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Article

Determinants of participation in pest management groups by smallholder cotton producers in Zimbabwe

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Individual pest management is often associated with high costs due to pest drift and lack of economies of scale. This study is intended to determine the factors affecting the decision by farmers to join group pest management which harmonizes community decision making in controlling pests. Using a logit regression analysis, the following factors were found to have a positive impact on farmer proclivity to be part of a pest management group; area planted to cotton, expected pest density, frequency of contact with extension workers, and the difference in benefits between individual and group pest management. On the contrary, the cost of joining a pest management group was found to have a significant negative effect on farmer inclination to join pest management groups.

Key Words: Pest management, logit model, Zimbabwe, group decisions.

INTRODUCTION

Although large proportions of pest control resources, such as pesticides, cultural practices and pest control consultants, are utilized by individual farmers, there is growing interest in forming groups or cooperatives for pest management (Meister, 1980; Good, 1977; Ganyard1997; Jowa, 2004). Feder (1979) and Regev (1993) indicate the importance of considering mobile pests as a common property resource with the divergence between social and private pest control policies.

In Zimbabwe, pest management groups (in the form of farmer field schools or community cooperatives) have been tried in order to manage cotton pests in the high cotton producing regions of Gokwe and Sanyati with the aid of some non-governmental organizations and the Cotton Company of Zimbabwe. These regional groups were intended to internalize production externalities because of mobile pests, pesticide drift, or pest control information. Group economies of size may lower costs to the group members and aid in delivery of new pest management techniques.

The pest control groups require uniform use of pest control resources over wide, contiguous areas. A farmer may not wish to participate in a group if organizational control activities are very different from his/her own.

This study is an evaluation of the choice between group pest control, which may lower application costs and save labour, and individual pest control, which can be varied to match unequal demands for pest control.

Conceptual framework

The group participation model

Each farmer has the options of joining or not joining a group. It is assumed that there is no uncertainty or transaction cost and that non-pest control inputs are independent of the group participation choice (Pridgen and Sarah, 1980). The difference in profits on a per hectare basis is given by:

$$P_y (Y-Y^*) - [P_i (I - I^*) + P_g G] \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where,

P_y = Price of the output (cotton per Kg),
Y = Yield of cotton per hectare if the farmer joins pest

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control group,
Y^* = Yield of cotton per hectare if the farmer does not joins pest control group,
P_i = Price of an individually applied pest control input,
I = Quantity of an individually applied pest control input if the farmer joins pest control group,
I^* = Quantity of an individually applied pest control input if the farmer does not join pest control group,
P_g = Price of group services on a per hectare basis and
G = The quantity of group applied pest control input.

If the difference in profits is greater than zero, one expects the farmer to join the pest control group. It is assumed that each group member receives the same amount of pest control per hectare and each member pays the same price per hectare. The quantity of pest control a farmer desires will not necessarily coincide with the quantity the group provides. If any farmer joins a group, he/she must accept group decisions on the level of pest control received. If the group members have single-picked preferences, then by simple majority voting the group will select the level of the median voter or member (Black, 1948). This uniform purchase constraint, according to Gutierrez 2003, modifies usual marginal conditions for optimal input use and gives a different incentive structure for group versus individual input use.

Groups may be able to coordinate the pest control activities of members to internalize production externalities and increase productivity of pest control inputs. This increase in input productivity enlarges the P_y (Y-Y*) term in equation (1). Farmers within a pest or a beneficial insect population's range "share" the pest or the beneficial insect population (Regev, 1993; Gutierrez 2003). Group co-operation may avoid chasing the pests from one farmer's field to another and may encourage the establishment of a natural enemy or beneficial insect pest population to help control the pest throughout the host's range.

Because of economies of scale, the cost of group services may be lower than those for individual pest control ($P_g < P_i$). In equation (1), the terms $[P_i (I - I^*) + P_g G]$ measure the net expense of participation. This net expense includes the cost of group services, $P_g G$, and the savings due to the replacement of individually applied pest control inputs with group applied inputs. Larger farms may experience economies of size and pay lower input prices. Also the higher the operator's opportunity cost of time, the more likely he/she is to relinquish his pest control duties to a group. The lower the P_g is relative to the P_i, the higher the net benefits of joining.

METHODOLOGY

Data collection

Data used in this study is based on a random sample of 320 farmers in the vicinity of 18 pest control groups in Gokwe and Sanyati districts (10 in Gokwe and 8 in Sanyati). These districts lie in the western parts of the country and are the largest producers of cotton in the country with pest control being critical due to the high temperatures and relatively humid environments in the rainy season. The pest control groups were organized starting in 2002 by the Cotton Company of Zimbabwe

(Cottco) and Concern International with the technical backup from government extension services through the then Agricultural Research and Extension services (AREX). Entry into these groups was entirely voluntary with the role of the facilitators being that of uniform information dissemination to all the cotton farmers in the vicinity of the groups.

