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# SOCIO-ECONOMIC CHARACTERISTICS AND PESTICIDE MISUSE IN PHILIPPINE VEGETABLE PRODUCTION

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# Socioeconomic Characteristics and Pesticide Misuse in Philippine Vegetable Production

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## ABSTRACT

The results of two farm-household level surveys were analyzed in a logit analysis to assess socio-economic factors influencing pesticide misuse on vegetables in the Philippines. Reduced misuse is associated with age, education, pest management training, and credit from a cooperative. Increased misuse is associated most strongly with visits by chemical company representatives or by Department of Agriculture technicians. One problem with technician visits may be the absence of IPM strategies for technicians to impart; another problem may be the training they receive from chemical company representatives.



## KEYWORDS

Pesticide misuse, logit, socio-economic, vegetables


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# Socioeconomic Characteristics and Pesticide Misuse in Philippine Vegetable Production

## INTRODUCTION

Since World War II, increased use of pesticides has contributed to sizeable productivity gains in agriculture worldwide. The result has been a growing market for pesticides, including ones that are potentially hazardous to the environment and human health. Dangers to the environment and health are particularly strong in developing countries where environmental laws tend to be lax and the public is little aware of potential problems. For example, scientists at the International Rice Research Institute (IRRI) have found that injudicious use of insecticides in the Philippines, particularly early in the growing season, are disrupting the natural ability of the rice ecosystem to cope with pest infestations. And, they have found that unsafe application practices are damaging farmer health (Rola and Pingali, 1993). A farmer survey (Lazaro et al., 1995) and participatory appraisal activity with rice-vegetable farmers in Nueva Ecija province in the Philippines found both heavy pesticide use on onions, eggplant, and yard-long beans as well as apparent pesticide misuse (Litsinger et al., 1995).

Pesticide misuse can have several dimensions. From the farmers' perspective, pesticide misuse occurs whenever a pesticide is applied such that its choice, amount, or timing fails to control the pest in an economically optimal manner or if the pesticide is applied in a way that causes health problems for the farmer or farm family. From society's standpoint, optimal pesticide use considers off-farm environmental and health costs associated with pesticide use as well. Pesticide misuse can have both short- and long-run impacts. Short-term impacts include acute human health problems, potential productivity losses, and decreased water quality on or

near the farm. Long-term impacts can include surface and groundwater pollution, increased pesticide resistance and pest resurgence, reduction in natural enemy populations, danger to animal species, and long-run harm to human health.

Despite these potential problems, pesticide misuse persists, particularly on vegetable crops that are vulnerable to a wide range of pests. In order to assess social, economic, and other factors influencing pesticide misuse on vegetables in the Philippines, the results of two farm-household level surveys were analyzed using logit analysis. The purpose of this paper is to review the results of that analysis and to suggest actions that might reduce pesticide misuse.

## DESCRIPTION OF STUDY AREA AND PEST MANAGEMENT PRACTICES

Six villages in the area around San Jose City in Nueva Ecija were targeted for the analysis. The San Jose area has a total of 18,725 hectares, 92,000 people, 4800 farm families, and the six villages comprise approximately 44 percent of the total agricultural land in San Jose. The area contains eight retail outlets for pesticides, nine banks, and 34 farm cooperatives.

Nueva Ecija is in the Central Luzon, the rice bowl of the Philippines, but San Jose also produces substantial amounts of vegetables during the dry season and is considered the heart of the onion growing area in the country. An interview survey of 300 farmers, 50 from each of the six villages, found that 77 percent produce both rice and vegetables, 18 percent produce only rice, and 5 percent produce only vegetables (Lazaro et al, 1995). Over 90 percent identified onions as their primary vegetable crop.

Farmers planted an average of 0.65 hectares of dry season vegetables and 1.1 hectares of wet season rice, and earned roughly four times as much from their vegetables as their rice. All farmers were able to describe the pest damage in their fields, but had difficulty identifying specific pests that caused the damage. Pests named by farmers were general categories and included worms, thrips, hoppers, whiteheads, moths, and butterflies. Damping-off and bulb rot were mentioned as fungal diseases. Forty-five percent of vegetable producers were aware of natural enemies, but the "natural enemies" mentioned most were spiders and dragonflies.

Pest control was considered important by vegetable farmers with over 98 percent applying pesticides on their most recent vegetable crop. Half of the farmers believed that pesticides must be sprayed before the crop is four weeks old. Another 20 percent sprayed pesticides when pests were identified in the field or at the first sign of damage. Twelve percent sprayed at least once per week. Many farmers sprayed by the second week after planting. The average number of applications was four, with a few farmers spraying up to 24 times per season. Several farmers had no particular pests they were targeting with pesticides and used whichever pesticide was available. A follow-up survey of 228 of the original 300 respondents was conducted to obtain information on their social and economic characteristics. Seventy-eight percent of the respondents were between the ages of 31 and 60. Fifty-three percent owned the property they farmed, 29 percent were tenants or lessees, and the remainder were either hired laborers or holders of a pre-ownership "certificate of land transfer". Only one respondent had no schooling while 43 percent had only primary schooling, 45 percent had some high school training, and more than 11 percent had attended college.

