Knowledge of Farmers about Pest Management Practices in Pambaimadu, Vavuniya District: An Ordered Probit Model Approach

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Abstract

Similar to many developing countries, pesticide related issues in Sri Lanka have become a major concern in the recent past. Many researches were conducted to evolve technical alternatives for eco-friendly agriculture, but very less emphasis was given to the knowledge and behaviour of the farmers. Having recognized the need, present study was conducted to assess the farmers' knowledge level on pest management practices and socio-economic factors influencing the existing pest management practices. Ordered Probit model was used to analyze the data from 50 vegetable farmers who were randomly selected from Pampaimadu, Agricultural Instructor range in the Vavuniya district. Nearly 60% of the farmers had medium level of knowledge of plant protection practices. Only 6% of the farmers had good level of knowledge towards the recommended plant protection measures. Almost all the farmers depended on chemical pesticides for the management of pest and diseases but at 35% higher concentration than recommended level. Farming experience and social participation were positive and significantly contributed to farmers' knowledge on safe pesticide use. Education, income, age and family size of farmers had showed no relationship with the knowledge level of pest management. Increased social participation and, effective extension programmes are important to improve farmers' knowledge on proper use of pesticides and its effect on their health and environment.

Key Words: Farmers Pest Management Knowledge, Ordered Probit Model,

Introduction

Pesticides use is a double-edged sword in the battle against pests as it affects human health and also contaminates the environment. Misuse and Overuse of pesticide is very common among farmers of developing economies and Sri Lanka is no exception. Sri Lankan farmers have a tendency to ignore technical recommendations and base usage on their own experience often leading to indiscriminate application (Wilson and Tiddsell, 2001). Yet, some farmers have a genuine problem of insufficient knowledge and information on the and spraying pesticides on their farms are exposed to pesticides and suffer from numerous morbidity effects ranging from headaches, nausea to cramps

and body tremors. According to World Health Organization (WHO) in 2005 the estimated occupational pesticides poisoning affected as many as 25 millions of the agricultural work force each year in developing countries. Acute pesticide poisoning has become a major problem in Sri Lanka. Farmers handling and spraying pesticides using hand sprayers suffer from numerous morbidity effects (Sivayoganathan et al., 1995).

Human health effects due to routine occupational exposures in pesticide application have not been well documented in Sri Lanka but assumed that continuous use of pesticides has caused human ill health and agricultural sustainability significantly. Wilson and Tiddsell (2001) have estimated the private cost of farmers' exposure to pesticides in Sri Lanka. They found that a farmer on average incurs a cost of around Rs 5465 a year (equal to about a month income) due to exposure to pesticides. On the other hand, use of the avertive /defensive behavior approach estimates the cost to be around Rs 405 a year or 12% of the monthly income of an average farmer per year. The contingent valuation method estimates give a higher figure of Rs 11, 471 or cost of more than 2 1/2 months income a year due to ill health resulting from exposure to pesticides. The intangible and indirect costs such as discomfort, stress, pain and suffering are important costs that are associated with exposure to pesticides. Deaths from exposure to pesticides are not uncommon. Hospital statistics in Sri Lanka show that on average 14,500 individuals were admitted to government hospitals and around 1500 individuals a year died from pesticide poisoning during the period 1986-1996 (National Poison Information Centre, 1997). The damage done from exposure to pesticides, not only to human health, but also to the native fauna and the environment in general is very large. The effect on neighboring individuals is likely to be considerable since water sources and the entire environment are affected. The entire food chain can be affected as a result. The damage done to consumers of cultivated food crops, though unknown, could also be high. Over use of pesticides occur due to lack of knowledge about environmental ill effects.