In 2005, stratified random sampling with probability proportional to strata size was used to select 182 farmers in the vicinity of Gokwe pest control groups and 132 farmers in the vicinity of Sanyati groups. Data were collected using a variety of ways including questionnaires, farm record sheets and other less structured means such as focus group discussions.

Data Analysis

The empirical model

A maximum likelihood logit estimation procedure was used. Table 1 shows the variables that were compiled for the logit model.

The estimation procedure is logit because ordinary least squares (OLS) gives biased estimates (Burrows, 1983; Domenich and McFadden, 1975). It is assumed that each individual's objective function is composed of a nonstochastic portion, which is a function of observable characteristics, and a stochastic portion, which is a function of unobservable alternative or individual characteristics (Domenich and McFadden, 1975). By assumption, the nonstochastic portion of the objective function equals B*X where B* is a row vector of parameters and X is a column vector of exogenous variables. The stochastic nature of the objective function allows one to define an individual's probability of choosing each alternative as a specific cumulative distribution function evaluated at a given value.

According to Burrows, 1983:

$$P_{join} = F(B^*X) \quad \text{......................} \ (2)$$

Where;

P_{join} = The probability of joining.
F = A specific cumulative distribution function.

If the cumulative distribution functions is a logistic function, then:

$$P_{join} = 1/[1 + \exp(-B^*X)]$$

RESULTS AND DISCUSSION

The estimation procedure provides numerical approximations for the maximum likelihood estimates of B, and the values of the partial derivatives of participation with respect to the explanatory variables. The results are summarized in Table 2.

The model predicts that a unit increase in the group price per hectare will reduce the probability of joining a group crop hectarage (say from 34 to35%) would incre-ase the probability of joining by 0.01. The significant fac-tors that increase farmers' probability of joining a group are: high on-farm opportunity cost of management time measured by the proportion of cropland planted to maize, farm size, expected cotton yield, the proportion of cropland planted to cotton and access to extension advice.

Table 1. The empirical representation of variables that were entered in the logit model.

Variable	Definition and Description	Hypothesized Sign
Group	Whether or not farmer joined group = 1 if yes and 0 otherwise	Dependant
Wage	Off-farm wage imputed from opportunity cost of labour	Positive
Management	On-farm opportunity cost of management time measured by the proportion of cropland planted to a major competing crop – Maize.	Positive
Cropland	Total cropland hectares	?
P_g	Group price as in equation (1)	Negative
Pest	Expected pest density as measured by previous year's pesticide use	?
Yield	Expected cotton yield as measured by previous year's yield	?
Externality	Pest control externality as measured by the number of cotton hectares in the geographical operating area of the pest control group	Positive
Demand	The absolute deviation in group and individual levels of pesticide use in previous year showing differences in group and individual demand levels.	Negative
Cotton	The proportion of cropland planted to cotton, indicating risk.	Positive
Extension	Frequency of contact with extension per year	Positive

Table 2. Results of the maximum likelihood estimation.

Variable	Coefficient, B	Partial Derivatives (Probability Change)
Constant	-3.42	-
Wage	-0.013	-0.0010
Management	12.330**	0.0563
Cropland	0.003***	0.0002
P_g	-0.131**	-0.0110
Pest	0.117	0.0095
Yield	0.005*	0.0040
Externality	-0.002	-0.0001
Demand	-0.646***	-0.0530
Cotton	5.280**	0.0290
Extension	1.331*	0.0095

Significant at 10% level; ** Significant at 5% level; *** Significant at 1%level; Adjusted R^2 = 0 .537

When a farmer joins a group for pest control, the group charges equal per hectare fees regardless of the pest control inputs used on that farmer's fields. In this study, the uniformity of pest control demand was found to be a strong determinant of participation. Small farms are unlikely to join pest control groups. This according to Olson (1998) can be attributed to their capability to free-ride. Also farmers with large proportions of their land planted to cotton have an incentive to join pest control groups. This is probably because such farms can easily enjoy economies of scale since pest control costs per farmer are fixed irregardless of cropped area. Efficient farms that produce high cotton yields are more inclined to join groups because they are also less like to free-ride. Extension advice seems to entice farmers to join group pest management. Extension personnel find it easier to work with groups than with individuals in pest control and they are thus likely to encourage farmers to form pest management groups. Pest density has a positive though insignificant impact on farmer probability to join groups.

Conclusions

This study has shown that group pest management only becomes attractive to farmers if joining a group reduces costs of pest control. Groups work best for larger cotton producers who enjoy economies of scale by joining groups than for small producers. In fact, small producers may lose out if the group fees are constant across farmers. It can be recommended that government institutions can be more effective if they intervene in group pest control in a way that reduces the cost of the pest control input and that discourages free-riding especially by small and inefficient producers.

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