Seventy-two percent of farmers received credit, with major sources being: cooperatives/land banks, 28 percent; relatives/neighbors, 34 percent; money lenders, 52 percent; and traders, 4 percent. Thirty-four percent received credit "in kind" as pesticides.

Advice on pest management came from a variety of sources. Fifty-five percent had attended or a family member had attended an IPM extension training program on rice called the Farmer Field School. Fifty-eight percent had been visited by an agricultural technician (extension agent) to discuss IPM. When reporting the most important factors and/or sources of information in deciding which pesticides to use on vegetables, 58 percent listed pesticide price as extremely important. Smaller percentages listed the advice of the agricultural technician (20%), chemical company representative (14%), retail pesticide dealer (12%), or neighbor (5%) as extremely important. Seventy-eight percent believed pesticides can harm water quality and 73 percent believed that water quality on their own farms has been affected by pesticides.

In addition to the two farmer surveys, a participatory appraisal (PA) was held in the villages during which a multi-disciplinary team of scientists were able to probe in more depth pest management practices and beliefs, institutional factors affecting pesticides use, and other factors. The PA revealed the potential importance of credit policies and cooperatives in influencing pesticide use or misuse.

## *METHODS*

Several studies have used a limited-dependent-variable approach to determine factors affecting technology adoption in agriculture, including several that have assessed factors affecting adoption of integrated pest management (IPM) technologies (Burrows, 1983;

McNamara, Wetzstein, and Douce, 1991; Rook and Carlson, 1985; Napit et al., 1988; Harper et al., 1990; Thomas, Ladewig, and McIntosch, 1990; and Fernandez-Cornejo, Beach, and Huang, 1992). However, no studies have considered factors influencing *misuse* of pest control.

Pesticide misuse in vegetables is a multi-faceted phenomenon. The Philippines pesticide misuse analysis focused on the timing of pesticide applications on onions, specifically whether pesticides were sprayed during the seedling stage for thrips (thrips tabaci), worms, and ants. Onions were the primary vegetable crop for more than 90 percent of the farmers and thrips are not a threat to onions until after the seedling stage as the plant is too small to protect the thrips from other mortality factors. Using pesticides for worms in the seedling stage is misuse because the leaves of the onion plant are too small and narrow for the moths to lay eggs on. Spraying for ants is misuse as many species of ants are natural enemies to pests. The reason for focusing on the seedling stage is that other aspects of misuse are still being identified more specifically through the field work of entomologists, plant pathologists, and weed scientists in San Jose.

Several factors were hypothesized to affect pesticide misuse during the seedling stage, including producer characteristics, farm structure and institutional arrangements, sources of pesticide information and pesticide and pest management perceptions. Among producer characteristics, the variables included in the model are: age (AGE), education (EDUCN), access to IPM training (FFS), exposure to pest management information from an agricultural technician (VISAGT), tenure status (TENSTAT), and membership in an organization (MEMBER). It is anticipated that the likelihood of misuse increases with age as older farmers may be slower to change practices and be less concerned about health effects of pesticides, which may not occur for several years. Increased education is expected to reduce pesticide misuse because farmers

are more likely to read pesticide labels and seek out other sources of information.

If the farmer or a member of their family has attended a Farmer Field School, the farmer is considered to have access to IPM training, which is expected to reduce pesticide misuse. The same is expected if the farmer has been visited by an agricultural technician, or has more secure tenure. Membership in a cooperative, farmer's association, or village association is expected to decrease pesticide misuse as these organizations provide a forum for discussion on production practices including IPM. However, cooperatives often purchase pesticides in bulk which may encourage excessive pesticide use and these organizations might be providing incorrect or biased information on pesticides. Also, some credit sources used by cooperatives require farm plans that encourage excessive pesticide use.

Pesticide misuse is expected to decrease as the number of working family members (LABOR) besides the farmer increases. As the number of farm laborers increases, the use of alternative pest management practices becomes more probable as the alternatives are often more labor intensive than pesticides.

The effect of receiving credit (BORROW) should increase pesticide misuse as farmers may be pressured by creditors to use pesticides. If the source of the credit is a cooperative/Landbank (COOP), the probability that a farmer will misuse pesticides may increase due to the requirement of a farm plan, but if the source of credit is a friend, relative, neighbor (FRN), or money lender (ML), the likelihood of pesticide misuse may be relatively less. Receiving pesticides in-kind as part of a loan (KINDPES) should also increase the chances that a farmer will misuse pesticides.

