of NGOs participating in the same extension project can also introduce diversity among institutional interests about the emphasis that a project should follow (i.e, project focus, targeted beneficiaries) affecting the extension performance.

Do multi-institutional extension projects benefit from a pluralistic institutional environment? Or does the diversity of participating institutions detract from overall performance? This empirical question has been ignored by previous impact studies of agricultural extension.

The delivery of IPM through a multi-institutional FFS project in Nicaragua

In 2001, with World Bank support, the Nicaraguan government started a major reform of public extension programs. It reduced the presence of the Instituto Nicaragüense de Tecnología

Agropecuaria (INTA), in many areas and promoted the creation of more NGOs to replace INTA in some areas (Barandun 2001). The influx of new extension providers occurred at a time when outreach programs were increasingly called upon to diffuse complex technologies like integrated pest management (IPM) (Staver & Guharay 2003).

Integrated Pest Management (IPM) is a group of pest control methods aimed to reduce environmental and health risks to farmers by keeping a crop pest infestation below an economic threshold level. This level is the pest population density at which control measures are necessary to prevent a decline in net returns (Fernandez-Cornejo et al 1998). Pest control methods may include pesticides when necessary, but these also include non-chemical inputs and specialized practices such as insect scouting, botanical insecticides and insect sticky traps[1] (Fernandez-Cornejo et al 1998).

IPM extension in Nicaragua has mainly followed the training and visit (T&V) approach (Benor et al 1984). The T & V system is based on short field visits to selected farmers who are put in charge of delivering technical packages to neighbor farmers. It has been criticized for being "top down" and for failing to organize farmers (Hussain et al 1994).This approach has resulted in a low IPM adoption in Nicaragua (PROMIPAC 2001).

In order to improve the adoption of IPM, the Project for Integrated Pest Management in Central America (PROMIPAC) has promoted the implementation of Farmer field Schools (FFS) since 2001. FFS combine the scientific knowledge and the practice of IPM with farmers' experience and interests under the learning by doing approach (Gallagher 1998).

Following the existing trends of extension services in many developing countries, FFS in Nicaragua have been implemented by a group of NGOs through a multi-institutional project. Some of the participating NGOs had experience in delivering IPM, but the others had their first

[1] Among several IPM practices these are the three most promoted practices in Nicaragua

IPM experience with FFS. Most of the NGOs with no previous IPM training experience grew out of the partial privatization of the extension services funded by the World Bank.

Differences among NGOs participating in the FFS project are not restricted to past experience with IPM. They also include differences in NGO size, resources for delivering IPM and institutional focus. As shown in Table 1, the NGOs participating in the FFS project differed in number of total extension agents, extension agents trained in IPM or in FFS, number of projects being operated by each institution and the area of influence of each of them. Also the seven NGOs present different institutional emphasis in their extension work that range from credit programs to soil conservation practices (Table 1). These differences could have affected farmer participation in IPM training or their subsequent likelihood of adopting IPM.

Table 1. Description of NGOs working on FFS implementation in Nicaragua

Institution	Number of extension agents			Number of projects	Institutional emphasis	Number of districts (influence)
	Total	With IPM training	With FFS training			
ADAAC	4	3	2	6	Soil conservation, local organization	4
CARITAS	6	6	4	5	Credit, local organization	4
CECOTROPIC	8	3	3	1	Woman work, environment	2
ESETECA	8	2	2	2	Fruits, coffee	10
FIDER	8	7	6	5	Credit, organic crops	6
ODESAR	6	2	1	5	Soil conservation, water wells	7
UNAG	8	5	2	3	Credit, local organization	6

* Those NGOs work in larger areas, but statistics are referred to the office of one Department.

The starting point for FFS in Nicaragua was common to all NGOs: Each of them sent some extension agents to participate in a two-month intensive training-for-trainers program. This training program was conducted by FFS trainers experienced in participatory research methods. With the variety of participatory techniques that facilitators learned in the training-for-trainers' course they were also expected to be able to offer different alternatives to solve farmers' problems, especially those related to pest control. Differences among individual FFS curricula conducted by different NGO's should thus only be attributed to different farmers' preferences.

Table 2. Curricula and other activities developed by each bean FFS in Nicaragua.