Although acute pesticide poisoning occurs at alarmingly high rates in Sri Lanka, it is a major problem through out the developing world. The worldwide incidence is about three million cases and 220,000 deaths each year. The largest numbers are in developing countries. Each year tens of thousands of farmers, especially in developing countries, are affected by exposure to pesticides. According to recent estimates 3 million people are poisoned and 200,000 died by pesticide poisoning each year (FAO, 2005). In Sri Lanka pesticide poisoning causes many deaths, particularly among males 40 – 54 years and the elderly. The suicide rate in Sri Lanka is about 160 per 100,000. Apart from these hospital data, various field studies carried out have also confirmed high levels of morbidity from direct exposure to pesticides ranging

from faintish feelings, headaches, nausea, diarrheoa, muscle twitching, rashes and cramps (Sivayoganathan et al., 1995).

Vegetable crop sector in Vavuniya district accounts for heavy use of pesticides. Pesticides are extensively used on upland cash crops due to higher susceptibility to pest and diseases and relatively higher economic returns from these crops. Usually, liquid formulation and wet-table powders are applied as spray mixture while granule and powders are broadcast simply by hand. Nowadays, increased attention is being paid on to selection of suitable pesticides, its formulation method and judicious use of pesticides to minimize risk and detrimental effects on health and environment. Department of Agriculture, Vavuniya has been promoting integrated approach for managing pest problems (IPM) in crop production from the last decade (Administration Report, 2003). In the long term, the wide spread adoption of IPM will be the only way to satisfy public demand for safe and sustainable pesticide usage. IPM is practiced in rice cultivation but very little on crops such as chillie and onion. In general insecticides are heavily used in the vegetable sector followed by the fungicides. Pesticide use continued to remain the most popular method of pest control by farmers even though pesticide showed harmful effects on human health, environment and crop ecosystem (Administrative Report , 2005).

With the background discussed above, present study was conducted to assess the farmers' knowledge level on pest management practices and socio-economic factors influencing the existing pest management practices and farmers' awareness about the ill-effects of pesticides use on the farmers' health and the environment.

Methodology

Study Area

Vavuniya District in the Northern Province of Sri Lanka was selected for this study because of the following reasons. Nearly 28,000 ha of land are being cultivated with paddy and other major field crops such as chillie, onion and vegetables. Lift irrigation from wells is utilized for the subsidiary food crops like chille, red onions, big onions and grain legumes, exotic and local vegetables. Annually, an average of 2145ha of land is used to cultivate vegetables and produce 34,575 mt of vegetable during maha and yala season in which 50 % is contributed by the yala season (Administration Report, 2005). The study area selected for the study was Bambaimadu Agricultural instructor (AI) range, which is a typical agricultural area that is threatened by high pesticide use in the Vavuniya district. Fifty vegetable farmers who cultivate chiille, red onion and vegetables in more than 0.25 ha were randomly

selected from three selected villages. Secondary data was extracted from the reports of the Department of Agriculture and base hospital, Vavuniya.

Keeping in view the objective of the study, socio-economic variables like farmers' age, education, family size, occupation, and experience in farming, operational holding, annual income, extension contacts and social participation were collected as independent variables. Farmers' knowledge on pesticides use practices and their awareness about the ill effects of pesticides on their health and environment were computed as dependent variable. Knowledge of farmers on cultural, mechanical and chemical protection practices and their ill effects of pesticides use were computed based on a simple five-point Lickert scale method. Knowledge scales were composed of approximately equal numbers of favourable and unfavourable statements concerning the pesticide use in vegetable cultivation, environment and health. Farmers were asked to respond to each statement in terms of their level of agreement. Scale scores were computed by summing the response scores of the component items with the response given, using the following integral values: Strongly agree 5, agree 4, undecided 3, disagree 2, or strongly disagree 1. The mean and standard deviations of measurements were used to categorize the respondents' knowledge of pesticides use (KNOW) into three groups viz., low, medium and high level of knowledge. The general form to identify farmers' knowledge of pesticide use is as follows

$$Y^*(KNOW) \begin{cases} Y = 1, \text{ IF Scale scores} < (\overline{X} - SD) \\ Y = 2, \text{ IF } (\overline{X} - SD) < \text{Scale Scores} < (\overline{X} + SD) \\ Y = 3, \text{ IF Scale scores} > (\overline{X} + SD) \end{cases}$$

Where
$\overline{X}$ - Mean of knowledge and awareness of pesticide use,
SD - standard deviation

To determine the factors that influence perceived ill effects of pesticide use, the above-calculated dependent variable was then regressed on the set of socio economic variables, using the Ordered Probit Model described below.

