# Health Effects of Pesticide Exposure among Filipino Rice Farmers[1]

**Satish K. Kedia[2] and Florencia G. Palis[3]**

## Abstract

*This article discusses the acute and chronic health effects of pesticide exposure among Filipino rice farmers. Data were collected from 50 farmers during 2002 and 2003 using a semi-structured questionnaire to elicit demographic information, various aspects of farming life, types and extent of pesticide use, exposure means, and self-reported acute and chronic illness experiences. Study participants had been farming for 20 years and applying an average of four to six pesticides approximately three times a year. The most common acute health problems reported by farmers were fatigue (52.0%), dizziness (50.0%), and body pain (32.0%). Farmers reported 43 different types of chronic health-related symptoms which were categorized as neurological (noted by 98.0% of farmers), dermal (90.0%), systemic (88.0%), respiratory (88.0%), ophthalmic (82.0%), gastrointestinal/renal (80.0%), and cardiovascular (56.0%). Chronic health problems were significantly lower for farmers who sold emptied pesticide containers (B=-3.479, p=0.01), for those with higher annual household incomes (B=-0.000, p=0.01), and for those who had attained vocational training compared to elementary school alone (B=6.101, p=0.02). Please see six tables of data following the article's text.*

## Introduction

The indiscriminate use of pesticides over the past half-century has caused extensive damage to the environment and human health. The advent of the Green Revolution in the early 1960s prompted the agricultural sector to dramatically increase pesticide use in order to boost crop production. The first use of dichloro-diphenyl-trichloroethane

(DDT) was in 1945. This synthetic insecticide is highly toxic as a contact poison because it apparently disorganizes the nervous system. Annual pesticide use has risen an estimated 50-fold to over five billion pounds worldwide (Pimentel et al. 1998; Kiely et al. 2004). In the Philippines, DDT was used in conjunction with the introduction of the hybrid strains of rice, which resulted in bumper crops of rice. While DDT was banned in the Philippines in 1994, the use of other equally potent pesticides continued to increase (Grabe et al. 1995; Pingali and Roger 1994; International Labor Organization 1999). The effects of these pesticides have been devastating to the entire ecosystem, affecting soil and water quality, flora and fauna, and humankind. The biggest impacts among human populations have been on the farmers who face the occupational hazards of working with, and often living in close proximity to, these toxic agents.

An estimated 1.3 billion workers are active in agricultural production worldwide, with 80% of these workers found in Asia (Rice 2000). In the Philippines, 41% of the total labor force is involved in agriculture (Forastieri 2000). Pesticides are widely used in order to increase crop yields and protect against insect infestation. Yet the International Labor Organization (ILO) estimates that as much as 14% of all occupational injuries are due to exposure to pesticides and other agrochemical constituents, and 10% of these injuries – around 17,000 per year – are fatal (International Labor Organization 2000). In subsequent reports issued between 1990 and 2002, the World Health Organization (WHO) estimated that from one to five million cases of pesticide poisoning occur among agricultural workers each year, resulting in approximately 20,000 fatalities (World Health Organization 1990). However, the reality of pesticide-related illness could actually be far worse, as no large-scale epidemiological studies have been conducted anywhere in the world.

Most documented studies related to pesticide exposure have included small groups of farmers in a select few countries and have been primarily based on self-reports or extrapolation from vital statistics. This is likely due to the challenges associated with clearly establishing the causal links of the chronic health symptoms with prolonged pesticide exposure. These studies have, however, consistently reported the negative health impacts of pesticide use. The primary goals of the research reported in this paper are:

(1) to ascertain pesticide exposure risks associated with a particular farming population, Filipino rice farmers;

(2) to discuss self-reported acute and chronic signs and symptoms of pesticide-related illnesses occurring in this population; and

(3) to assess vulnerability factors associated with pesticide-related illnesses among these Filipino rice farmers.

### Pesticide Exposure Risks

Modern agriculture has exacerbated some old risks and created several new hazards for the health, safety, and well-being of persons engaged in agriculture and related industries, particularly those in developing nations. In these countries, a lack of adequate manpower and financial resources to advise on and enforce the limited national laws and international regulations fail to safeguard farmers, often rendering them vulnerable to damaging direct exposure to pesticides and agrochemical residues. Some factors responsible for this situation are:

(1) unanswered needs for appropriate pesticide controls and legislation on labor conditions;

(2) a lack of pollutant monitoring for food, drinking water, or the environment; limited or no national procedures for approval or registration of modern pesticides;

(3) a need for information provision and awareness-raising aimed at small enterprises such as frms on proper storage, handling, or use of pesticides and disposal of waste pesticides, residues, and empty containers; and limited access to proper waste management.

To identify pesticides that require stricter controls, the World Health Organization (WHO) developed The WHO Recommended Classification of Pesticides by Hazard and Guidelines to Classification: 2004 (WHO 2005), a scale of acute toxicity that has established hazardous ratings of pesticides. The WHO system is based on LD50, the dose (oral or dermal) in mg of pure chemical per kg of body weight that was found to kill 50.0% of a sample population of rats that were fed the pesticide in laboratory tests. In this system, agrochemicals are classified according to their hazard level: IA–extremely hazardous, IB–Highly hazardous, II–Moderately hazardous, III–Slightly hazardous, U–Unlikely to present an acute hazard with normal use, FM–Fumigant not classified, and O–Obsolete or deleted chemical. In addition, the Food and Agriculture Organization (FAO) of the United Nations created its International Code of Conduct on the Distribution and Use of Pesticides in 1985 (FAO 2002) to reduce the health and environmental risks associated with pesticides. Although the FAO instructs producers and users in appropriate agrochemical handling practices, the FAO has no ability to enforce the codes. Generally, the FAO codes attempt to limit the significant adverse effects of pesticides on people or the environment by requiring quality packaging and market-appropriate labeling and directions on products, and by restricting pesticide use and prohibiting pesticides classified as IA or IB or those that require tropical climate-prohibitive or expensive protective gear.

Over the years, several countries have implemented the WHO and FAO recommendations in order to control pesticide use. The Sri Lankan government, for example, has been implementing WHO and FAO recommendations since the late 1980s to determine which pesticides should be allowed for use in the country. By the mid-1990s, all Class I pesticides were banned there, after which the number of deaths due to metamidaphos and other Class I organophosphorus compounds (OPs) fell dramatically (Roberts et al. 2003). Similarly, the Republic of the Philippines established certain pesticides as restricted or banned through its Fertilizer and Pesticide Authority (FPA), created on May 30, 1977, to manage the registration of pesticides, active ingredients, and formulations by ensuring (through examination of support data submitted from manufacturers and distributors as well as evaluations of biological efficacy and chemical, physical, and technological data) that any pesticide made available to end-users would be considered safe. The FPA has managed to remove the most extreme agrochemicals from common use. But the proper use of pesticides, as dictated by the manufacturers, remains a problem among end-users. This is because of a lack of knowledge about pesticide safety practices and their inability to comprehend the complex label instructions on agrochemicals, which are often written in foreign languages with no translation in the local language.

