Health Effects of Pesticide Use Among Indonesian Women Farmers: Part I: Exposure and Acute Health Effects

Helen H. Murphy, FNP MHS
Arik Sanusi
Russell Dilts, EdD
Marlinda Djajadisastra
Norbert Hirschhorn, MD
Sri Yuliantiningsih

INTRODUCTION

Over the last two decades there has been growing concern about the acute health effects of pesticide use among small scale farmers. This is particularly the case in developing countries where controls are less stringently enforced and hazardous handling practices are more common. In order to bring these issues to light, the scope of the problem needs better documentation. But estimating the scope of the acute health effects of pesticide use has been difficult due to a number of issues.

Helen H. Murphy is affiliated with the Program for Appropriate Technology in Health (PATH), Lombok, Indonesia.

Arik Sanusi, Russell Dilts, and Sri Yuliantiningsih are affiliated with Food and Agriculture Organization of the United Nations, Integrated Pest Management Project, Jakarta, Indonesia.

Marlinda Djajadisastra is Consultant, Papua, New Guinea.

Norbert Hirschhorn is currently consultant for WHO-Tobacco Free Initiative.

Address correspondence to: Helen H. Murphy or Russell Dilts, The FAO Programme for Community IPM in Asia, Jl. Jati Padang Raya 38-B, Jati Padang-Pasar Minggu, Jakarta 12540-Indonesia.

Journal of Agromedicine, Vol. 6(3) 1999

Many of the short-term effects go unreported unless they are life threatening, requiring visits to health care settings. The milder cases that do seek care at health facilities often go unrecognized because they mimic other health conditions[1]. Furthermore, health care providers commonly fail to take an occupational health history due to inadequate toxicology training.[2] Therefore the association between the presenting clinical picture and pesticides is often missed. Finally, those most heavily exposed low-income farmers often do not have the means of seeking medical advice. They accept ill health from pesticide use as part of the price one has to pay to have healthy crops[1]. They are convinced by chemical companies that their crops will fail without the use of toxic chemicals.

This is particularly the case in Indonesia where pesticides are indiscriminately used with few precautions. One landmark study on this issue was conducted in 1993 among male shallot farmers in Central Java, Indonesia. The results were striking. In 21% of all spray operations farmers experienced three or more signs and symptoms of pesticide poisoning. These effects were directly related to spraying frequency, the hazard levels of the pesticides used and skin exposure-either directly or through wet clothing. Farmers spent all day in water heavily contaminated with pesticides and their clothing was soaked after spraying. Pesticide concentrates were handled with bare hands and frequently inhaled from upwind spraying[3]. These conditions continue today.

Because women are commonly involved in agricultural activities in some areas of Indonesia, questions were raised after completion of the above study about the effects of pesticides on women's health. Not only were the acute effects of concern, but also that of reproduction. The Minang Kabau in Western Sumatra are matrilineal and matriarchal. According to plant protection officers in the area, it is women that are primarily involved in agriculture and likewise responsible for pesticide use. Given this situation, we were interested in documenting exposure patterns in women, estimating the acute effects, and finding out if these were similar to what was found among men in Central Java. Furthermore, we wanted to examine the impact of pesticide use on reproductive health. With the support of the Food and Agriculture Organization of the United Nations we conducted studies spanning two years to assess these three research questions. This paper, Part I, represents our findings related to exposure and acute health effects, while Part II will present the reproductive data.

METHODS

Design and sample size: The primary goal of the study was to determine reproductive outcomes in pesticide applicators. Therefore, the design was a retrospective cohort (cohort in that the study population was purposely selected based on pesticide and non-pesticide use and retrospective in that we looked back at all past birth outcomes of the study population). Because we wanted to document previous exposure validated by current active use (to be sure the exposed were truly exposed and visa versa), we added a cross sectional one-time observational component to gather data on pesticide use and acute health effects. Therefore for this aspect of the study, the sample size was based on a reproductive outcome, stillbirths, details of which will be described in a future report, entitled, Part II, "Reproductive Health Effects," for this journal. Using a two to one ratio to increase the statistical power, we used a sample size of 161 women sprayers and 353 rice farmers.

Sites: Two areas were selected for the study sites. Pesticide using women were selected from the mountainous sub-district of Alahanpanjang in West Sumatra because it produces a large volume of vegetables and likewise uses high amounts of pesticides. Because almost everyone is involved in some sort of agricultural activity in this area continuously throughout the year, using the same women off season as an internal control method was not possible. We also wanted women farmers. Therefore another sub-district, Surian, that was a rice producing community located near Alahanpanjang, was selected for the controls. Data was gathered to control for any socio-economic and current chronic disease rate differences between the two cohorts.

Selection: To find our sprayers, approximately 1,239 households were interviewed in the spraying area (Alahanpanjang) yielding a total of 161 respondents. