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Factors Associated with the Use of Pesticides in Uganda: Strategic Options for Targeting Integrated Pest Management (IPM) Programs

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Abstract

Targeting particular groups who share similar production practices and problems has proven to be a cost-effective, efficient way to design and disseminate agricultural technologies. The accumulated evidence indicates that where successful, Integrated Pest Management (IPM) programs have been goal-oriented and targeted. Since one of the primary goals of IPM is to control pests while reducing the use of synthetic pesticides, knowledge of social, economic and institutional factors that influence farm-level decisions to adopt pesticides may suggest different targets and strategies for disseminating IPM. Using a multi-staged sampling procedure, two hundred farmers from two districts in Eastern Uganda were interviewed regarding their socioeconomic background and pest management practices. Regression results indicate the most important predictor of pesticide use was growing tomatoes, followed in order by owning a backpack sprayer, farming in Kumi district, a higher level of education and more contact with extension. These results suggest targeting specific crops and cropping environments associated with high pesticide use for IPM programs. Farmers owning backpack sprayers could be targeted for programs that integrate pesticide safety and information about IPM. Extension agents also need to be provided information about and trained in IPM. Alternative IPM approaches are recommended for farmers who are not using pesticides.

Introduction

Developing and disseminating appropriate technological solutions for different agricultural producers and production systems is vital to agricultural development in Sub-Saharan Africa (Venkatesan and Kampen, 1998; Cleaver, 1993). One unavoidable lesson over the past 50 years of agricultural research and development is that one-size does not fit all and that recommendations must be tailored to the needs of the end-user. Despite appearances of homogeneity, small farmers have different production practices, needs and constraints (Carr, 1989). Targeting particular groups who share similar production practices and problems has proven to be a cost-effective, efficient way to design and disseminate agricultural technologies (Rivera and Gustafson, 1991).

A market segment, or target, is a subgroup of people or organizations sharing one or more characteristics that cause them to have similar needs. The strategy is to identify different segments of a program's potential adopters and to develop a priority ordering of segments which maximize the accomplishment of the program's objectives (Roberto, 1972). Both commercial firms and many national agricultural research and extension organizations have used targeting. In the Farming Systems Research literature, targets are designated as domains that consist of farmers who share similar production practices and circumstances (Ruthenberg, 1980). Past extension strategies targeted innovative or progressive farmers, however, these approaches fell out of favor because they benefited elites and exacerbated rural socio-economic inequality. Participatory agricultural research and extension approaches attempted to counter this bias by advocating that resource poor farmers and disadvantaged groups, such as women or minority ethnic groups, be specifically targeted.

For over two decades, attempts have been made to develop and disseminate Integrated Pest Management (IPM) strategies to small farmers in sub-Saharan Africa and around the world. IPM is touted as a cost effective, environmentally friendly, and sustainable strategy for small-scale farmers. Yet, these efforts have met with limited success, particularly among small farmers (Yudelman et al., 1998; Morse & Buhler, 1997). A one-size-fits-all approach to the dissemination of IPM may have underestimated small farmer heterogeneity and impeded its adoption. To improve the adoption of IPM, it may be important to differentiate the demand/need for IPM, as suggested by the marketing concept of targeting (Maxwell, 1996; Morse & Buhler, 1997).

One of the primary goals of IPM is to control destructive pests and diseases while simultaneously eliminating or reducing the use of synthetic pesticides. Previous studies have indicated that more intensive use of pesticides is often associated with greater knowledge and awareness of non-chemical control strategies such as IPM (Erbaugh et al., 2001; Morse and Buhler, 1997). Research in the diffusion of agricultural innovations has demonstrated that knowledge/awareness of a new technology is a necessary first step in the adoption decision-making process (Rogers, 1995). This line of research also indicates that adoption behavior in the past is often a useful indicator for predicting future technology adoption (Hooks et al., 1983). Thus, factors associated with pesticide use may suggest potential targets for IPM programs.

Objectives

The main objectives of this study are: 1) to identify factors associated with pesticide use; and, 2) to use this knowledge to suggest different targets and strategies for disseminating IPM.