Farmers in developing countries like the Philippines are left even more vulnerable due to their poor working conditions, lack of awareness about the dangers of pesticides, mismatched farmers' perceptions and beliefs regarding pesticides and health, inferior protective measures taken during the pesticide sprays, and an absence of adequate medical facilities. The considerable expense required to obtain and renew protective equipment is out of reach for most of the largely-impoverished farmers in developing countries. Interventions or policy recommendations, where existent, do train farmworkers in the so-called safe use of pesticides by suggesting that wearing gloves, aprons, face shields, cotton work clothes, and boots provide adequate protection from most pesticides. However, even such mediocre equipment is overly cumbersome for farmers in the hot and humid tropical climates typical to agricultural communities in developing nations and is therefore rarely used. Without proper equipment or product-handling knowledge, these farmers are exposed to pesticides directly through the skin, the mouth, inhalation, and ingestion, and also indirectly through chemical residues that contaminate their clothes, water, and food. This, in turn, results in the presence of agrochemical residues in their working and living environments, thus leading to unintentional, occupational pesticide poisoning (Warburton et al. 1995). When farmers do manage to use protective equipment or wear minimally protective and absorptive long-sleeved and long-legged work clothes, the resulting excessive perspiration can actually increase dermal exposure to the toxic chemicals handled.

Hazardous chemical substances are not often transported or handled with proper care by farmworkers, and excessive use or misuse is pervasive. Focus group discussions with Indonesian farmers indicated that they believed frequent applications of strong pesticides were necessary to kill all damaging insects and to prevent blemishes on cash crops (Kishi et al. 1995, cited in Murphy et al. 1999). Sales representatives of large agrochemical industries reinforce this message regularly in developing nations, so that feeling ill from exposure and the laborious work is understood by the farmers as a necessary cost of doing business (Kishi et al. 1995, cited in Murphy et al. 1999). Acutely toxic pesticides, used without adequate safety measures or protective clothing, are mostly mixed or otherwise prepared by hand in these farming communities and are often stored in containers or bottles typically used for benign purposes such as holding beverages. Re-use of pesticide containers for food or water storage is an invariable source of contamination and toxic exposure by farmers, farm-workers, and farming households, as is inappropriate use such as using pesticides to catch fish or for other environmentally hazardous tasks. Yet another exposure risk typical to agricultural communities in developing nations is the storage and use of pesticides in or near the home, which also endangers farmworker families.

The work and home environment can easily be further contaminated when pesticide containers are not disposed of properly, whether through dumping remnants on the ground or in surface water during the cleaning process, or through neglecting to clean containers and unsuitably storing or burying them. Though only residual agrochemicals typically remain as a result of these inadvertently negligent practices, "[s]ome such pesticides, says the FAO [Food and Agricultural Organization], are so toxic that a few grams could poison thousands of people or contaminate a large area" (Rice 2000: 62).

## Recognized Health Effects of Pesticide Exposure

Although the health risks of pesticide exposure are widely known, many of the manifestations of toxicity resemble the symptoms of other conditions linked to farm-workers' lives. These include infectious disease, unsanitary environments, taxing labor, substance abuse, and overall poor health (Arcury and Quandt 1998; Murphy et al. 1999; Arcury et al. 2000; FPA 2002). Due to this uncertain etiology, pesticide toxicity is generally determined by documenting those symptoms associated with agrochemical exposure in clinical observations and self-reports of persons with a history of likely exposure. Still, problems with this diagnostic approach are shrouded with a number of caveats as reported by Reigart and Roberts,

First, all manifestations of illness have multiple causes, pesticidal and nonpesticidal. Second, there are no specific symptoms that are invariably present in poisonings by particular pesticides. Third, many poisonings are characterized by unexpected manifestations. Finally, neither route of exposure nor dosage of pesticide is taken into account in [signs or symptom listings] (Reigart and Roberts 1999: 210).

Nonetheless, there is extensive literature on an alarming range of specific health impacts tied to pesticide poisoning. For example, a study comprising before-and-after observations of Indonesian shallot farmers established that over one fifth (21.0%) of pesticide sprayings produced "three or more neurobehavioral, gastrointestinal, and respiratory symptoms of pesticide poisoning" (Kishi et al. 1995: 124). Research on farmers in the state of Iowa in the United States exposed to an unusually high amount of pesticides reveals an array of symptoms. These include "headaches, skin irritation, nausea or vomiting, dizziness, and feeling excessively tired . . .chest discomfort, breathing difficulties, nervousness or depression, eye irritation, jerking or involuntary movement of the arm and legs" (Alavanja et al. 2001:560).

Toxicity is simply "the innate capacity of a chemical to be poisonous" (US EPA 1992: 26). And a full understanding of the health problems resulting from pesticide exposure requires additional consideration of the toxicity type, the agrochemical(s) involved, the frequency and pathway(s) of exposure, the quantities used per given parcel, and the physical characteristics of the individual such as size and weight. Health impacts from chronic (prolonged or repeated) pesticide exposure include "tumors and cancer, reproductive problems such as sterility and birth defects, damage to the nervous system, damage or degeneration of internal organs such as the liver, and allergic sensitization to particular chemicals" (FPA 2002:126). In a 2000-2001 study on pesticide poisoning from data of hospitals in such regions of the Philippines as Luzon, Visayas, and Mindanao, 9.1% of poisoning cases were severe, 33.4% were moderate, 51.9% were minor, and 5.6% were non-cases (Panganiban 2005). In an earlier Sri Lankan research project, 62.0% of farmers reported experiencing acute (rapid onset) health effects from direct pesticide exposure during spray applications, including headaches, dizziness, nausea, and blurred vision (Van der Hoek et al. 1998). Other studies note that chronic toxicity from a history of spraying creates longer-lasting neurological problems, including anxiety, memory loss, mood changes, impaired vision, and delayed neuropathy (Marquez et al. 1990; Arcury and Quandt, 1998). Those who are applying pesticides are not the only ones to experience health problems. Residents living near sprayed sites, who are exposed to pesticide drifts from the fields, have complained of chronic headaches, nausea, vomiting, respiratory distress, fatigue, and tingling in the hands and feet. They evidence a connection between agrochemical exposure and mood change as measured by neuropsychological tests (Marquez et al. 1990; Pingali et al. 1994).

## Research Methodology

We conducted fieldwork during 2002 and 2003, with brief follow-up visits in 2004 and 2005, in two villages near Cabanatuan City in the northeast Lagare area of the Nueva Ecija Province in Central Luzon, Philippines, approximately 150 kilometers (93 miles) from Manila, the capital city. The agricultural base of the Nueva Ecija Province consists of rice and vegetable cultivation with an immediate market for produce in neighboring provinces and in Manila. In 1999, the Philippine government began a program called Masagana 99 or Bountiful 99, with the goal of harvesting 99 sacks of rice from each hectare of land. Through this program, farmers of Nueva Ecija were introduced to a modern rice variety that doubled the production but also required heavier agrochemical use and, therefore, a closer examination of potential health impacts of pesticide exposure on the farmers and their work and living environments.

Study participants were men who (1) had been actively involved in farming and pesticide applications continuously for at least five years, who (2) were primarily a rice farmer or farm worker, and who (3) had no history of major health problem(s) before becoming a farmer or farm worker. We recruited eligible participants using non-probability consecutive sampling. Women were excluded from the study population because, whereas Filipino females participated in some aspects of agricultural activities, they almost never sprayed pesticides in the fields and were not involved in physical labor on the farm. Although the changing cash economy, with diversified livelihoods, is pushing some women in the Philippines to work on farms, most still retain their roles as primary caregivers and managers of the household.

