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Factors Affecting Pesticide Use by Farmers in Vavuniya District

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ABSTRACT. *Pesticide related issues in Sri Lanka have become a major concern in the recent past. Present usage of pesticide in Sri Lanka is relatively higher than that in countries such as India, the Philippines, and Egypt. In this context, this study aims to answer the following questions; what is the extent of pesticide overuse by farmers? What are the determinants of pesticide use by farmers? What are the impacts of pesticide use on crop yield and farmers' health? In March 2007, 38 paddy cultivators and 34 chilli cultivators were randomly selected from three Agricultural instructor (AI) ranges in two divisional secretariat divisions in the Vavuniya district. Descriptive statistics and Ordinary Least Square methods were used for analysis.*

The estimated average amounts of active ingredients of pesticide applied were 1.9 kg and 11.5 kg/ha/yr for paddy and chilli, respectively. About 60% farmers had applied 30 - 40% higher concentrations than the recommended level. Econometric analysis revealed that high price of chemicals minimizes pesticide use and use of family labour in spraying tends to increase the use of pesticide. There were no significant relationships found between the strength of spray mixture use with farmers education, experience and crop extent. Farmers perceived high yield losses are due to pest attack. None of the farmers were well aware about the long-term and short-term effects on their health by wrong practices of pesticide usage. The hidden long-term health cost of pesticide usege should be investigated. Improvement in the awareness and the training programmes on the safe use of pesticides are indispensable for sustainable agriculture.

INTRODUCTION

The pesticide related issues have increasingly and extensively been highlighted in the media and have attracted sharp focus among industrialized and developing countries. A rough estimate shows that about one third of the world's agricultural production is lost every year due to pests despite pesticide use which totaled more than 2 million tons. According to the Food and Agriculture Organization (FAO, 2005), developing countries accounted for more than 99% of poisonings, although they accounted for 20% of worldwide pesticide use. At the beginning the majority of poisoning occurs in these countries due to easy access of more toxic products, less protection against exposure, limited knowledge to health risk and

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safe use of pesticides. Continuous use of pesticides has resulted in damage to the environment, caused human ill health, negatively impacted on agricultural production and reduced agricultural sustainability (Wilson and Tisdell, 2001). Indiscriminate use of pesticides and its detrimental effects are now of major concern in the medical and environmental sector in Sri Lanka.