Factors associated with pesticide use: A basic premise of the traditional diffusion model is that adoption behavior is influenced by personal background characteristics, or human capital, such as experience or its proxy age, and level of education (Feder, 1985). Gender is another important background characteristic particularly in sub-Saharan Africa that affects access to information and influences adoption decisions (Saito et al., 1994). Critics of the diffusion model suggest that access to information and the capacity to act on this information was limited by economic constraints (Hooks et al., 1983; Feder, 1985). Thus, the differential possession of economic assets such as land, labor and capital were more important predictors of technology adoption than human capital. Others have argued, particularly in the case of agricultural technologies, that individuals with greater access to information will be more likely to adopt new technologies (World Bank, 1991; Padel, 2001). Contact with agricultural extension agents measures a farmer's access to information. Distance from the farm homestead to the nearest town measures geographical access to input markets and agricultural information.

Rogers (1995) indicates that innovations more compatible with existing modes of production will be more readily adopted. Ashby (1982) argues that the adoption of agricultural technologies can often be explained by their suitability for specific crops and environments. In fact, there is substantial evidence linking production goals with production practices including pest management (Seckler, 1993; Ruthenberg, 1990). In Kumi District, farmers have had more experience with pesticides owing to their long history of growing cotton commercially. Finally, complementary technologies can facilitate adoption of other technologies (Feder, 1985). Owning a backpack sprayer will facilitate frequent and efficient application of pesticides.

Methodology

A multi-staged sampling procedure was used to select eight villages in two districts in Eastern Uganda. In each district, four sub-counties and one village in each sub-county were randomly selected. Household lists were obtained for each village from government officials. A systematic random sample of 25 farmers was selected from each village, totaling 100 interviews from each district, and 200 interviews in all.

The survey instrument was based on a previous version used to study socioeconomic background characteristics and pest management practices of farmers in the same districts in 1996. Field enumerators were selected from local extension staffs based on their familiarity with local languages and survey methodology. Female enumerators, two for each district, were instructed to interview female farmers knowledgeable of the farm operation when possible. A one-day training workshop for enumerators was held, and teams of enumerators conducted a pre-test of the instrument with five farmers in their respective districts. Each enumerator completed 25 questionnaires through personal interviews.

The dependent variable, pesticide usage, was measured by asking farmers to name crops they had sprayed and the different pesticides used on each crop. This measure was considered to provide a more reliable approximation of pesticide usage per farmer than the number of spray events per crop per season because most small-scale farmers in Uganda do not maintain records on pesticide rates or application frequency. Without records several commonly reported farmer practices, including applying pesticides frequently at lower than recommended rates; applying less frequently at higher than recommended rates; and making pesticide cocktails by mixing several pesticides together, rendered estimates of pesticide rate and application frequency unreliable. Although both responses relied upon farmer recall of information, most were able to recall if they had sprayed a crop or not, and if they had used one or more different pesticides. In several cases where they were unable to recall the name of the specific pesticide used, they were able to retrieve a bag or container with the name of the pesticide on it from the household or storage area.

Independent variables were selected from previous studies on the adoption of agricultural technologies and their potential influence on the adoption of synthetic pesticides. Since markets can be segmented using a single or several variables, these were then grouped into explanatory sets or blocks of factors to facilitate assessing their effectiveness as potential targets for future IPM programs.

Findings

Table 1 shows the characteristics of the respondents from Iganga and Kumi districts. The mean response pattern on educational level, crop acreage, and age was similar to data gathered from the last National Census in 1992. The average age was 40 years old. There were slightly more female than male respondents, probably because "head-of-household" was intentionally not used as a screening question so that female agricultural decision-makers (52%) had a better chance of being represented in the sample. Average education was nearly seven years, which is equal to the number of years required for a primary leaving certificate. Crop acreage was slightly higher in this sample because farm size in Kumi district tends to be larger than the national average. Farm income averaged $100-$220 per annum, which approximates a World Bank study (1993) that found the average farm income in Uganda was $104 per annum.

Table 1

Means and Standard Deviations for Dependent and Independent Variables

Variable Name	Mean	SD
Pesticide Usage	1.56	1.63
Age	40.10	12.41
Educational level	6.83	3.27
Acres in Crops	5.68	4.90
Farm Income	3.07	1.73
Part time labor	2.13	1.75
Extension Contact	3.86	4.56
Town Distance	10.79	8.55
Commercial Acreage	41.46	18.63
Tomatoes	.14	.35
growing 14%		
not growing 86%		
District	.50	.50
Iganga 50%		
Kumi 50%		
Owning Sprayer	.16	.37
owning 16%		
not owning 84%		

The majority of farmers (63%) were applying at least one synthetic pesticide during the cropping season with over 25% of the respondents making three or more applications. Farmers in Kumi district used more pesticides than farmers in Iganga district. Women were as likely as men to have their fields sprayed; however, men were much more likely to do the actual application of pesticides. The most common method of applying pesticides was hiring someone to spray, borrowing a sprayer, or using ones' own sprayer. In this sample 16% of the farmers owned their own backpack sprayer.