We employed a semi-structured questionnaire following a triangulated research methodology. We used quantitative and qualitative questions to collect data on demographics, various aspects of farming life, types and extent of pesticide use, exposure means, and self-reported acute and chronic illnesss to determine factors associated with higher levels of chronic health symptoms. Three researchers at the International Rice Research Institute (IRRI) and a local field assistant from one of the villages reviewed our draft questionnaire, We modified it based on their input. The original English questionnaire was translated into Tagalog, the native language of the study population. We had the help of two local Tagalog-speaking field assistants. One was from the International Rice Research Institute who was also well-versed in English and could effectively navigate between Tagalog and English, and the other was from one of the study villages. Translation into Tagalog was under the supervision of Florencia G. Palis, this paper's co-author, who is proficient in both Tagalog and English. Both research assistants had considerable experience interviewing local farmers for other IRRI projects. And they were specifically trained to conduct interviews using our questionnaire, which was pilot-tested for linguistic nuances and cultural subtleties and modified to eliminate any confusion.

The questionnaire includes demographic items such as age, linguistic group, education, marital status, number of children, and annual household income. There are farming history items such as the age the respondent began farming and the age he began applying pesticides. The agricultural activities include pesticide use, spray, and disposal practices, and acute/chronic manifestations of pesticide exposure. Farmers were asked how they felt during and immediately following pesticide spraying to ascertain acute manifestations and were then probed about their general health condition to gauge the chronic signs and symptoms possibly related to pesticides. The interviews were conducted in Tagalog, and the field assistants took notes and tape-recorded the interviews. All tapes were later transcribed, translated into English, and coded. Quantitative data were entered into Microsoft Excel and analyzed using the statistical package SPSS and SAS. Data analyses comprise descriptive statistics, cross-tabulations for ordinal and categorical dependent variables in relation to independent variables, means for interval variables, and multivariate regression analysis.

Of the lengthy responses elicited from farmers concerning their work and lifestyles, those regarding basic demographics, types and extent of pesticide use, and reported exposure means were examined. Pesticide application frequency and container disposal methods were considered the primary means of exposure, since people in close proximity to spray equipment and pesticide containers were subject to exposure, and unsafe pesticide storage and disposal practices indicated a high probability of accidental exposure. Some additional sources of exposure were also briefly examined, including pesticide preparation, protective gear use, and the handling and washing of work garments. Acute and chronic signs and symptoms reported by the farmers were noted to document the pesticide-related illnesses experienced by the study population. These reported symptoms were then compared to documented health impacts noted in previous studies. In keeping with the literature, particularly Reigart and Roberts (1999), chronic manifestations reported by the study population were grouped into seven categories: neurological, respiratory, ophthalmic, dermal, gastrointestinal/renal, cardiovascular/blood-related, and systemic/generalized.

Finally, we run multivariate regression analysis (Pedhazur 1997) using procedure regression from SAS/Stat Version 9.1 to identify those factors most likely to be associated with the number of symptoms for chronic illnesses experienced by the farmers related to pesticide exposure. We adjusted for possible alternative contributors such as age and smoking history. Socioeconomic characteristics thought to influence risk were entered as the independent variables for the regression analysis, and the number of chronic signs and symptoms were used as the dependent variables to ascertain factors associated with chronic health symptoms. We looked for other factors such as size of the land, household income, farmer's age, years farming, and years spraying. We took into account variables with a referent category, including educational level such as high school, college, and vocational versus elementary schooling; protective measures such as wearing a gas mask and/or gloves; container disposal (sold to junkshop, washed/ reused, buried, and burned versus put in local environment). Smoking history as current smoker and ex-smoker versus nonsmoker were included as independent variables in the regression model.

## Results: Study Population Demographics

Of the 50 Filipino rice farmers who met the inclusion criteria, the majority (98.0%, n=49) spoke Tagalog while (36%, n=18) spoke both Tagalog and Ilokano (see Table 1). Most (66.0%) of the farmers were between 31 and 40 years old (37.16 mean, 5.51 SD, 25–48y range). There were about the same number of farmers in the 36–40 age group (26.0%, n=13) as in the 41–50 group (28.0%, n=14). About one third had attained an elementary education (34.0%, n=17), and almost half had a high school education (46.0%, n=23), but few (20.0%) had continued their education in college (n=6) or vocational training (n=4). Almost all farmers (90%, n=45) were married, and most (68.0%, n=34) had one to four children. Study participants had been farming from 6 to 32 years (20.14y mean, 6.43 SD) and applying pesticides from 5 to 33 years (18.76y mean, 7.11 SD), having first farmed between 12 and 25 years old (17.02y mean, 3.39 SD) and first handled agrochemicals between 12 and 29 years old (18.53y mean, 4.18 SD). The mean annual household income, which included rice farming plus other sources of income, in Filipino pesos was P28822.13 (sd = P22661.49), or approximately US$540.15 (sd=US$424.69) annually. Some earned as little as P4000.00/US$74.96 and others as much as P103000.00/US$1930.29, where P53.36=US$1 (Reuters 2006).

## Pesticides Used

When asked which pesticides they had used in the past 12 months, the participating Filipino rice farmers provided a rather extensive list of brand names, often with similar or the same chemical base, yielding 29 agrochemicals (separate or combined), nine of which were herbicides, 15 insecticides, three molluscicides, and two rodenticides (see Table 2). The most common pesticides used by the study population contained some of the highly hazardous chemicals, as listed in The WHO Recommended Classification of Pesticides by Hazard (WHO IPCS 2005). Among the 34 individual active ingredients used alone or in combination by the Filipino farmers participating in this study, four (11.8%) are classified as IB or Highly hazardous, nineteen (55.9%) as II or Moderately hazardous, two (5.9%) as III or Slightly hazardous, and nine (26.5%) are classified as U or Unlikely to present acute hazard. Two thirds of the 13 agrochemicals used by the most farmers (26.0% to 50.0%), including three that consist of two active ingredients, are either moderately or highly hazardous; three classified as U, one as III, eight as II, and one as IB.

In terms of chemical family (see Table 3), the majority of the farmworkers used insecticides from the pyrethroid (76.0%), organophosphate (36.0%), or phenyl methylcarbamate (34.0%) families; herbicides from the acetamide-propanamide (50.0%), acetamide (36.0%), and thiocarbamate (34.0%) families; molluscicides from the hydroxybenzamide (56.0%) and aldehyde (28.0%) families; and rodenticides classified as inorganic compounds (38.0%). All other agrochemical families were only used by 2.0% to 14.0% of participating farmers. An examination of spraying frequencies show that four of the six agrochemicals with the highest average number of applications annually (5.00, 4.00, 3.88, and 3.56) were insecticides (two of which were only used by 8.0% or less of the study participants), while the fifth and sixth (3.33 each) most-frequently applied were two of the least reported chemical families used (Benzene herbicides and Coumarin rodenticides, both used by only 6.0% of the farmers).

