Effect of Pesticides on Paddy (*Oryza sativa*) Productivity in Hingurakgoda Area of Polonnaruwa District.

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ABSTRACT

The extensive yield losses incurred in rice by pests (Insects, Weeds and other Pathogens) and detrimental effect of pesticides on farmers' economy are immense. Inefficient uses of pesticides have negative impact on farmers' economy, health and environment. The purpose of this study was to determine the relationship between the pesticide doses applied in paddy farming and the paddy productivity, to asses the loss of excess amount of pesticide used by farmers and, the percentages of wastage of pesticides under prevailing farming conditions. Data were collected from a sample survey of seventy five paddy farmers in Hingurakgoda area in Polonnaruwa district.

The results of the analysis indicated that the amount of pesticides applied was far higher than optimal level for profit maximization. Further it revealed that, the farmers apply excessive amounts of herbicides, insecticides and fungicides far higher than the recommended doses for paddy cultivation by 63 percent, 18 percent and 19 percent respectively, resulting a parallel decline of the net income.

KEY WORDS: Input loss, Paddy productivity, Pesticides.

INTRODUCTION

Rice is the staple food of the people of the country and paddy farming is the main source of income for the majority of the rural population in Sri Lanka. On average, 560,000 hectares are cultivated during *maha* season (Anon, 2004[a]). Out of that 54,356 hectares are cultivated in Polonnaruwa district (Anon, 2005).

Insect pest are the major constraint in achieving higher production in paddy. In Sri Lanka, nearly 10 to 20 percent of the annual rice production is lost due to insect pest (Nugaliyadde *et al*, 2000). In addition to that, other wide spectrum such as diseases, weeds and mammals also cause to reduction of the paddy yield. Among them, grassy weeds are the main biotic problem in rice especially in the dry and intermediate zones while broad leaf and sedges are the dominant in wet zone (Hector, 1999).

Under the Mass Rice Production Intensification Program (1960s to 1970s) pest problems were controlled by using a unilateral method with only pesticides. Because of that, they had come to believe pesticides are the main assurance for high production. Therefore paddy farmers applied chemicals three to four times at regular intervals to eradicate the pest.

Eighty six percent of the farmers, who reported pest problems, had applied pesticides to control the pest. Furthermore, seven percent did not apply anything, three percent used bating and small proportion of farmers resolved to traditional methods in Sri Lanka (Dissanayaka *et al*, 2003).

Farmers had tended to increase input application overtime to sustain yields under intensive cultivation system, because, most of the farmers have similar behaviors and attitudes, towards pesticides usage in managing pest, diseases and weed. Therefore, they mainly found to emphasize more on killing insects or eradicating weeds from the field by using highly toxic pesticides with high doses. Especially, Asian farmers do not typically utilize recommended doses of pesticides (Antle *et al*, .1994). When increasing the input application of paddy cultivations, with the purpose of increasing the yield, it causes to raise the cost of production. Consequently, gain of farmers will be reduced.

However a continuous increase in pesticides applications in excess of the necessary level causes spillover effects on economic return, and also badly affect to the ecology, and especially on farmers' health. The income earned from paddy is not sufficient to fulfill basic needs of the family (Weerahewa, 2003). Therefore, poverty is prevalent among paddy farmers, especially who cultivate on a small scale. To liquidize above mentioned issue it is essential for paddy farmers to keep the pesticide amounts at the optimal level in order to maximize profit

The main objective of this study was to determine the relationship between the pesticide doses and paddy productivity. Simultaneously, to identify the excess amount of pesticide used by farmers and, the percentages of wastage of pesticides under prevailing farming conditions.

METHODOLOGY

Sample Selection

Polonnaruwa District was purposively selected for the study, as it has a large potential for Paddy cultivation. The yield and net income from paddy cultivation are recorded highest in Polonnaruwa district indicating 2332 kg/ha and a net return of Rs 19,777/ha whereas Rs 27,950 ha if the farmers used his own inputs (Anon, 2004b). Out of entire areas in Polonnaruwa, the highest yield per hectare recorded Hingurakgoda area was selected for the study.

Data Collection

Primary data were collected using pre-tested questionnaire. Field survey was conducted from May to July 2006. Seventy five Paddy farmers were selected through random sampling Technique.

Estimation Procedure

The empirical analysis of this study relied on two procedures. Initially, production elasticity and optimal level of pesticide were derived from the productivity function model. Then, graphical method was used to estimate the pesticide wastage amounts by farmers.