Pesticide use was regressed on five sets or blocks of variables presented in Table 2. In examining the block regression results, personal background variables explained only 5% of the variation in total pesticide usage. The only statistically significant predictor within this block was educational level, which showed a beta coefficient of .152. The second block of variables representing economic assets explained 12% of the variance in pesticide usage and when combined with the first block of variables, explained 14% (+9% increase). None of the variables in this block were statistically significant.

By itself, the third block of information and market access variables, explained nearly 11% of the variance in total pesticide usage. The most important variable was extension contact, showing a beta coefficient of .129. However, when this block was combined with the first two blocks, it increased the variance explained by only 6%.

The fourth block consisted of three variables that were compatible with pesticide use. By itself this fourth block explained nearly 33.4% of the variance, and combined with the first three blocks of variables, accounted for 41.4% in pesticide use (+21.5%). The two statistically significant variables in this block were growing tomatoes and living in Kumi District.

The fifth block was a single variable: owning a backpack sprayer. By itself this variable explained 20.8% of the variance and increased the total explained variance by +9%. The total model was successful in explaining nearly 51% of the variance in pesticide use, indicating that it was moderately successful in identifying factors associated with farmers' use of pesticides.

Table 2

Blocked Regression Analysis: Pesticide Use on Independent Variable (Beta Coefficients)

Variables	R^2	Adjusted R^2	Total Adjusted R^2	Change in total Adjusted R^2
Background				
Educational Level	.152**	.048		
Sex	.045			
Age	-.016			
Economic Assets				
Acres in Crops	-.052	.122	.139	.091
Farm Income	.062			
Hired Labor	.062			
Infrastructure				
Contact with Extension	.129*	.106	.199	.064
Distance from town	.099			
Compatibility				
Commercial acreage	.078	.334	.414	.215
Tomato grower	.356**			
District	.313**			
Complementary Technology				
Sprayer ownership	.316**	.208	.505	.091

** Significant = $p<.01$ – one-tailed test
* Significant = $p<.05$ – one-tailed test

Discussion and Conclusions

Regression results indicate that the independent variables included in the model explained the majority of variance in pesticide use. The most important predictor was growing tomatoes, followed in order by owning a backpack sprayer and farming in Kumi district. A higher level of education and more contact with extension were also moderately associated with more pesticide use. It appears that greater pesticide use is better explained by compatibility with particular crops and environments and by the possession of complementary technology. Also, higher levels of education and extension contact facilitate greater pesticide use, but economic barriers do not restrict pesticide adoption.

The second objective of this paper was to investigate whether factors associated with greater pesticide use suggest potential targets and strategies for diffusing IPM practices. The first strategy, justified by the explicit IPM goal of lowering the use of synthetic pesticides, would specifically target pesticide users. There is evidence from a previous study in Uganda that pesticide user's share a similar need to reduce pesticide usage (Erbaugh et al., 2001). Thus, farmers using more pesticides may be more interested in alternative pest management practices such as IPM than are farmers who are not using pesticides. Targeting specific crops and cropping environments associated with high pesticide use could further refine this strategy. Farmers in this sample clearly perceived that pesticides were required to grow tomatoes and were more frequently used with cropping systems in Kumi. Although not included in this study, greater pesticide use was also associated with growing cowpea. Thus, farmers growing these crops or living in Kumi might be more interested in alternative pest and disease management practices that allow them to reduce pesticide usage.

A component of IPM is using pesticides safely and effectively. Thus an accompanying strategy might target farmers who own backpack sprayers for programs that integrate pesticide safety with information about IPM. This information could accompany the technology where it is purchased or could form the core of an extension program. Since extension contact was associated with pesticide use, extension agents need to be trained in and provided with appropriate information on pesticide use, safety, and IPM.