**Frequency of Application.**

The more frequently pesticides were applied, the higher the potential level of toxicity to the farmer handling these agrochemicals (see Tables II and III). Of the ten active ingredients or compounds that were used by more than 26.0% and up to 50% of farmers, eight were also the chemicals applied in the heaviest quantities (18.10-38.73 L/ha and 21.17-122.20 kg/ha). The remaining two, Metaldehyde (1.60L/ha and 9.60kg/ha) and Cyhalothrin, lambda (16.65L/ha), are both WHO Class II chemicals, or moderately hazardous. Carbofuran (IB, highly hazardous) and Niclosamide (U, unlikely hazardous) were less-frequently applied but were nevertheless applied in large quantities (21.17 kg/ha and 23.01 kg/ha, respectively). Of those active ingredients handled by the most farmers and/or applied in the largest quantities, six were sprayed an average of three or more times each year (two were classified as IB, four as II). Among those pesticides applied three to six times annually, one was classified as IB, five as II, and two as U. When examined by chemical family, those used by study participants in largest mass per hectare were liquid pyrethroids (Class II) at 54.3 L/ha, hydroxybenzamides (Class U) at 45.1 L/ha, acetamide-propanamide (Class U and III) compositions at 38.7 L/ha, organophosphates (Class IB and U) at 25.6 L/ha, and thiocarbamates (Class II) at 22.1 L/ha; or dilutable powder acetamides (Class U) at 139.9 kg/ha, phenyl methylcarbamates (Class II) at 29.1 kg/ha, inorganic compound rodenticides (Class IB) at 33.2 kg/ha, and benzofuranyl methylcarbamates (Class IB) at 21.2 kg/ha). All other pesticide amounts fell below 12 kg or 7 L/ha but still contributed an additional 18.2 kg/ha of molluscicides and rodenticides as well as 15.5 L/ha of insecticides and herbicides.

Even the lower chemical doses were not as marginal as they first appear, considering the actual number of times that the dosing occurred (1.64 to 4.00 times annually, an average of 2.90 times). Additionally, 48.0% of the study population used four (n=9), five (n=8), or six (n=7) different brands of pesticides each year. Only 10.0% (n=5) limited usage to one chemical annually, and the remaining farmers (50.0%), besides one that did not give a definitive response to the question, used two brands (n=3), three brands (n=6), seven brands (n=6), eight brands (n=3), and the maximum nine brands (n=2) reported.

**Pesticide Exposure**

Lack of appropriate information concerning the safe handling of agrochemicals and their possible health and environmental impacts contributed to the participating farmers' chronic pesticide exposure and related illnesses. Most farmers in this study reported receiving information from other farmers/landowners or from pesticide companies, many citing multiple sources for their information. Twenty-five (50.0%) received information on pesticide use from other farmers, one from his landowner, and five from their fathers. Three farmers said they relied on their own prior experiences. Another 23 reported receiving information from pesticide company agents or sales representatives, 13 from presentations and meetings, three from agricultural supply stores, one from meetings expressly given by pesticide company agents, and one from pesticide product labels. While three stated that they had obtained information from technicians at their Department of Agriculture, only three looked to pamphlets or books on pesticides. Another three got information from the radio, one from his local councilman, and one from his own studies.

Most of the pesticide exposure for the rice farmers in this study resulted from five or more years of multiple applications each season, from mishandling agrochemicals, and from a lifetime of environmental exposure through working and inhabiting areas barraged by pesticides. The potential for chronic toxicity is high because of methods of application and pesticide container disposal.

When preparing agrochemicals for an application, the concentrated liquids or powders had to be diluted, and, invariably, the participating farmers would use unprotected hands to do so. Only 30.0% of the participating farmers reported using protective gas masks, and only 16.0% wore gloves or boots during a spraying application.

Spills during the mixing process or while pouring into spraying machinations were additional sources of dermal exposure risk, as were the simple and ineffective use of ordinary pants, long-sleeve shirts, improvised capes, and t-shirt masks meant to stave off unhealthy pesticide exposure. In fact, these local means of protection served to create a greater risk because they were porous and soaked with pesticides by the end of an application, keeping doses of toxins close against the skin. Pores, open and expanded by the heat and sweat of such work, were constantly in contact with the agrochemicals through their soaked clothing and makeshift protection. Habits such as wiping sweat from the face with hands caked in pesticide or with chemical-soaked t-shirt masks also exposed pores.

Few reported bathing (30.6%) or removing or washing clothes (14.3%) immediately following a pesticide application. Many wore the same clothes for days, across applications of varying agrochemicals, without pausing to wash out formerly soaked-in pesticides. Almost all of the farmers (98.0%) only wore rubber slippers, if they wore any foot gear, during spraying, further exposing the skin through constant contact with newly sprayed grounds and plants, leaving sores and cuts on the feet and ankles exposed to toxins. Fine pesticide mists aggregated on the farmers' skin or were inhaled air-borne as farmers often walked behind the sprayers during applications. Furthermore, most farmers reentered recently sprayed fields, where they smoked, ate, and drank throughout the day, with only a quarter (26.5%) washing their hands before doing so.

## Container Disposal

Most of the farmers in this study did not have storage units outside their houses for pesticide containers and stored empty containers somewhere in their houses. Additionally, none of the farmers spoke of appropriately cleaning the containers before disposal. Over half of the farmers (58.0%, n=29) reported eventually selling empty containers to junkshops, where they were likely to be reused as water or food containers, thus allowing pesticide residues to be easily reintroduced. The next most common disposal method employed by the study participants was burial, with about half (50.0%, n=25) reporting that they placed the containers at times only a foot deep in soil near their homes or fields. Many farmers had built a storage cabinet under their house flooring or had simply piled empty containers in an unfenced site on their farms. A fifth (20.0%, n=10) stated that they stored them out of reach of their children, but the containers' proximity to the ecosystem or vulnerability to weather or untrained people were not reported except by those who stated that they threw empty containers into the local environment (12.0%, n=6 in bamboo groves or trees; 8.0%, n=4 in the environment or nearby water) or stored them nearby (10.0%), either in animal pens (n=1), a shed behind the house (n=3), or a hut on the farm property (n=1). Another 4.0% said that they accumulated containers in abandoned structures (n=1) or places far from the home (n=1). Four percent (n=2) reported washing and reusing the containers, and one (2.0%) said that he burned empty pesticide containers, though none mentioned following the proper procedures or guidelines to ensure safe disposal.

## Health Impacts of Pesticide Exposure, Acute Pesticide Effects

Compared to the number of chronic manifestations, relatively few acute signs or symptoms were reported by the Filipino rice farmers included in this study, though a majority did report fatigue (52.0%, n=26) or dizziness (50.0%, n=25) immediately after spraying (see Table 4). About one-third of the farmers reported generalized body pain (32.0%, n=16) and weakness (26.0%, n=13) as acute signs or symptoms, while nausea was only reported by four farmers (8.0%). All other acute manifestations were reported by only one or two Filipino rice farmers: drowsiness, headache, shortness of breath, coughing or sneezing, abdominal pain, diarrhea, burns, stiffness, numbness, cramps, blurred vision, or achy eyes.