Farmers were asked to rank on a scale from one (extremely important) to four (not important), the influence of price (cost) and of five sources of information in deciding which pesticide to use. These information sources include: agricultural technician (AGTECH), pesticide dealer (PESTDEAL), chemical company representative (CHEMCO), neighbor (NBOR), and the FPA pesticide safety label (SAFETY). Increased importance of pesticide price and advice from a pesticide dealer or chemical company representative is expected to increase pesticide misuse. Information from an agricultural technician and FPA safety label would reduce it.

The perceptions that killing natural enemies will hasten pest infestation (NENEMY) or harm water quality (WAQUAL) are expected to reduce pesticide misuse. Farmers may be less likely to misuse pesticides if they believe they will reduce water quality on their own farm. Finally, farmers who have been personally harmed by pesticides either by their farm's water quality having been affected or by someone in their family having become ill from pesticides (IMPACT), will be less likely to misuse pesticides.

## STATISTICAL PROCEDURE

The pesticide misuse analysis uses a logit model in which a dependent variable value of 1 indicates pesticide misuse. In the general bivariate logit model, the probability of pesticide misuse by the *i*th farmer is given by $P_i = F(B'X) = 1/[1 + \exp(-B'X)]$, where F is the cumulative distribution function. The log likelihood function of the general multinomial logit model is $\log L = \sum_{i=1}^{n} \sum_{i=1}^{m} Y_{ij} \log P_{ij}$, where $Y_{ij}$ is a dummy variable equal to 1 if individual *i* falls into the *j*th category and 0 otherwise. It is assumed that each producer's objective function

contains a nonstochastic portion which equals $B'X$ where $B$ is a row vector of parameters and $X$ is a column vector of the exogenous variables. The model is estimated using maximum likelihood.

The parameter estimates provided by the logit model do not provide the change in probability associated with the change in an explanatory variable. Instead, the marginal effects must be computed using the following equation: $\partial P_i/\partial x_{ij} = \beta_j P_i(1 - P_i)$, where $\beta_j$ is the initial parameter estimate for independent variable j. These probabilities are provided for each variable.

The overall significance of the model is measured two ways. Goodness of fit is evaluated using the McFadden $R^2$ which is defined as: McFadden $R^2 = 1 - [\text{Log } L(\beta_{ML}) / \text{Log } L_0]$, where Log $L(\beta_{ML})$ and Log $L_0$ are the log-likelihood values of the restricted model and unrestricted model respectively. The McFadden $R^2$ equals zero when the likelihood function with all parameters is no greater than the likelihood function with the constraint that all parameters equal zero except the constant. The predictive ability of the model is judged by the number of correct predictions divided by the total number of observations. A variation of this measure is reported for each outcome by dividing the number of correctly predicted misusers or non-misusers by the number observed. Significance levels of variables are reported as well.

Data used in the analysis are from the IPM-CRSP baseline and follow-up baseline surveys. The final sample used for the logit analysis included 164 observations, with only those farmers included who listed onions as their main vegetable crop. AGE, EDUCN, and LABOR were included as continuous variables, information sources were included as a ranking from 1 to 4, and all other independent variables were included as intercept dummies.

## RESULTS

Results of the logit analysis are presented in Table 1. The initial model has a log-likelihood value of 72.49 and a McFadden $R^2$ of 0.214. A McFadden $R^2$ of between 0.2 and 0.4 is typical for logit models (Sonka, Hornbaker, and Hudson, 1989). The model's chi-squared value is 39.45 which is significant at 1.77 percent. Of the 164 total observations, 80 percent are predicted correctly, with 92 percent of misusers and 44 percent of non-misusers correctly predicted.

Variables in the model that are significant at least at the 20 percent level include: AGE, EDUCN, FFS, VISAGT, MEMBER, BORROW, COOP, FRN, ML, KINDPES, CHEMCO, and WAQUAL. The only variable significant at 1 percent was CHEMCO. As the farmers reduces the level of importance given information from a chemical company representative when deciding which pesticide to use (e.g. from extremely important to very important, etc.), the probability of misusing pesticides decreases by 16 percent. MEMBER is significant at the 5 percent level, as membership in a cooperative, village association or farmers' association increases the probability of pesticide misuse by 20 percent.