Although IPM adoption may be facilitated by the strategy of targeting pesticide users, an unforeseen consequence may be the furthering of rural social and economic inequality. Evidence from this study appears to indicate that economically advantaged farmers are not more likely to be using pesticides. Thus targeting pesticide users for IPM programs should not advance rural inequality. However, an additional strategy would target farmers who are not using, or who are using low levels of pesticides. This approach would focus IPM research and development activities on longer-range approaches to crop and pest management. Since ecological IPM approaches are recognized as being knowledge intensive, approaches that maximize experiential learning opportunities, such as farmer field schools might be used. Thus, the IPM strategy used would depend on the target. If the goal of an IPM program is to reduce or eliminate the use of synthetic pesticides then differentiating the market for IPM according to pesticide use might prove to be a useful strategy for promoting IPM with different population segments.

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References

Ashby, J. A. (1982). Technology and Ecology: Implications for Innovation Research in Peasant Agriculture. Rural Sociology, Summer, Vol. 47, No. 2.

Cleaver, K. M. (1993). A Strategy to Develop Agriculture in Sub-Saharan Africa and a Focus for the World Bank. World Bank Technical Paper: No.203, The World Bank, Washington, D.C.

Carr, S. J. (1989). Technology for Small-Scale Farmers in Sub-Saharan Africa. World Bank Technical Paper, No. 100, The World Bank, Washington, D.C.

Erbaugh, J. M., C. Igodan, P. Kibwika, & Kyamanywa, S. (2001). Factors Associated with Knowledge of IPM: Implications for Targeting IPM Program. African Crop Science Conference Proceedings, Lagos, Nigeria. Vol.5, Part II: 699-704.

Feder, G., R. E. Just, & D. Zilberman. (1985). Adoption of Agricultural Innovations in Developing Countries: A Survey. World Bank Staff Working Papers No. 542, The World Bank, Washington, D.C.

Hooks, G., T. Napier, & M. Carter. (1983). Correlates of Adoption Behaviors: The Case of Farm Technologies. Rural Sociology, Summer, Vol. 48, No. 2:308-323.

Maxwell, F.G. (1996). Introduction to the Symposium Proceedings on Integrated Pest Management in Developing Countries: Constraints, Challenges, and Controversies. The Journal of Agricultural Entomology. July, Vol. 13, No. 3:171-172.

Morse, S. & Buhler, W. (1997). Integrated Pest Management: Ideals and Realities in Developing Countries. Boulder, Co. Lynne Rienner Publishers.

Padel, S. (2001). Conversion to Organic Farming: A Typical Example of the Diffusion of an Innovation? Sociologia Ruralis, January, Vol. 41, No. 1: 40-61.

Rivera, W. M. & Gustafson, D. J. (1991). New Roles and Responsibilities for Public Sector Agricultural Extension: The Impact of Multi-Institutional Activities. IN W.M. Rivera and D.J. Gustafson, Agricultural Extension: Worldwide Institutional Evolution and Forces for Change. Elsevier, Amsterdam.

Roberto, E. (1972). Social Marketing Strategies for Diffusing the Adoption of Family Planning. Social Science Quarterly, 53:33-51.

Rogers, E. (1995). Diffusion of Innovation. New York: Free Press.

Ruthenberg, H. (1980). Farming Systems in the Tropics. Clarendon Press. Oxford.

Saito, K., Mekonnen, H. & Spurling, D. (1994). Raising the Productivity of Women Farmers in Sub-Saharan Africa. World Bank Discussion Paper: 230, The World Bank, Washington, D.C.

Seckler, D. (1993). Agricultural Transformation in Africa. Winrock International Institute for Agricultural Development. Pp: 153-156.

Yudelman, M., Ratta, A. & Nygaard, D., (1998). Pest Management and Food Production: Looking to the Future. Food, Agriculture, and the Environment Discussion Paper 25. : International Food Policy Research Institute (IFPRI). Washington, D.C.

Uganda National Census of Agriculture and Livestock. Volume I., II., and III., (1992). Ministry of Agriculture, Animal Industries, and Fisheries, Entebbe, Uganda.

Venkatesan, V. & J. Kampen. (1998). Evolution of Agricultural Services in Sub-Saharan Africa: Trends and Prospects. Discussion Paper/No. 390. The World Bank, Washington, D.C.

World Bank. (1993). A World Bank Country Study: Uganda. The World Bank, Washington, D.C.