Use of pesticides in Sri Lankan agriculture began in early 1950s, and since then the amounts used have shown a steady increase by almost 110 times between 1970 and 1995 (Wilson, 1998). There are 118 kinds of pesticides presently available in the market for use in crop production. Compared to a neighboring country like India, Sri Lankan farmers use stronger concentration of pesticide with increased frequency of applications, and also mix some pesticides together to combat pesticide resistance (Chandrasekera,*et al*.,1985). In 1996, Sri Lankan farmers applied 10.61 kg of active ingredient of pesticides per hectare a year, which is relatively higher than in countries like India, the Philippines, China and Egypt. Some empirical studies in the Philippines and Vietnam found that pesticide use reduces the yield and causes adverse impact on health. Dismally, the value of crop loss due to pest attack is invariably lower than the cost of pesticide, illnesses and the associated loss in farm productivity in many Asian countries (Nguyen and Tran, 1999; Antle and Pingali 1994,). Excessive reliance on synthetic pesticides has posed threats to the environment and health effects on farmers; even leading to death of farmers (Wilson and Tisdell, 2001). Hospital statistics in Sri Lanka show that on an average 14,500 individuals were admitted to government hospitals and around 1500 individuals annually died from pesticide poisoning during the period 1986 -1996 (National Poison Centre, 1997). Hospital statistics of the study area showed that 296 individuals were admitted and 36 died due to pesticide poisoning in the year 2004. Apart from hospital data, various field studies carried out in Sri Lanka have also confirmed high levels of morbidity from pesticide use ranging from headaches, faintish feelings, nausea, diarrhea, muscle switching, rashes and cramps (Hock et al., 1997; Dharmawardena, 1994). Ill health effects resulting from pesticides are a major health hazard in the agricultural sector in developing countries and the problem shows no signs of abatement (Maumbe and Swinton, 2003). Effects of pesticides occur in the short term as well as in the long-term. Farmers can experience short-term symptoms during spraying time and shortly after spraying. Ill health mainly results from careless use of pesticides. Average health cost for farmers in the Philippines and Vietnam was estimated to be US $ 32.83 and US $ 59.66 per year respectively. In Sri Lanka, Wilson (1998) has estimated that a farmer on an average incurs a cost of around US $ 49.33 (Rs. 5465.00) per year whereas estimates by contingent valuation method gave a higher figure of Rs 11, 471.00. Further the studies showed that 96 % of the respondents had suffered from short-term symptoms on typical pesticide spraying days but not leading to hospitalization or private treatment. Many studies in the United States have also documented on long-term illnesses arising from exposure to pesticide (Neilson and Lee, 1987). Human health hazards like cancer; kidney ailments and reproductive hazards are known to be the major delayed outcomes of careless use of pesticide. In all of these categories, farmers suffer private direct, indirect and intangible health costs arising from pesticide use. The direct costs include medical costs, dietary expenses resulting from illnesses, traveling costs associated with medical treatment, cost of hired labour due to inability to work and crop damage due to inability to stay in farms. The indirect costs are loss of workdays, time spent on traveling to get treatments and leisure time losses. The intangible costs include pain, discomfort, stress and suffering. Farmers also incur precautionary or defense costs. When all these costs are aggregated they are substantial to farmers.

In the context discussed above, the general objective of the study was to investigate the pattern of pesticide use and its impact on farmers' economy and health and use the results of this study to make improvements toward environmental friendly pest management in the Vavuniya District. The specific objectives of the study were:

1. To determine the perception of farmers on the effects of pesticide use
2. To evaluate the existing pest management practices in paddy and chilli cultivation.
3. To find out the major determinants of quantity of pesticide use on paddy, chilli cultivation.
4. To determine the health cost of labour involved in spraying activity by exposure to pesticide.

METHODS

Farmers' perception on pesticide use

In this study, farmers' perception towards pesticide externalities and health effects was measured in relation to cultural, mechanical and chemical plant protection aspects by using Likert scaling method. The response to each perception aspect was recorded as strongly agree (5), agree (4), neutral (3), disagree (2) and strongly disagree (1), for favorable statements and vice versa. To get an overall perception, total scores for all five response perceptions were summed up and then made into three major categories of high (>11), medium (5-10) and low (0-4) perceptions.

Tabular analysis was used to investigate the farmers' practices on pesticide handling and spraying. It pictures what farmers presently adopt on selection of pesticide and safe use measures when handling, spraying and storage. Concentration of spray mixture and frequency of application were also collected to calculate the amount of chemicals sprayed by the farmer per season per unit area.

Factors affecting pesticide use

To estimate the impact of chemical use on crop productivity, a multiple regression approach was used. The dependent variable, level of pesticide used by farmers, was measured by a ratio of actual amount of pesticides used to recommended level. The farmers' pesticide use level was hypothesized to depend on various socio economic, crop and chemical price variables. Such information was useful not only for a better understanding of farmers' behaviour on pesticide use, but for deciding a suitable strategy on improving present pest and pesticide management techniques.

It was the perceived view that amount of pesticide use can be influenced by farmer's education, farming experience, farming system, income, and type of labour involved in spraying, that is own/family labour or hired labour and chemical price. Thus, it was hypothesized that better educated and experienced farmers apply recommended quantities of chemicals. Farmers with higher income may use more chemicals than lower income farmers. It was also hypothesized that a low quantity of the chemical is used when its price is increased. The variables, their measurement and the expected relationships are given in Table 1. A linear regression model of the following form was fitted to estimate

results on pesticide use in paddy and chilli separately. The following model was estimated using the Ordinary Least Square (OLS) method.