FFS Community	Institution	Number of IPM practices promoted	Other activities in FFS	Other experiments conducted	Field comparison of IPM vs. Conventional Yield	Net revenue
Llanos 2	ADAAC	2	X	X	Less	Less
Cacao arriba	CARITAS	2			Less	Less
Santa Teresa	CECOTROPIC	3			Less	Less
Las Crucitas	ESETECA	1			More	Less
Fátima	ESETECA	1	X	X	More	Less
Cusmají	FIDER	3	X		Less	Less
El Quebracho	FIDER	2			More	More
El Japón	FIDER	2	X	X	More	More
Cerro la mina	ODESAR	2	X	X		
Llanos 1	UNAG	3				
El Tule	UNAG	3				
Las Puertas	UNAG	3				
El Bramadero	UNAG	3				

The implementation of FFS in Nicaragua, however, brought some differences related to the special emphasis that each NGO decided to give to the FFS under its control. Table 2 shows the individual curricula developed by each of the 13 FFS for bean producers in Nicaragua. Each curriculum was developed differently according to individual NGO priorities. Only FIDER, CECOTROPIC and UNAG promoted the 3 most common IPM practices in Nicaragua, while the other NGOs promoted only one or two. Two of them decided to focus on soil erosion and low productivity, which they identified local priorities in the communities where they implemented FFS while two explicitly included health concepts as another activity in their curricula (Table 2).

According to the training received by facilitators, field experimentation should be a strong component in each FFS. However, experimentation varied widely across FFS (Table 2). In particular, the core comparison of a plot under IPM management with a plot under a traditional management was ignored by two NGOs operating five of the 13 FFS.

The next sections test whether individual characteristics of NGOs serving bean growers enhanced or limited the FFS impact on their graduates' adoption of IPM practices, pesticide use and bean net revenue.

Analytical Framework

The evaluation of program impacts is usually done using the counterfactual analysis where targeted outcomes are measured for some individuals receiving the program (treated group) and for some individuals that do not (counterfactual group) (Ravallion 2005). This paper extends this methodology for evaluating the average impact of IPM training on farmers by examining the effects of six specific NGO characteristics: NGOs' size, resource capacity, longevity core, expertise (eg., experience with IPM and FFS), links to targeted farmers and institutional focus.

Using an agricultural household model framework, we hypothesize 1) that FFS will improve knowledge about pests and pest controls and potentially influence farmers' input decisions and farm net revenues. We also hypothesize 2) that the delivery of knowledge will be influenced by the individual characteristics of NGOs in charge of the delivery programs. In the rest of this section we provide details of the data collection and econometric strategies for testing these hypotheses.

Sample design and data collection

A set of farm level data was collected in 2004 with a cross-sectional survey of 436 households of Nicaraguan bean growers. The sampling design followed a double stratification (Deaton, 1997) to compare the effect of different IPM training methods (FFS vs. T&V) and to include diverse settings. Households were interviewed in 74 rural communities, including 13 where FFS were implemented, 9 where FFS graduates lived but no FFS were held, 26 communities selected randomly where no FFS exists but other IPM extension services were available, and 26 communities selected randomly where no IPM extension was present. In each community, households were selected randomly and included clients and non clients of NGOs.

Econometric estimation

The main potential econometric problem in this paper is the endogeneity associated with self selection of farmer participation in IPM extension programs and the non-random placement of these programs (Owens et al 2003, Feder et al 2003). Farmers with good pre-existing relationships with NGOs could have been more willing to participate in IPM training, whereas farmers with poor NGO relationships could have been less so. This paper test for selection bias using two stage least square (2SLS) (Wooldridge 2002).

The sample design poses secondary econometric problems of a clustered and stratified sample that can bias the parameter estimates (Wooldridge 2002). Clustering is corrected by adjusting the variance matrix and including cluster dummy variables using survey regression methods, while the unbalanced representation of farmers (especially FFS trainees) in the sample, is corrected by using population weights (Wooldridge 2002).

This paper specifies one model for the number of IPM practices adopted by households, two models for pesticide demand and one model for the bean net revenue function. All models have the same set of explanatory variables with the general model:

$$X_J = P_K \beta_P + T_T \beta_T + I_N \beta_I + T_{FFS} I_N \beta_{FFS,N} + C_H \beta_{CH} + C_C \beta_{CC} + U$$

The J dependent variable depends on vectors of k output and input prices (P_K), household participation in the t IPM training program (T_T), the n individual characteristics of the NGO delivering IPM to the household (I_N), the interaction of FFS participation and NGO characteristics ($T_{FFS}I_N$), socioeconomic and other household characteristics (C_H) and community fixed effects (C_C), with disturbances assumed to be independently distributed (U).

For the 2SLS models the predicted probability of participation in each IPM training is used as an instrument for true program participation. The predicted probability is estimated using a probit specification with the original exogenous variables plus some redundant variables that explain the variation of FFS and other IPM program participation (Wooldridge 2002). Each probit uses the same set of explanatory variables as the previous models plus a vector of Z variables containing the redundant variables related to IPM training participation.

<u>Dependent variables:</u> Household input demand for insecticides and herbicides and fungicides is represented by the quantity of toxicity weighted pesticide active ingredients used by each household in bean production during the most recent bean season in 2003 (USDA, 1998). The number of IPM practices adopted by households during the most recent bean season is the sum

of following IPM practices adopted 1) scouting, 2) botanical insecticides and 3) yellow insect traps. Bean net revenue is a continuous variable measured in US$/ha during the most recent season in 2003.