## Health Impacts of Pesticide Exposure, Chronic Pesticide Effects

By far, chronic manifestations were recounted in much greater numbers than the acute health problems reported among farmers. All but one of the seven chronic illness categories, cardiovascular, revealed that 80.0% or more of the study participants experienced a sign or symptom of that classification (see Table V). By category, neurological symptoms far exceeded all others, with 98.0% (n=49) of farmers reporting one or more neurological symptom compared with dermal (90.0%, n=45), respiratory (88.0%, n=44), systemic or generalized (88.0%, n=44), ophthalmic (82.0%, n=41), gastrointestinal or renal (80.0%, n=40), and cardiovascular or blood-related (56.0%, n=28). Among individual symptoms, systemic pain and dermal excessive sweating were reported by more farmers (each 86.0%, n=43) than any other chronic manifestation. Following pain and excessive sweating in frequency reported were headache (84.0%, n=42), blurred vision (60.0%, n=30), drowsiness (56.0%, n=28), fatigue (54.0%, n=27), sleeplessness (52.0%, n=26), and abdominal cramps (50.0%, n=25). Although cardiovascular health problems were the least-frequently noted as a broad category, chest discomfort was still recorded by almost half of the study population (48.0%, n=24).

Of the remaining manifestations, only ten fell at or below 10.0% of the study participants (loss of appetite, anemia, tremors, kidney disorder, abnormal heart rate, impaired coordination, disorientation, contracted pupils, paralysis, cancer), while four impacted 12.0% to 20.0% (eye problems, sinus, skin rash, abnormal blood pressure). Four were reported by about one quarter (22.0% to 26.0%) of the pesticide-spraying farmers (skin disorders, numbness, nail problems, and vomiting or nausea). An additional seventeen were reported by one third or more (32.0% to 48.0%) of the pesticide-spraying farmers (nasal congestion, chest discomfort, cough with phlegm, frequent sore throat, hearing loss, red eyes, twitching, recurrent cough, runny nose, diarrhea, weakness, watery eyes, fever, dizziness, breathlessness, shaky hands, and irritated eyes).

## Comparison with Previous Studies

This study found a number of similarities with, and a few divergences from, previous research documenting the effects of pesticide exposure. Almost all of the most common signs and symptoms recorded in the literature (with the exception of excessive salivation) were also seen to some degree in the chronic health problems reported by the Filipino farmers of this study: excessive sweating 86.0%, headache 84.0%, blurred vision 60.0%, abdominal pain and cramps 50.0%, chest discomfort 48.0%, diarrhea 36.0%, dizziness 34.0%, and vomiting or nausea 22.0%.

Notable is that, three of these manifestations (excessive sweating, headache, and blurred vision) fall among the ten most reported by the Filipino rice farmers in this study (by 60.0% or more). Seven others (generalized pain, drowsiness, fatigue, sleeplessness, abdominal cramps, nasal congestion, and chest discomfort) were reported by at least one fifth of participating farmers (20.0% or more). Similar to previous studies (Gomes et al. 1998; Rojas et al. 1999; FPA 2002; Lu, 2005), this study population reported generalized weakness as a systemic manifestation of pesticide exposure (36.0%), as well as fever (34.0%) and unspecified pains (86.0%). The Filipino rice farmers in this study acknowledged experiences of chest discomfort (48.0%) as well as abnormal blood pressure (12.0%) and/or heart rate (8.0%). Our results echo the cardiovascular and blood-related effects of pesticide exposure. Such is reported by Kishi et al. (1995), Schulze et al. (1997), Beshwari et al. (1999), Murphy et al. (1999), Rojas et al. (1999), Sodavy et al. (2000), Alavanja et al. (2001), FPA (2002), Martin et al. (2002), and Abu Mourad (2005).

Thirteen neurological effects of chronic pesticide exposure were also found in this study, including headaches, tremors, twitching, numbness, dizziness, sleeplessness, drowsiness, fatigue, disorientation, and impaired coordination found in multiple studies (Pingali et al. 1994; Kishi et al. 1995; Arcury and Quandt 1998; Gomes et al. 1998; Beshwari et al. 1999; Murphy et al. 1999; Sodavy et al. 2000; Alavanja et al. 2001; Ngowi et al. 2001; FPA, 2002; Martin et al. 2002; Kunstadter et al. 2003; Lu 2005). Headaches were particularly prevalent at 84.0%, an even higher incidence than the 51.0% rate that Murphy et al. (2002) found among Vietnamese pesticide sprayers. None of the Filipino farmers reported convulsions or fits as previously documented by Kishi et al. 1995, nor were more severe symptoms such as unconsciousness, slurred speech, ataxia, and mood disorders reported by the Filipino farmers (Kishi et al. 1995; Beshwari et al. 1999; FPA 2002).

The dermal manifestations reported by this study's population: excessive sweating, nail problems, skin disorders, and rashes, have also been previously well documented. However, it is uncertain whether the general skin disorders noted in this study would encompass the more specified descriptions found by other researchers: abraded, irritated, burning, cold, flushed or otherwise discolored skin, or dermatitis and integumentary (Pingali et al., 1994; Kishi et al., 1995; Arcury and Quandt, 1998; Beshwari et al., 1999; Murphy et al., 1999; Rojas et al., 1999; Sodavy et al., 2000; Alavanja et al., 2001; Ngowi et al., 2001; FPA, 2002; Martin et al., 2002; Kunstadter et al., 2003; Abu Mourad, 2005; Lu, 2005). On the other hand, the ophthalmic and respiratory problems recorded by the farmers in this study fairly mimic those reported in previous literature (Kishi et al., 1995; Gomes et al., 1998; Beshwari et al., 1999; Murphy et al., 1999; Rojas et al., 1999; Wilkins et al., 1999; Sodavy et al., 2000; Alavanja et al., 2001; Ngowi et al., 2001; FPA, 2002; Martin et al., 2002; Kunstadter et al., 2003; Abu Mourad, 2005; Lu, 2005). Also consistent between this and prior studies of pesticide exposure health impacts were the common gastrointestinal manifestations of nausea, abdominal pain or cramps, vomiting, and diarrhea (Kishi et al., 1995; Gomes et al., 1998; Rola and Widawsky, 1998; Beshwari et al., 1999; Murphy et al., 1999; Rojas et al., 1999; Sodavy et al., 2000; Alavanja et al., 2001; Ngowi et al., 2001; FPA, 2002; Martin et al., 2002; Kunstadter et al., 2003). However, the widely reported excessive salivation, as well as the less common constipation, intestinal problems, and incontinence reported elsewhere (Kishi et al., 1995; Beshwari et al., 1999; Murphy et al.,1999; Sodavy et al., 2000) were not found in this study.

## Predictors of Chronic Health Effect

We performed multivariate regression analysis to assess factors related to the number of chronic conditions found among the study participants. The regression model was highly significant (p=0.019) with an R-square of 57.3%, indicating a relatively high goodness of fit. Results showed that disposal of emptied pesticide containers in the immediate environment instead of selling them to junkshops, a lower household income, and lower educational level (a lack of vocational training) would increase the number of pesticide-related chronic ailments (see Table VI). Note that container disposal method was used as an indicator for primary means of exposure. Farmers who sold emptied pesticide containers as their disposal method exhibited a significant reduction in the number of chronic disease effects (B=-3.479, p=0.01), as did those with higher annual household incomes (B=-0.000, p=0.01) and those with higher educational level with vocational training. All other variables in the model did not exhibit significant effects on the predictability of pesticide associated chronic manifestations (see Table 6).