$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8)$

Where, Y is the level of pesticide used by the farmer, Xs are factors affecting pesticide use by farmers (Table 2)

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 chilli, onion and vegetables.

Data collection

The study area covers three Agricultural instructor (AI) ranges in two divisional secretariat divisions of the Vavuniya district and 38 paddy cultivating farmers and 34 chilli cultivating farmers were randomly selected and interviewed at their sites by using a structured interview schedule. A pilot survey was undertaken to see whether the interview schedule was well suited for the study purpose and the appropriate information was gathered for meaningful analysis. Secondary data were extracted from the reports of the Department of Agriculture and base hospital, Vavuniya.

Table1. Expected relationship of selected variables and contribution to pesticide use ratio.

Independent variables (X)		Expected relationship
Education	(X1) No. of yrs in the school	Negative
Experience	(X2) No. of yrs of experience in farming	Negative
Income	(X3) Household monthly income (Rs.)	Positive
Labour	(X4) (Family labour =1; Hired labour =0)	Negative
Land extent	(X5) (hectares)	Negative
Age of Crop	(X6) (Long period =1; Short period =0)	Positive
Farming type	(X7) (Full time = 1; Part time = 0)	Positive
Price of pesticide	(X8) (Rs./ml)	Negative

Note: Dependent variable (Y): Ratio of actual pesticide use to recommended level

RESULTS AND DISCUSSION

Characteristics of households

The descriptive statistics of the collected data are given in Table 2. The average age of the household head was 47 yrs with 24 yrs of farming experience. About 22% and 28% of farmers have had less than secondary education and above respectively. Nearly 90% of the sample population is engaged in full time farming. About 1/3 of the sample was involved in both paddy and chilli cultivation while the remaining either do paddy or cash crops

cultivation. The average family income of the sampled population was Rs.13, 328.00 per month, with variation from Rs. 5,000.00 to Rs. 19,167.00.

Perception of effects of pesticides

Most farmers in the study area were unaware of the effects of pesticides and their opinion was that pesticides are less effective and this persuades them to overuse pesticides. Farmers' awareness about long-term effects of pesticides on health, beneficial insects, predators, crops and live stock was very low, with only about 11% of the sample population having an understanding of short term as well as long term effects of pesticides, while 36% and 53% are in the low and medium level of perception, respectively.

Table 2. Variable definition and descriptive statistics.

Variable	Definition	Mean	SD	Minimum	Maximum
Age	Farmer's age (yrs)	46.58	5.92	28	68
Education	Farmer's years of education	8.14	1.38	02	11
Land	Extent (ha)	2.56	0.36	0.6	5.6
Experience	Farming experience (yrs)	24.14	3.70	10	52
Price	Chemical price (Rs/ml)	3.02	0.17	0.11	12.5
Labour	Family labour	0.63	0.09	0	1
Farming	Fulltime =1; Part time =0	0.67	0.14	0	1
Income	Monthly household income (Rs)	13328	6677	5000	29167

The estimated pest related yield losses perceived by the farmers before the harvest in the study sample are presented in Table 3. The results showed that yield losses perceived by farmers were 50% for paddy and 74% for chilli. But according to well-to-do farmers who adopt mainly cultural practices of pest control the actual pest related yield loss was about 30% and 41% for paddy and chilli respectively. This explains that when farmers perceived high yield loss they tend to use more chemicals and also they expect quick return.

Table 3. Pesticide applied and farmers' perception on crop loss due to pest problem in paddy and chilli cultivation in Vavuniya District.

Crops	Paddy	Chilli
Active ingredients of pesticide applied kg/ha/yr	1.9 (0.6)	11.5 (4.7)
Crop loss expected	50 % (10)	74 % (19.8)
Experience of well-to-do farmers	30% (6)	41% (9)

Note: Figures in parenthesis are standard errors.