<u>Selected explanatory variables</u>[2] IPM training participation is specified for FFS graduates, other IPM training program participants and the interaction of the two[3]. Households without IPM training contact are kept as the control group. Some characteristics of the participating NGOs that usually differ across them are explicitly specified. We use variables that measure NGO size and resource capacity (average number of extensionists per NGO project, average number of NGO extensionists per district), NGO expertise and experience (proportion of NGO staff with IPM and FFS training, and years of experience of NGO working in the respondent's community), and NGO institutional focus (whether the NGO has a main focus on soil conservation or agricultural credit, whether the NGO conducted IPM experiments through FFS, whether farmers observed greater yields in the experimental IPM plot, whether farmers observed greater net revenues in the experimental IPM plot, and whether the NGO organized other complementary experiments during FFS implementation). Interactions for FFS participation and individual NGO characteristics were also included as explanatory variables in order to measure whether each individual NGO characteristic affects FFS impacts[4].

The redundant variables used to control for endogeneity of extension participation measure pre-existing linkages between the individual NGO and client farmers. The variables include whether households received previous credits from the NGO, whether they received food

[2] Due to space limitation we only provide details on IPM training and NGO characteristics variables. Details on other variables can be found in Labarta (2005)
[3] There were 35 FFS graduates who had previous participation in other IPM training programs
[4] Therefore interaction for the predicted probability of IPM training participation (instruments) and individual NGO characteristics were also generated for all 2SLS estimations.

assistance or any cash support, and whether they adopted soil conservation practices prior to their IPM training.

5. Results

Table 5 FFS and NGO characteristics effects on adoption of IPM practices. IV Least squares survey regression results 436 Nicaraguan bean growers, 2003-04

	Number of IPM practices	Insecticides	Herbicides	bean net revenues
FFS	-1.031	0.277	-0.037	-79.03
	(0.35)	(1.27)	(1.28)	(0.75)
Other IPM training	**1.213*** **	0.016	0.003	-0.448
	(3.29)	(1.28)	(0.88)	(0.05)
Double IPM training	-0.580	0.222	-0.043	-72.89
	(0.19)	(0.99)	(1.39)	(0.70)
Interactions with FFS				
Extensionists per project	-0.021	0.345	**-0.073** **	-37.35
	(0.00)	(1.04)	(2.61)	(0.29)
Extensionists per district	-6.517	-0.595	**0.141** **	-29.92.
	(0.60)	(0.94)	(2.35)	(0.14)
NGO years of experience	-0.023	-0.012	**-0.003***	57.49
	(0.16)	(1.02)	(1.83)	(0.15)
Extensionists with IPM training	17.619	0.863	**-0.217** **	**28.70***
	(0.81)	(0.84)	(1.99)	(1.68)
Extensionists with FFS training	-1.335	-0.084	-0.003	0.273
	(1.12)	(1.26)	(0.57)	(0.05)
Emphasis in soil conservation	2.287	-0.178	0.030	75.139
	(0.72)	(0.82)	(0.90)	(0.75)
Emphasis in credit programs	**-1.070***	0.107	-0.017	-28.56
	(1.69)	(1.16)	(1.44)	(0.62)
Comparative experiments	-4.377	0.117	0.002	-20.04
	(0.60)	(0.42)	(0.08)	(0.16)
Other experiments	0.011	0.096	**-0.034***	-64.42
	(0.01)	(0.69)	(1.72)	(1.01)
Observed more yields	**20.894***	0.006	-0.025	267.52
	(1.88)	(0.01)	(0.26)	(0.62)
Observed more net revenues	0.569	-0.189	0.045	-235.37
	(0.88)	(0.24)	(0.51)	(0.59)
Observed less yields	2.160	**-0.073** **	**-0.005***	25.71
	(1.59)	(1.99)	(1.66)	(0.59)
Observations	436	436	436	436
R-squared	0.50	0.35	0.50	0.37
Hausman test				
F-Statistic	3.01	2.05	1.80	2.53
P-Value	0.0003	0.0152	0.0388	0.0022
Aggregate FFS effect				
F-Statistic	5.54	2.42	1.90	2.22
P-Value	0.0000	0.0034	0.0267	0.0077

The Hausman tests in Table 3 show evidence of endogeneity, which is corrected using 2SLS models (Wooldridge 2002). FFS participation by itself had no significant impact on the adoption of IPM practices, pesticide use or bean net revenues (Table 3). These findings are consistent with similar studies in Indonesia (Feder et al 2004). The participation on other non-FFS IPM training programs performed slightly better in Nicaragua, increasing the number of IPM practices adopted (Table 3). Some of these findings can be explained by poor results of FFS demonstration plots. FFS graduates could observe yield gains from IPM experimental plots in only four of the 12 FFS and net revenue advantages in only two. Most of the FFS graduates observed superior yields and net revenues on bean plot employing conventional pest management (Table 2).