## Discussion

Considering the high estimates reported for illness rates among farmers using agrochemicals in developing countries, it is not surprising to discover that all the Filipino rice farmers included in this study reported experiencing signs or symptoms of at least one chronic illness category. Most cases of pesticide-related illness and poisoning are not reported because victims do not generally consult with a biomedical doctor or hospital or because their illnesses are not accurately diagnosed as related to pesticide exposure. In the Philippines, for example, the number of poisonings is likely underestimated because most cases do not reach the hospital, and in instances when cases do reach the hospital, health officers may not always correctly diagnose pesticide poisoning (Maramba 1995; Mendoza 1995). Although this study is based mainly from farmer interviews and not from evidence drawn from clinical data, the signs and symptoms reported in this study affirm the frequently-noted manifestations related to agrochemical toxins that are found in much of the existing literature.

For example, none of the study participants reported convulsions or fits that have been documented elsewhere (Kishi et al. 1995), but the tremors, twitching, and shaky hands recorded in the present study could be construed as similar. Other health issues anticipated by previous findings that were not documented among the Filipino farmers, including lack of concentration, poor comprehension, and reading problems, as well as nervousness/depression, increased anxiety, memory loss, and neurotoxic manifestations (Beshwari et al. 1999; Mancini et al., 2005), may have been revealed. That might have been so if clinical tests for such complications had been performed on the study population rather than relying solely on participant self-reports.

Respiratory manifestations related to pesticide exposure have been disputed in the literature as such signs and symptoms may likely be the result of tobacco use, which has been found to be prevalent among farmers; however, there has been some evidence in previous and present research to the contrary. While Pingali et al. (1994) found that farmers who smoke and apply one recommended dose of insecticides and herbicides are 50.0% more likely to have abnormal respiratory problems, such health impacts also increased with more chronic insecticide exposure despite whether or not the farmers were smokers. In fact, respiratory ailments increased by an additional 16.0% when farmers had participated in two doses/applications, and 30.0% with three (Pingali et al. 1994). Similarly, the present study revealed that being a current smoker or ex-smoker, when compared with nonsmokers in the multivariate regression analysis, was not a significant attribute of farmers with chronic health problems.

Though only three of the factors tested with multivariate regression analysis showed significance in predicting chronic illness related to pesticide exposure, several additional conditions collectively increased the risks and vulnerability of the Filipino rice farmers and cannot be ignored. These conditions include contaminated food and drinking water, inadequate nutrition, lack of healthcare, and poor working conditions. Additionally, the local farmers, as represented by the study population, are either not fully informed of or are unable to follow common guidelines for proper storage, handling, and use of pesticides, not to mention the proper disposal of waste pesticides and empty containers. Few used protective equipment or adequately cleaned themselves or their clothes after applying pesticides, even prior to smoking or consuming food or water. These combined vulnerability factors increased the risk of pesticide exposure and subsequent illness to farmers and their families, as they led to excessive and pervasive use or misuse of hazardous chemical substances.

Despite the growing concern over pesticide-related impacts and the increasingly-debated global issue of whether pesticides should even be used, there are few international or national programs and policies being implemented at the ground level. There is a need to raise the awareness of the harmful effects of pesticide exposure for human beings and to the ecosystem and to identify factors that increase the farmers' vulnerability to pesticide related illnesses. Further, the need for more health education programs should tap farmers' belief systems and cognitive categories to stress the need for precautions (Palis et al., 2006). As in the case of Filipino farmers, Palis et al. (2006) found that their perceptions and beliefs about health, illness causation, and pesticides have inevitably led to certain actions that hampered their taking preventive measures to protect themselves from the negative effects of pesticides. These beliefs include: the belief of immunity, that some (particularly the young) are not susceptible to the adverse health effects of pesticides; the dichotomy in the belief that pesticides are both medicine and poison, wherein the medicine concept has been placed above the poison concept; and the belief that using gloves to protect the hands from pesticides spill over and sprinkles might cause other illnesses such as pasma (exposure illness). Thus, health education programs should not only stress the poisonous aspect of pesticides, but also that everyone is at risk for acute or chronic pesticide poisoning, especially those who are exposed to pesticides on a regular basis.

Governments, companies and industries, non-governmental organizations (NGOs) such as the Food and Agriculture Organization (FAO), the World Health Organization (WHO) of the United Nations, and the International Rice Research Institute (IRRI), should all be involved in an integrated approach for sustainable agriculture with minimal use of toxic chemicals. National governments, whether in developed countries or not, have failed to support FAO guidelines in eliminating significant adverse effects of pesticides on people or environment. These guidelines also call for (1) the use of quality packaging and market-appropriate labeling and directions and (2) worldwide prohibitions on the sale and import of WHO classified IA or IB chemicals or chemicals requiring tropical climate-prohibitive or expensive protective gear. International efforts by WHO to identify dangerous agrochemicals should be backed by legislative enforcement, adequate access to appropriate healthcare, and globally accepted regulations regarding pesticide use guidelines, Integrated Pest Management (IPM) trainings, and product labeling requirements.

A sustained dialogue is urgently needed to improve communication between various stakeholders, especially in developing countries where marketing efforts by multinational corporations, paired with inadequate health and environmental regulations, have encouraged farmers' reliance on pesticides, even those generally banned elsewhere. Farmers are inundated with ads, incentives, and loans from pesticide corporations, shop keepers, and their own governments. At least half of the farmers in this study received information on pesticides from pesticide companies and an equal amount from other farmers, leaving it likely that prevailing local knowledge on agrochemicals comes directly from those who profit by their use without regard to the farmers' well-being. Moreover, while exposure method varies across pesticide studies, farmer vulnerability often lies in frequent and improper handling of pesticides and pesticide containers because of a lack of proper protective equipment and poor education and training on proper handling of disposal methods. For example, the regression analysis results show a significant reduction in chronic manifestations among farmers who removed emptied pesticide containers from their environment by selling them and among those who had completed agricultural vocational training.

## Future Studies

Future studies should continue to expose shortcomings in intervention and prevention methods that could be abated through informing national and international policy. The common body of knowledge on pesticide exposure health impacts should be expanded, including: morbidity, mortality, surveillance and epidemiological data, environmental and biological monitoring of pesticide residues, medical screenings, effective program or education campaigns and individual or community programs. They should also recognize that certain manifestations of pesticide exposure or exposure incidences among specific populations may require more urgent attention because they occur with greater frequency or severity, or are influenced by culture and economy.