Pesticide use

The estimated average amounts of active ingredients of pesticide applied were 1.9 kg and 11.5 kg/ha/yr for paddy and chilli crops respectively (Table 2). Among the various pesticides used by farmers, nearly 50% of the brand used in the study area falls under World health organization categories of class I and class II which are comparatively highly toxic to

humans. Most of the class II categories are insecticides which are highly used by farmers in chilli cultivation compared to other pesticides.

The study further found that in pesticide selection, most farmers (60%) firstl use their own experience and then go for other sources, discussion with fellow farmers (23%), pesticide dealers (7%) and advice from extension workers (10%). Farmers usually approach the extension workers when spread of pest incidence is high, also to know about new chemicals for pest control. Farmers who usually visit the Agrarian Centre for input purchases have close contact with extension workers.

Farmers in the study area used minimum protective clothing during handling and spraying of pesticides. About 45% of farmers of the total sample underwent training on safe use of pesticides. No one wore proper protective clothing as it was expensive (32%), also hard to wear in sunny conditions (23%) and current chemicals were perceived to be less poisonous (44%). The common dress they wore when spraying was long sleeve shirts either with sarong or trousers. About 20% of the total farmers interviewed had a set of clothes for spraying activity only. Betel chewers had totally avoided this habit during spraying operations whereas among the smokers who are mostly hired labourers, only 50% stop smoking while spraying.

About 33% farmers hired labour for their spraying activity. About 95% farmers used pesticide-measuring lid instead of bottle lid during mixture preparation. Farmers were highly negligent in proper disposal of empty containers; only 2% of farmers bury the empty containers, others throw them either on field bunds or dump in bush areas adjoining their field. More than 30% of the farmers keep pesticides in a bag hanging on their rear side of the house and other farmers keep them on the farm without any safety measures. The average spray time per day varies highly with the type of labour. More than hired labor, farmer himself sprayed more hours; it was 4.6 and 6.8 hrs per day respectively (Table 4). Farmers usually spray only in the morning whereas hired laborers are engaged both the morning and in the afternoon as they are paid Rs.30/= per tank instead of day wages. Average spray time per tank (with double nozzles) for family labour and hired labourer is 0.3 and 0.2 hrs, respectively

Table 4. Handling and spraying exposure to pesticides in Vavuniya district.

Direct exposure time day	Average hours of a typical spraying	
	Family labour	Hired labour
Spraying hours per day	4.0 (0.61)	5.8 (0.73)
Handling and mixing hours per day	0.6 (0.04)	1.0 (0.02)
Total	4.6 (0.65)	6 .8 (0.75)

Note: Figures in parenthesis are standard errors

Over-dosage and frequency of application of pesticides were common practices among farmers in the study area. About 65% of chilli crop cultivators applied pesticide to their crops before appearance of any pests or symptoms as a precaution. Lack of legal framework, strong campaign toward pesticide use and farmers' attitude had contributed to increasing pesticide application. More than 60% of farmers used 30% to 50% higher

concentration of pesticides over the recommended level despite 52% having higher knowledge and 45% having average knowledge on safe use of pesticides. Concentrations of mixture for spraying are decided by their own experiences. They did not adhere to the recommendation, even though most farmers (70%) read instructions. However for herbicides use, 90% farmers adopted either recommended or closer to the recommended level (Table 5).

Table 5. Range on level of pesticide use by farmers in relation to recommendation.

Type of pesticides	Farmers use range in relation to recommendation (%)			
	Average	Minimum	Maximum	SD
Herbicides	110	80	120	12.5
Insecticides	135	80	160	19.7
Fungicides	127	120	140	16.3

Table 6. Regression results of OLS model for the important attributes.