Significant at the 10 percent level are AGE, EDUCN, FFS, VISAGT, and COOP. Contrary to expectation, as age and education increase, the probability that the farmer misuses pesticides decreases. Access to IPM training (FFS) has the effect of reducing misuse by 15 percent as expected. Contrary to expectations, a visit by an agricultural technician to discuss

## TABLE 1
## Socio-economic determinants of pesticide misuse in San Jose City.

| Variable | Coefficient | Standard Deviation | Significance Level | Probability Effect |
|---|---|---|---|---|
| Constant | 4.1596 | | 0.0558 | 0.6409 |
| AGE | -0.0033 | 12.3700 | 0.0990 | -0.0005 |
| EDUCN | -0.7128 | 0.6754 | 0.0566 | -0.1098 |
| FFS | -0.9795 | 0.4919 | 0.0611 | -0.1509 |
| VISAGT | 0.8243 | 0.4864 | 0.0094 | 0.1270 |
| TENSTAT | -0.1741 | 0.4952 | 0.6940 | -0.0027 |
| MEMBER | 1.2743 | 0.5014 | 0.0198 | 0.1963 |
| LABOR | 0.1672 | 1.3107 | 0.3821 | 0.0026 |
| IRRIG | 0.3868 | 0.4952 | 0.4155 | 0.0060 |
| ONAREA | -0.2063 | 0.5907 | 0.6186 | -0.0032 |
| BORROW | 1.3306 | 0.4270 | 0.1580 | 0.2050 |
| COOP | -1.8004 | 0.4232 | 0.0636 | -0.2774 |
| FRN | -1.2003 | 0.4270 | 0.1863 | -0.1849 |
| ML | -1.1298 | 0.4444 | 0.1869 | -0.1741 |
| KINDPES | 1.3352 | 0.3774 | 0.1009 | 0.2057 |
| COST | -0.3649 | 0.6599 | 0.2953 | -0.0562 |
| AGTECH | 0.3765 | 0.6851 | 0.3249 | 0.0058 |
| PESTDEAL | 0.3373 | 0.6626 | 0.4777 | 0.0052 |
| CHEMCO | -1.0607 | 0.7361 | 0.0075 | -0.0163 |
| NBOR | 0.1300 | 0.9105 | 0.6250 | 0.0020 |
| SAFETY | 0.2716 | 0.4193 | 0.6276 | 0.0042 |
| NENEMY | -0.8180 | 0.2710 | 0.2614 | -0.1260 |
| WAQUAL | -0.1964 | 0.4308 | 0.8005 | -0.0030 |
| IMPACT | 0.8432 | 0.4152 | 0.2811 | 0.1299 |
| McFadden R Squared | | 0.214 | | |
| Log Likelihood | | -72.49 | | |
| Chi-squared | | 39.45 | p-value | 0.0177 |
| Correct prediction (%) | Total: 79.88 | Misusers: 91.87 | Non-Misusers: 43.90 | |

non-pesticide means of pest management increases the probability that a farmer will misuse pesticides by 13 percent, while receiving credit from a cooperative reduces the probability of pesticide misuse by 28 percent.

Five variables are significant at the 20 percent level. If a farmer receives credit for vegetable production, the model predicts that the farmer is 20 percent more likely to misuse pesticides. Receiving credit from a friend decreases the likelihood that a farmer will misuse pesticides by 18 percent, while receiving credit from a money lender decreases the likelihood of misuse by 17 percent. If a farmer receives credit in-kind as pesticides, the probability that the farmer misuses pesticides increases by 21 percent. Finally, a farmer that agrees with the perception that pesticides can harm water quality is 3 percent less likely to misuse pesticides.

## POLICY IMPLICATIONS AND CONCLUSIONS

Several implications and conclusions can be drawn from the logit analyses. First, the need for farmer training and awareness is evident in the reduced instances of pesticide misuse by farmers who attended the Farmer Field School and by farmers who viewed pesticides as harmful to water quality and natural enemy populations. Furthermore, because farmers belonging to cooperatives, farmer organizations, and village organizations are more likely to misuse pesticides, targeting these groups with training in the proper use of pesticides could be beneficial. Similarly, targeting farmers who receive credit may reduce the amount of pesticide misuse on vegetables.

Second, it is evident from the analysis that IPM training needs to be improved for Department of Agriculture technicians. The high value placed on an agricultural technician's

advice increases the probability of pesticide misuse unless technicians are imparting the latest IPM advice. One problem may be the absence of IPM strategies for the technician to impart. In addition, an examination of the relationship between DA technicians and chemical companies may be warranted. Because the influence of chemical company representatives increases the probability of pesticide misuse by farmers, chemical company training may also be inducing agricultural technicians to recommend pesticide use when it is unnecessary. The advice of an agricultural technician, which may be necessary to receive crop insurance, could actually promote misuse. A firm commitment to responsible pesticide use and to IPM by the extension system in the Department of Agriculture could help decrease pesticide misuse.

Future research should focus particularly on broadening the definition of misuse to include more aspects such as application of the correct pesticide, amount of pesticide applied, and timing of pesticide applications. Future studies should also examine the relationship between pesticide price and incentives to misuse pesticides. The nonsignificance of the price variable in this study was primarily due to the lack of variation in the variable as nearly all farmers said they considered price extremely important in deciding which pesticide to use.

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