Table 3 also includes results of the F-test indicating that NGO characteristics are jointly part of the FFS aggregate treatment effect. In all models we reject the null hypothesis that FFS participation and its interactions with NGO characteristics do not influence the number of IPM practices adopted, pesticide use and bean net revenues.

The adoption of IPM practices among FFS graduates was significantly affected by the institutional emphasis given to individual FFS implementation (Table 3). FFS graduates linked to NGOs that focus on credit programs were less likely to adopt IPM practices. Farmers working with NGO’s that conducted comparative trials finding higher yields in the IPM plot were more likely to adopt more IPM practices. These results highlight the importance of FFS field experimentation where graduates have the opportunity to apply directly the IPM knowledge learned. It also shows that farmers observing field advantages of IPM are more likely to adopt it.

Pesticide use among FFS graduates was directly affected by how NGOs operated their FFS. Graduates of FFS run by NGOs that implemented a comparative trial during the FFS experimentation and observed higher revenue in the IPM plot decreased their use of insecticides and herbicides (Table 3). Likewise, FFS graduates exposed to comparative experiments that resulted in lower bean yields in the IPM plot significantly increased the use of both types of pesticides. Field experimentation and especially positive results from IPM treatments seems to be highly relevant for inducing a reduction of pesticide use. Failure to show FFS graduates tangible advantages of IPM over chemical pest control can result in no incentives to change the level of pesticide use.

NGO capacity and expertise in IPM had relatively less effect on FFS graduates' pesticide use. The graduates of FFS managed by NGOs with more extension agents per project only reduced herbicide use. Those from FFS managed by NGO's with a higher ratio of extension agents per district actually increased the use of herbicides. Graduates of FFS linked to NGOs with more extension agents trained in IPM and with more years of experience working in farmer communities significantly reduced the use of herbicides (Table 3). This result suggests that more IPM expertise among extension providers can to produce impacts on graduates' pesticide use.

Finally, NGO characteristics had much less impact on bean net revenues of FFS graduates than on their adoption of pest management practices. Only NGOs having more extension agents trained in IPM increased bean net revenues of their FFS graduates. As explained before, the fact that most FFS field comparison showed higher bean yields and revenues in the conventional bean plot rather than the IPM plot can explain the poor performance of FFS and the extension providers implementing them on farm outcomes.

Conclusions

Impact assessment of extension services in developing countries has largely ignored the effect of the diversity in institutional characteristics among extension providers (Raina 2003).

We found that these characteristics significantly affect farmers' choices of management practices and, to a lesser extent their crop net revenues. In particular, the institutional focus, expertise in IPM and the capacity of NGOs implementing multi-institutional extension projects significantly affect their clients' input decisions and adoption of agricultural technologies.

The impact of extension programs can be enhanced or diminished by individual characteristics of the institutions delivering agricultural technologies. NGOs with more expertise and extension experience tend to enhance the delivery of these agricultural technologies, as many papers have highlighted (Hassan 1993, Carney 1998). By contrast, NGOs with an institutional emphasis different from the focus of the extension program deliver poor extension performance. Depending on the magnitude of these effects, the positive effects generated by desirable NGO characteristics can be offset by negative effects from NGOs with institutional focus irrelevant to the extension focus in question.

The findings presented here highlight how FFS impacts can be erroneously measured in an analysis that fails to correct for endogeneity among explanatory variables. So far, both of the IPM training programs implemented in Nicaragua have had little effect on participating farmers' pesticide use and adoption of IPM practices, two of the main goals of any IPM extension program. However, farmers served by NGOs with a higher proportion of extension agents trained in IPM, with greater expertise in IPM, and longer experience in working with farmer communities tended to achieve better results. Scientific knowledge of IPM turned out to be more important than communication knowledge about delivering IPM.

This research provides important insights for policy makers and international donor agencies that wish to broaden the participation of NGOs as extension providers. It is necessary improve the selection of NGOs that will deliver agricultural technologies, to strengthen their capacity (especially their scientific basis) and to match the institutional emphasis of individual NGOs with the main focus of the extension program. Our findings also underscore the major role played by FFS field experimentation in shaping farmer input decisions. Direct exposure to benefits and limitations of new technologies should always be present in extension programs. However, it is necessary to keep in mind that experimental or demonstration results may not favor the proposed technology. Institutions in charge of delivering this technology should be able to react quickly and incorporate farmers' feedback to the technology development process, even to the point of discarding the proposed technology.

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