1. Paddy Productivity Function.

Simple Cobb-Douglas regression function can be used to determine the relationship between the paddy productivity and the pesticide doses. If coefficient of pesticide amount variable becomes insignificant the productivity will be zero. To remove that error the Transcendental function was used to relate material inputs to Paddy yield in order to examine pesticide productivity.

$$Y=AX_1^{\beta_1} X_2^{\beta_2} X_3^{\beta_3} X_4^{\beta_4} e^{\beta_5 X_1 + \beta_6 X_2 + \beta_7 X_3 + \beta_8 X_4}$$

This function in logarithm form is expressed as follows;

$$lnY = \ln A + \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \beta_4 lnX_4 + \beta_5 X_1 + \beta_6 X_2 + \beta_7 X_3 + \beta_8 X_4$$

Where;

Y = Productivity (kg/ha)

β_0-β_8 = coefficients

A = constant

X_1 = Seed amount (kg/ha)

X_2 = Fertilizer amount (kg/ha)

X_3 = Man day/ha

X_4 = pesticide amount (l/ha)

2. Optimal level of pesticide for Profit Maximization.

To determine the optimal amount of pesticide used, under the assumption of profit maximization behavior, the following relationship was derived:

The Marginal Physical Product (MPP) of pesticides was equated to the ratio of the pesticide and paddy price that is;

$$MPP = dy/d\text{Pesticide amount} = p_p / p_y$$

Thus,

$$MPP = \beta_4 (Y/ \text{ pesticide (l/ha)}) = p_p / p_y$$

Then, will be;

$$\text{Pesticide amount} = (\beta_4 . Y . p_y) / p_p$$

Where;

β_4= production elasticity of pesticide

MPP= Marginal Physical Product of Pesticides

p_p = unit price of pesticide (Rs/l)

p_y = farm gate price of paddy (Rs/kg)

3. Descriptive statistics.

To determine the pesticide wastage was done by the paddy farmers, descriptive statistics was used. In order to get the idea about how much pesticide were used than the recommended amounts.

RESULTS AND DISCUSSION

The summarized statistics related to the variables used for the analysis are depicted in Table1. Paddy productivity varied 1867 kg/ha to 9167 kg/ha. Pesticide amount per hectare (l/ha) had varied from 0.33 to 11.25. And also fertilizer amount had varied from 146.9 kg/ha to 1083.3 kg/ha. The minimal value of seeds cost per hectare was zero, because some of the farmers had used their own seeds and cost of those inputs had not incurred in determining the expenditure. An average of 2 liters and 54 milliliters of pesticides (herbicides, insecticides, fungicides) had been applied.

Table 2 - Transcendental result:

Variable	Coefficient	Std Error
Constant	9.204	1.914
*ln*seeds/ha	0.233*	0.132
*ln*Fertilizer/ha	0.086**	0.368
*ln*Man day/ha	0.114	0.221
*ln*Pesticide/ha	-0.120	0.103
Pesticide/ha	0.035**	0.036
Fertilizer/ha	0.001	0.001
seeds/ha	0.001	0.001
Man day/ha	0.001	0.005

*Significant at 5% ** Significant at 10%

R^2 (Adj) =0.7942

The results of the Transcendental regression for the entire sample are shown in Table2. The *ln*pesticide/ha coefficient is small and insignificant, but in the Transcendental form the pesticide/ha coefficient is significant, indicating that the pesticide input has little productivity at current use level and is therefore 'overused'. Yield increases by 0.86 units corresponding to a ten units rise in the amount of fertilizer used. Similarly, ten units increase in the total dose of pesticide per hectare will contribute to micro- increases of 0.35 units of yield

Hence, economic value of the returns and the expenditure on pesticides should be considered before increasing the pesticide doses. This raises the question of what optimal level of these chemicals should be applied so as to get maximum profit, given current farm- gate prices.

Table 1 - Descriptive statistics for variables in the production function for Paddy farmers:

variables	Minimum	Maximum	Average
Productivity (kg/ha)	1867	9167	5101.91
Seed cost (Rs/ha)	0	5000	2597.264
Power cost (Rs/ha)	956	33083	6930.98
Labor cost (Rs/ha)	0	46417	15847.88
Fertilizer (Rs/ha)	1750	10813	3809.367
Fertilizer amount (kg/ha)	146.9	1083.3	510.637
Labor /ha	9.58	107.5	47.92
Pesticide amount (l /ha)	0.33	11.25	2.544
Pesticide cost /ha	1300	9850	4179.932
Farm gate price (Rs)	12	18	16.36
Pesticide cost (Rs/l)	*	*	2143.35

Optimal level of pesticides for profit maximization

Given the average yield (5101.91kg/ha) and prices of paddy (16.36 Rs/kg) and pesticide (2143.35Rs/l), the optimal level of pesticide that farmers should applied in the Maha season for profit maximization is;

$= (0.035 * 5101.91 * 16.36) / 2143.35$

$= 1.363$ l/ha

However, the mean level of pesticide used in the Hingurakgoda area was 2.544 l/ha and it indicates that the farmers had overused pesticides by 1.181 l/ha. Consequently, farmers profit was reduced by Rs 2531.23 per hectare as the result of uneconomical use of pesticides in their paddy farming. Profit maximization is attained at the optimal level; therefore any increase in pesticide use higher than the optimal level is really not a rational investment. Furthermore, in the trend of overusing pesticide, there is a definite damage to environment and are creating health problems. Figure 1 shows the overuse of pesticides by farmers.

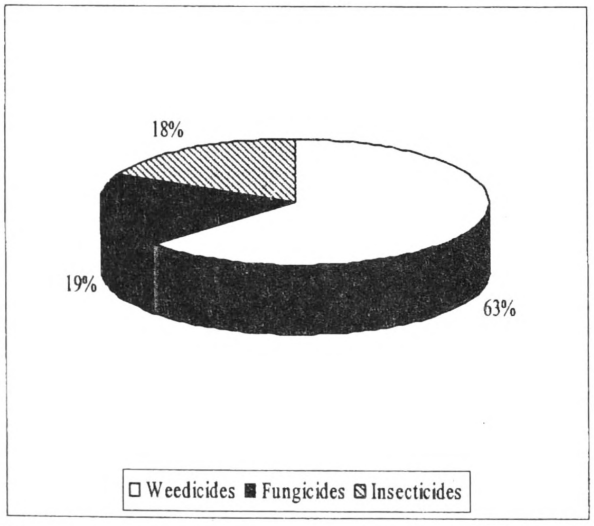

Figure 1 - Farmers overused pesticides:

The excessive use of herbicides, insecticides, and fungicides amounted to 63%, 18% and 19% per hectare respectively indicating that the farmers do not apply pesticides according to the recommended quantities. (Figure 2.)

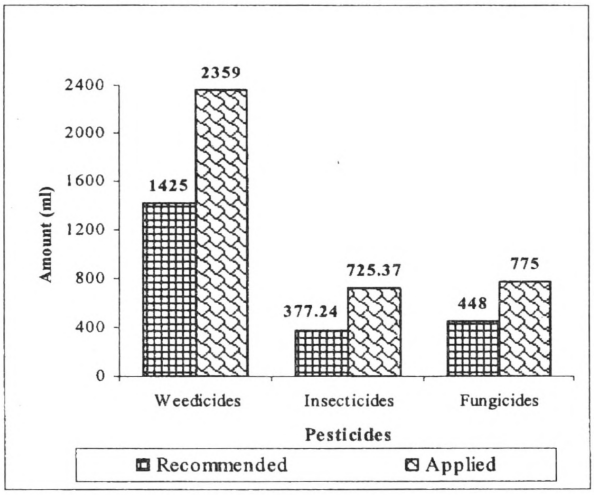

Figure 2 - Pesticide application variation /ha with Recommendation:

Yield losses due to pest.

Yield losses caused by pest in paddy have been estimated by different researchers ranging 10%-20% of rice production. On farm weed control studies have reported that farmers loose about 28% of their potential rice yield in the low country wet zone due to poor implementation of weed management practices (Nugaliyadde *et al*, 2000).

Yield losses because of paddy pest, is greatly affected to the agricultural economics in Sri Lanka. These losses were illustrated in Table 3, which shows the per hectare yield losses in both quantity and monitory terms.

Table 3 - Yield losses per hectare:

	Average yield losses per hectare
Kg	510.19 - 1020.38
Rs	8346.72 - 16693.44

It was revealed that the yield losses due to pests affected the farmers' economy immensely. The results showed 510.19 kg/ha - 1020.38 kg/ha yield was reduced from paddy farmers' production when they did not apply pesticides. Furthermore it was also revealed that 8346.72 - 16693.44 Rs/ha was wasted form their income when farmers' neglect to apply

pesticides (Table 3). To obtain optimum yield farmers have tended to implement pest control methods. Although non chemical methods were promoted, chemical methods become the predominantly adopted cost effective option among 90% farmers (Nugaliyadde *et al*, 2000). However the analysis was revealed that farmers not applied the optimal pesticides doses to gain optimal income. Further, it was also negatively affected to farmers' income by input loosing.

Thus, an additional 1.181*l* of pesticides for the farm implied extra input cost approximately Rs 2531.23 per hectare. The excess usage of pesticides per hectare was depicted in figure 3.

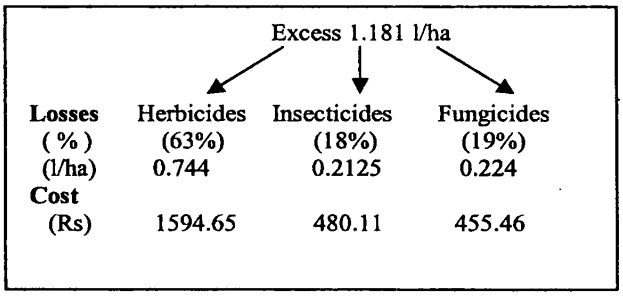

Figure 3 - Input losses:

According to the above results, it was identified that farmers' income is higher even applied excess amount, up to the 1.181 l/ha pesticides than without application of pesticides (considered only income part, not environment and farmers health effects).

CONCLUSIONS

According to the above findings the inappropriate pesticide usage was affected to the farmers' economy. The policy makers who deal with promotions have to consider the detrimental effects of the pesticides, when deciding the promotional policies in Sri Lanka.

An effective extension services focus on IPM (Integrated Pest Management) may be minimizing the usage of pesticides that would lead to obtain optimal income of paddy farmers.

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