Variables	Paddy			Chilli		
	Coefficient	T-ratio	P-value	Coefficient	T-ratio	P-value
Nature of farming Family	0.1226	1.14	0.2562	0.0702	0.30	0.7661
Family labour	0.0768	2.83	0.0054 **	0.0271	0.09	0.0301
Experience	0.0022	0.70	0.4821	-0.0011	-0.17	0.8623
Education	-0.0073	-0.52	0.6055	-0.0068	-0.20	0.6438
Crop age	0.0035	0.06	0.9558	-0.0101	-2.71	0.0587**
Land extent	-0.0001	0.02	0.9872	0.0195	0.13	0.8987
Income	1.0989	0.30	0.7625	1.5398	-0.02	0.9818
Chemical price	-0.0501	-2.31	0.0225**	-0.0501	-2.47	0.0650**
Constant	0.8485	2.64	0.0092**	1.5743	2.06	0.4400**
R-Square	0.3904			0.3979		
R-Square adjusted	0.3577			0.3776		
F value	2.12			2.65		
No. Observations	36			34		

Note: *significant at P = 0.10 and ** significant at P = 0.05.

Determinants of pesticide use

The OLS models in Table 6 show robust results. Both models show reasonably high coefficient of determination values ($R^{2)}$ of 0.358 and 0.378 for cross-sectional household data. The model focused on whether quantity of pesticide used is significantly influenced by nature of farming, farming experience, income, age of the crop, and crop extent, type of labour and chemical price. There were significant relationships of family labour and price of chemicals to ratio of pesticide use over the recommendation. Family labour had positive relationship. Farmers had a tendency to use more chemical as they took more care and spend more time to spray. Farmers sprayed 15 to 25 L more spray mixture for an acre compared to hired labourer. Therefore, it necessitates that the farmers be made well aware of adverse effects of pesticides in addition to safe use of pesticides.

Chemical price had a negative relationship to the amount of pesticides use. When the price of chemicals increase farmers reduce the amount of chemical use and also take care while handling and spraying of high priced chemicals. If prices of high toxic chemicals are maintained at a little higher level over other categories, it leads to a decline in the use of highly poisonous chemicals.

There is no significant relationship found between the strength of spray mixture use with farmer's education, experience and crop extent. However, in chilli, crop age has a significant negative relationship with chemical use. Short age crops such as onions are intensively sprayed with high amount of chemicals within a period compared to long age chili crops.

Cost of illnesses due to pesticide spraying

Illnesses due to spraying were recorded only among six farmers in the study sample. Common illnesses were fainting, vomiting, eye irritation, headache, fever and diarrhea. Except in the case of fainting three other farmers undertook home made treatment by drinking thick squeezed coconut milk. They did not go for private treatment. When they feel ill after spraying, they chew betel to diagnose whether their body has been poisoned by the symptoms such as heavy body sweating and uneasiness in throat. Average health cost among the affected farmers was Rs.2, 325 per year. The danger posed to humans by long-term effects of pesticide is currently suspected to cause various diseases like cancer and kidney ailments. Failure to find relationship between health costs and chemical spraying of this study calls for more in-depth investigation.

CONCLUSIONS

Excess and careless use of agrochemicals is a common practice prevalent in the study area. Farmers have limited knowledge and awareness on health risks, particularly the long-term effects of chemicals and safe use of pesticides. They often ignored technological recommendations and use their own experiences, which lead to indiscriminate use of pesticides. None of the farmers were well aware about the long-term effects on their health by such wrong practices and short-term health effects were minimal.

It is a fact that farmers need more information on the health impact of pesticide use and that safety training needs to be improved. There is a need for general improvement in the use and handling of pesticides. It is recommended that the hidden health cost of pesticide use should be investigated in-depth rather than short-term effects. Further, it is necessary to restrict the availability of the more toxic pesticides in order to decrease their usage and also it is recommended that a tax should be implemented on hazardous chemicals to reduce the use of pesticides.

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