Toxic exposure has led to the Filipino farmers' acute and chronic illness experiences, with fatigue and dizziness as the most noted acute signs and headache, excessive sweating, pain, and blurred vision as the most recorded chronic symptoms. Almost every participating farmer in this study was impacted by some neurological or dermal chronic manifestation of exposure to agrochemicals. Even more pressing is the fact that their exposure to pesticides was primarily due to a lack of information combined with misguided local farming practices and was, therefore, avoidable. ❍

*Table 1. Study Population Demographics* (*N* =50)

| Characteristics | Filipino Rice Farmers | |
|---|---|---|
| | **Frequency (n)** | **Percent (%)** |
| *Ethnicity/Linguistic group* | | |
| Tagalog | 31 | 62.0 |
| Tagalog and Ilokano | 18 | 36.0 |
| Tagalog, Ilokano, and Pangasinense | 1 | 2.0 |
| *Age group* | | |
| 25–30 | 3 | 6.0 |
| 31–35 | 20 | 40.0 |
| 36–40 | 13 | 26.0 |
| 41–50 | 14 | 28.0 |
| *Education* | | |
| Elementary | 17 | 34.0 |
| High school | 23 | 46.0 |
| College | 6 | 12.0 |
| Vocational | 4 | 8.0 |
| *Marital status* | | |
| Single | 5 | 10.0 |
| Married | 45 | 90.0 |
| *Number of children* | | |
| 0 | 8 | 16.0 |
| 1–2 | 15 | 30.0 |
| 3–4 | 19 | 38.0 |
| 5 or more | 8 | 16.0 |
| | **Mean (SD)** | **Range** |
| *Age of Farmer (years)* | *37.16 (5.51)* | *25–48* |
| When started farming | 17.02 (3.39) | 12–25 |
| When started applying pesticides | 18.53 (4.18) | 12–29 |
| *Timespan (years)* | | |
| Spent farming | 20.14 (6.43) | 6–32 |
| Spent applying pesticides | 18.76 (7.11) | 5–33 |
| *Annual household income** | *FP* 28822.13 (22661.49) | *FP* 4000.00-103000.00 |
| | US$577.25 (453.87) | US$80.11-2062.89 |

*One of the 50 farmers did not provide an answer to this question
*FP* = the Filipino peso; *FP* 49.93=US$1 (Reuters 2006).

*Table 2. Types and Frequencies of Pesticides Used Annually by Active Ingredient as Reported Among Filipino Rice Farmers (N = 50)*

| Pesticide Type and Active Ingredient | Chemical Family | WHO Class* | % of Farmers | Quantity Per Ha | Avg Spray Freq |
|---|---|---|---|---|---|
| *Herbicides* | | | | | |
| Butachlor† + Propanil† | Acetamide; Propanamide | U; III | 50.0 | 38.73 L | 1.76 |
| Butachlor† | Acetamide | U | 36.0 | 122.2 kg, 17.70L | 1.61 |
| Thiobencarb† + 2,4-D IBE‡ | Thiocarbamate | II; II | 28.0 | 18.10 L | 2.14 |
| Bispyribac sodium | Pyrimidinyloxybenzoic acid | U | 12.0 | 6.19 L | 2.33 |
| 2,4-D IBE‡ | Chlorophenoxy acid or ester | II | 6.0 | 1.40 L | 3.00 |
| Cyhalofop Butyl | Aryloxyphenoxypropionic | U | 6.0 | 4.76 L | 2.67 |
| Thiobencarb† | Thiocarbamate | II | 6.0 | 4.00 L | 2.33 |
| Oxyfluorfen‡ | Benzene | U | 6.0 | 0.63 L | 3.33 |
| Glyphosate Monoethanolamine Salt | Organophosphorus | U | 6.0 | 6.25 L | 1.00 |
| *Insecticides* | | | | | |
| Cypermethrin‡ | Pyrethroid | II | 48.0 | 35.43 L | 4.08 |
| MIPC/Isoprocarb† | Phenyl methylcarbamate | II | 34.0 | 29.17 kg | 3.88 |
| Chlorpyrifos† + BPMC (Fenobucarb)† | Organophosphate; pyridine organothiophosphate | II; II | 26.0 | 18.63 L | 3.00 |
| Cyhalothrin, lambda‡ | Pyrethroid ester | II | 26.0 | 16.65 L | 2.85 |
| Carbofuran† | Benzofuranyl methylcarbamate | IB | 8.0 | 21.17 kg | 5.00 |
| Acephate† | Organophosphorus | III | 2.0 | 0.71 kg | 1.00 |
| Diazinon† | Organophosphate | II | 2.0 | 0.67 L | 1.00 |
| Cypermethrin, beta‡ | Pyrethroid ester | II | 2.0 | 1.00 L | 2.00 |
| Deltamethrin‡ | Pyrethroid | II | 2.0 | 1.25 L | 2.00 |
| Tetradifon‡ | OrganoChlorine | U | 2.0 | 3.00 L | 4.00 |
| BPMC/Fenobucarb† | Carbamate | II | 2.0 | 2.00 L | 5.00 |
| Chlorpyrifos† + Cypermethrin‡ | Organophosphate; Pyrethroid | II; II | 2.0 | 1.00 L | 1.00 |
| Monocrotophos† | Organophosphate | IB | 2.0 | 0.33 kg | 2.00 |
| Carbaryl† | Carbamate | II | 2.0 | 0.50 kg | 3.00 |
| Phenthoate† + BPMC/Fenobucarb† | Orghanophosphorus | II; II | 2.0 | 2.00 L | 6.00 |
| *Molluscicides* | | | | | |
| Clonitralid/Niclosamide Ethanolamine Salt‡ | Hydroxybenzamide | U | 40.0 | 20.49 L, 1.60 KG | 1.80 |
| Metaldehyde‡ | Aldehyde | II | 28.0 | 1.60 L, 9.60 kg | 1.64 |
| Niclosamide | Hydroxybenzamide | U | 16.0 | 23.01 kg | 1.19 |
| *Rodenticides* | | | | | |
| Zinc phosphide† | Inorganic, compound | IB | 38.0 | 33.17 kg | 3.11 |
| Coumatetralyl† | Coumarin | IB | 6.0 | 6.85 kg | 3.33 |

†These active ingredients have been identified at least either as highly acutely toxic, cholinesterase inhibitor, known ground water pollutant, known/probable carcinogen, and/or a known reproductive or developmental toxicant (PAN Pesticides Database, n.d.).

‡These active ingredients have been identified at least as either moderately or slightly acutely toxic, a possible carcinogen, a potential pollutant, or suspected endocrine disruptor (PAN Pesticides Database, n.d.).

*IA = Extremely hazardous; IB = Highly hazardous; II = Moderately hazardous; III = Slightly hazardous; U = Unlikely to present acute hazard in normal use; FM = Fumigant, not classified; O = Obsolete or deleted chemical (WHO IPCS 2005).

Note. The percentages may not add up to exactly 100.0% and the frequencies may be higher than the total number of farmers (50) because of multiple responses among categories.