Ordered Probit Model

Response chosen in an opinion survey often appears as a discrete choice set rather than a continuous one. When the dependent variable takes more than two values, but these values have a natural ordering, as is common in survey responses, the ordered probit model is often appropriate. The Ordered Probit model is a fairly straightforward extension of the binary probit model that

can be used in cases where there is multiple and ranked discrete dependent variables. Discrete choice variables fall into two categories: The first one is ordered variables and the second one is unordered variables. The previous studies have mostly utilized multiple regression models and binary probit or log it models to study statistical relations between dependent and explanatory variables. Because of the discrete nature of the dependent variable in this study, ordinary least squares regression would be an inappropriate model. Probit or logit model specification is utilized for dichotomous dependent variables and it gives discrete outcomes too. With this in mind, multinomial model for discrete choice of ordered data is more applicable for this data analysis. Nevertheless the ordered probit model, which can make full use of every response choice, is statistically more efficient than the binary logit and probit model. Therefore the follwing ordered probit model that uses *Maximum Likelihood* (ML) analysis (Borooah, 2002) was employed in this study. Models for ordinal dependent variables can be formulated as a threshold model with a latent dependent variable:

$$Y^* = \beta^! X + \in \quad \text{..(1)}$$

Where, Y*, is unobserved. It is assumed that   is normally distributed with zero mean.   , is a vector of unknown parameters to be estimated. X, is a vector of a respondent characteristics.

Equation (1) can be used to specify the empirical model given in equation (2).

$$Y^* = \beta_0 + \beta_1 FSIZE + \beta_2 EDU + \beta_3 EMP + \beta_4 EXP + \beta_5 LAND + \beta_6 AINC + \beta_7 SOC + \varepsilon$$

Where

Variable Name	Description of Variable	Type of Variable
KNOW	Ordered Dependent Variable Farmers' knowledge about safe pesticide use and its ill effect on the Environment and health	Y* 1 to 3 levels Ordinal
FSIZE	Number of member of the farmers' family	Discrete
AGE	Farmers' Age	Continuous

EDU	Number of years of farmers' education	Discrete
EMP	Full time farming -1, Part time farming-0	Dummy
AINC	Net annual household income	Continuous
EXP	No of years of experience in farming	Continuous
SOC	Social participating score	Dummy

Results and discussion

Profile of vegetable cultivating farmers

Analysis of the data collected on socio-economic variables of chillie and red onion cultivators in Pampaimadu Vavuniya district indicated that farmers had an average age of 47 years with average number of experience in farming of 16 years (Table 1). The average family size was around 4 per family, which is lower than the national average of family size of 4.3. Formal education was average with almost 60% of the farmers having up to only 11years of schooling. About 21% had less than primary education. Agriculture training was low in the area as only 25% of farmers attended an agriculture-training programme conducted by the Department of Agriculture. The average of operational landholding was 0.81 ha. The yearly average income of the household was Rs. 161,160. The average nature of farming was 0.78, which explains that most of the farmers were full time vegetable farmers. At least 22% of the farmers had additional sources of income, which demanded approximately 10% of their working time and contributed approximately 15% of total family income. The average social participation score was 0.82, which indicates that most of the farmers were members of social organizations and participating in some form of social activities in the village.

Table 1: Personal traits of vegetable farmers – Pampaimadu, Vavuniya Distrcit

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
AWAR (Scale)	50	25.44	7.1860	12	40
FSIZE (No.)	50	4.02	1.8460	1	7
AGE (Yrs.)	50	46.52	11.8274	27	73
EDU (Yrs.)	50	10.96	2.2943	5	18
EMP (Scale)	50	0.78	1.5556	0	3
AINC (Rs.)	50	161160	80324.94	36000	368000
LAND (ha.)	50	0.81	4.2162	0.2024	1.822
EXP (Yrs.)	50	16.16	6.8254	4	35
SOC (Scale)	50	0.82	0.3881	0	1

Knowledge on safety uses of pesticide

At present insecticides are heavily (70%) used in the vegetable sector followed by fungicides (20%). Weedicide use was very minimal in this sector (10%), except in onion. It was also found that the majority of the pesticides were newly introduced and highly toxic chemicals. No one was concerned about long-term ill effects and consequence of pesticide use on human's health and environment. Almost all the farmers depended on chemical pesticides for the management of pest and diseases and most of them use moerately toxic chemicals but at 35% higher concentration than recommended level. Farmers' choice of pesticide was primarily based on efficacy rather than safety.

In the study area, 80% of the respondents were over mixing than using the recommended rate (Table 2). Some of them were using wrong mixtures in chemical use such as combining use of Marshal and Lannet. The reasons for over mixing were that recommended rates were not effective due to resurgence of pest to chemicals. Farmers were having low knowledge about pesticide use. Significant percentage (78%) of the farmers was concerned about the chemicals expiry date. About 72% of the farmers undertook the spraying themselves due to the reason that carelessness of labourers cost more for them in social and economical point of view. About 48% of the hired laborers did not consider wind direction while applying chemicals. Some of the farmers were also spraying in the evening because they were working in other sectors. But most of the hired labor was spraying in the morning and evening. These statistics show that most of the farmers were having medium knowledge about general knowledge of handling.

Table 2: The status knowledge on handling Pesticides

General Knowledge of handling	No. of farmers	%
Mixing ratio (over)	40	80%
Concern on Expiry date	39	78%
Concern on Wind direction	24	48%
Family labour	36	72%
Hired Labour	14	28%

Farmers did not adopt (Table 3) precautionary measures using fully body covers such as mask, gloves and caps when using all chemicals. Some of the farmers were saying that usually we cover our body when using harmful pesticides. Betel chewers and smokers almost totally avoided these habits during spraying. Farmers were in opinion that present chemicals were in less potent persuading them to over use chemicals. However, among the various pesticides used by farmers, nearly 50% of the brand used in the

study area falls under WHO categories of class I and class II, which were more frequently (70%) used by farmers compared to other pesticides. In the study area, 60% of the farmers take a bath with soap after spraying pesticides, indicating their concern on precautionary measures. These statistics show that most of the farmers were having medium knowledge about precautionary measures while handling and spraying pesticides.

Table 3: Knowledge on precautionary measures (When spraying harmful pesticide)

Practicing precautionary measures	No. of farmers	%
Wearing mask and gloves	5	10%
Wearing mask and wearing caps	8	16%
Wearing mask, gloves and caps	0	0%
Avoid chewing Betel	49	98%
Avoid smoking tobacco	50	100%
Cleaning body with soap before taking food	30	60%

Table 4 highlights that farmers were highly negligent in the proper disposal of empty containers. It was also observed that many small boutiques display the large size empty pesticide cans. In all, the knowledge on correct disposal method implied a high knowledge gap for farmer. It is recommended that burying is the safest method, but very few farmers (14%) had adopted this practice others threw them either on field or dumped in bush areas adjoining their field. About 22% of the farmers reuse and sell the empty bottles and large size cans to store kerosene, other oil items and used small size bottles to make oil lamp. About 16% of the farmers were burning empty plastic bottles. This shows that most of the farmers were having low-level knowledge about disposal and storage methods of pesticide.

Table 4: Knowledge of disposal and storage method

Method of disposal	No. of Farmers	%
Re using and selling	11	22%
Burying	07	14%
Throwing on land	24	48%
Burning	08	16%
Store in boundary of house	30	60%

Knowledge and awareness about ill effects of pesticides

Nearly 60% of the farmers had medium level of knowledge of plant protection practices. The average score of farmers' awareness about ill effects of

pesticide on humans' health and the environment was 25.44. This implies that most of the farmers were having medium level awareness. Most farmers preferred to prevent insect pest rather than control. Therefore, sprayed peticides to crops whether there was insects or pest to eliminate potential risk. Only 6% of the farmers had good level of knowledge towards the recomended plant protection measures and understanding of long-term ill effects of pesticides on their health and environment. The IPM strategy for vegetables and other food crops were not available.

Ordered probit regression analysis

The results of the probit analysis of the 50 observations are presented in Table 5. The goodness of fit of the model show reasonably high pseudo R^2 of 0.55 and significant at 1% level, which suggest that 54% of the variability in knowledge can be explained by the seven selected socio economic variables in the ordered probit regression model.

The ordered probit model focused on factors that influence the farmers' knowledge about the use and ill effects of pesticide on the environment and health. Farming experience and social participation were positive and significantly contributed to farmers' knowledge on the ill effects of pesticide use on humans' health and the environment. Education, incomes, age and family size of farmers had showed no relationship with the knowledge level of pest management. Social participation depends on existing institutional structures, particularly on mutual communication and information. It does not rely on the level of education, age and income.

Table 5. Factor influencing farmers' knowledge and use of pesticides

Log likelihood = -20.877862   Number of obs. = 50   LR chi2 (7) = 50.94
Prob › chi2   = 0.0000   Pseudo R2   = 0.5495

	Coef.	Std. Err	z	P›z	95%	Confidence Interval
FSIZE	-.0710	.1469	-0.48	0.629	-.3588	.2169
EDU	-.0325	.1351	-0.24	0.810	-.2972	.2323
EMP	-.0125	.1809	-0.07	0.945	-.3670	.3420
AINC	2.31e -06	3.57e -06	0.65	0.518	-4.69e -06	9.31e -06
EXP	.19651 **	.0550	1.57	0.000	.0888	.3042
LAND	-.05577	.2752	-0.20	0.839	-.5952	.4836
SOC	2.4313***	.7557	3.22	0.001	.9502	3.9125

Significant Level: ** P‹ 0.05 and *** P ‹ 01

Correlation analysis shows higher positive correlation of $r = 0.834$ of farmers' farming experience with farmers knowledge about ill effects of pesticide on the environment and health. Furthermore, those who were participating more in social activities were having high awareness about ill effects of pesticides on the environment and health. Farmers' social participation had positive significant correlation of $r = 0.614$ with farmers' knowledge about ill effects of pesticide on the environment and heath. The family size, nature of farming, annual income and operational land holding were insignificant and further farmers' annual income and farmers' education had negative correlation with farmers' awareness on ill effects of pesticide uses. However, experience and social participation, which reflect some ethical considerations borne by the people, provide some hope for safe use of chemicals.

Conclusion

The appraisal of the knowledge status of the vegetable cultivating farmers towards pest management indicated that almost all the farmers were dependent on chemical pesticides for the management of insect pest and diseases and most of them were using moderately toxic pesticides but at a very high frequency and dosage. About 60% of the vegetable-cultivating farmers were having a medium level of awareness and only 6% of the farmers were having a above average level about the pesticide use and their ill effect. Lack of knowledge on the ill effects of agrochemicals made them to over use chemicals and affects their health, sustainability of agriculture and the environment. Ordered Probit model results indicated that farming experience and social participation were positive and significantly contributed to farmers' knowledge and awareness of the ill effects of pesticide use on humans' health and the environment.

Increased social participation and, effective extension programmes are important to improve farmers' knowledge on proper use of pesticides and its effect on their health and environment. Agricultural extension need to be employed to follow a systematic, well planned and coordinated approach in the area for improving the knowledge status of vegetable growers towards pest management. In this regard there is a need for biological and social scientists to collaborate more closely to help farmers make better decisions regarding pesticide use.

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