***Table 3. Types and Frequencies of Pesticides Used Annually by Chemical Family as Reported Among Filipino Rice Farmers (N =50)***

| Chemical Family | Farmers Using<br>*n* (%) | Quantity Used<br>Annually per ha | Avg Freq<br>of Sprays |
|---|---|---|---|
| *Insecticide* | | | |
| Pyrethroid | 38 (76.0) | 54.3 L | 3.56 |
| Organophosphate | 18 (36.0) | 25.6 L | 2.59 |
| Phenyl methylcarbamate | 17 (34.0) | 29.1 kg | 3.88 |
| Benzofuranyl methylcarbamate | 4 (8.0) | 21.2 kg | 5.00 |
| Carbamate | 2 (4.0) | 2.5 L | 4.00 |
| *Herbicide* | | | |
| Acetamide and Propanamide | 25 (50.0) | 38.7 L | 1.76 |
| Acetamide | 18 (36.0) | 139.9 kg | 1.61 |
| Thiocarbamate | 17 (34.0) | 22.1 L | 2.18 |
| Pyrimidinyloxybenzoic acid | 6 (12.0) | 6.2 L | 2.33 |
| Aryloxyphenoxypropionic | 3 (6.0) | 4.8 L | 2.67 |
| Chlorophenoxy acid or ester | 3 (6.0) | 1.4 L | 3.00 |
| Benzene | 1 (2.0) | 0.6 L | 3.33 |
| *Molluscicide* | | | |
| Hydroxybenzamide | 28 (56.0) | 45.1 L | 1.96 |
| Aldehyde | 14 (28.0) | 11.3 kg | 1.64 |
| *Rodenticide* | | | |
| Inorganic, compound | 19 (38.0) | 33.2 kg | 3.11 |
| Coumarin | 3 (6.0) | 6.9 kg | 3.33 |

Note. The percentages may not add up to exactly 100.0% and the frequencies may be higher than the total number of farmers (50) because of multiple responses among categories.

***Table 4. Pesticide-Related Acute Health Problems Reported by Filipino Rice Farmers (N =50)***

| Health Problem | Frequency<br>*n* (%) | Health Problem | Frequency<br>*n* (%) |
|---|---|---|---|
| Fatigue | 26 (52.0) | Abdominal Pain | 1 (2.0) |
| Dizziness | 25 (50.0) | Diarrhea | 1 (2.0) |
| Body pain | 16 (32.0) | Burns | 1 (2.0) |
| Weakness | 13 (26.0) | Stiffness | 1 (2.0) |
| Nausea | 4 (8.0) | Numbness | 1 (2.0) |
| Drowsiness | 2 (4.0) | Cramps | 1 (2.0) |
| Headache | 2 (4.0) | Blurred vision | 1 (2.0) |
| Shortness of breath | 2 (4.0) | Achy eyes | 1 (2.0) |
| Cough/sneeze | 1 (2.0) | Abdominal Pain | 1 (2.0) |

Note. The percentages may not add up to exactly 100.0% and the frequencies may be higher than the total number of farmers (50) because of multiple responses among categories.

***Table 5. Pesticide-Related Chronic Health Problems Reported by Filipino Rice Farmers (N = 50)***

| Health Problem | Frequency *n* (%) | Health Problem | Frequency *n* (%) |
|---|---|---|---|
| *Neurological* | *49 (98.0)* | *Systemic/Generalized* | *44 (88.0)* |
| Headache | 42 (84.0) | Pain | 43 (86.0) |
| Drowsiness | 28 (56.0) | Weakness | 18 (36.0) |
| Fatigue | 27 (54.0) | Fever | 17 (34.0) |
| Sleeplessness | 26 (52.0) | Cancer | 1 (2.0) |
| Hearing Loss | 21 (42.0) | | |
| Twitching | 20 (40.0) | *Ophthalmic* | *41 (82.0)* |
| Dizziness | 17 (34.0) | Blurred Vision | 30 (60.0) |
| Shaky Hand | 16 (32.0) | Red Eyes | 20 (40.0) |
| Numbness | 12 (24.0) | Watery Eyes | 18 (36.0) |
| Tremors | 4 (8.0) | Irritated Eyes | 16 (32.0) |
| Impaired Co-ordination | 3 (6.0) | Eye Problems | 10 (20.0) |
| Disorientation | 3 (6.0) | Contracted Pupil | 3 (6.0) |
| Paralysis | 1 (2.0) | | |
| | | *Gastrointestinal/Renal* | *40 (80.0)* |
| *Dermal* | *45 (90.0)* | Abdominal Cramps | 25 (50.0) |
| Excessive Sweating | 43 (86.0) | Diarrhea | 18 (36.0) |
| Skin Disorders | 13 (26.0) | Vomiting/Nausea | 11 (22.0) |
| Nail Problems | 12 (24.0) | Loss of Appetite | 5 (10.0) |
| Skin Rash | 8 (16.0) | Kidney Disorder | 4 (8.0) |
| | | | |
| *Respiratory* | *44 (88.0)* | *Cardiovascular/Blood* | *28 (56.0)* |
| Nasal Congestion | 24 (48.0) | Chest discomfort | 24 (48.0) |
| Cough with Phlegm | 23 (46.0) | Abnormal blood pressure | 6 (12.0) |
| Frequent Sore Throat | 22 (44.0) | Anemia | 5 (10.0) |
| Recurrent Cough | 19 (38.0) | Abnormal heart rate | 4 (8.0) |
| Runny Nose | 19 (38.0) | | |
| Breathlessness | 17 (34.0) | | |
| Sinus | 9 (18.0) | | |

Note. The percentages may not add up to exactly 100.0% and the frequencies may be higher than the total number of farmers (50) because of multiple responses among categories.

***Table 6. Multivariate Regression Analysis of Risk Factors Associated with Chronic Illnesses Due to Pesticide Exposure Reported by Filipino Rice Farmers (N = 50)***

| Risk/Vulnerability Factors | Regression Coefficient *B* | Standard Error of *B* | *p*-value |
|---|---|---|---|
| *Ordinal Scale Variables* | | | |
| Size of the land | -0.710 | 0.490 | 0.158† |
| Household income | -0.000 | 0.000 | 0.010* |
| Farmer's age | -0.2557 | 0.210 | 0.232† |
| Years farming | 0.300 | 0.204 | 0.151† |
| Years spraying | -0.140 | 0.162 | 0.393† |
| *Referent Variables* | | | |
| Educational level vs. elementary | | | |
| High school | 0.552 | 1.358 | 0.688† |
| College | 2.777 | 1.867 | 0.147† |
| Vocational | 6.101 | 2.476 | 0.020* |
| Protective measures vs. other | | | |
| Gas mask | -1.711 | 1.230 | 0.174† |
| Gloves | -0.272 | 1.441 | 0.852† |
| Container disposal vs. local environment | | | |
| Sold to junkshop | -3.479 | 1.260 | 0.010* |
| Washed/reused for other pesticides | -2.728 | 2.948 | 0.362† |
| Buried | 0.064 | 1.393 | 0.964† |
| Burned | 1.175 | 3.574 | 0.745† |
| Smoking history vs. nonsmoker | | | |
| Current smoker | 1.117 | 1.290 | 0.393† |
| Ex-smoker | 0.659 | 1.916 | 0.733† |

†Nonsignificant; *significant $p \leq 0.02$

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2. Satish Kedia received his Ph.D. in anthropology from the University of Kentucky. He is an associate professor of anthropology at the University of Memphis. He may be reached at the Department of Anthropology, 316 Manning Hall, University of Memphis, Memphis, Tennessee (TN) 38152-3390 USA, as well as at 901-678-1433 by telephone and at **skkedia@memphis.edu** by email.

3. Florencia Palis's Ph.D. in anthropology is from the University of the Philippines. She is a social scientist at the International Rice Research Institute in Manila, Philippines. She may be reached at the Social Sciences Division of the International Rice Research Institute, DAPO 7777, Metro Manila, Philippines, as well as at 63-2-845-0563, x 713 by telephone and at **f.palis@cgiar.org** by email.

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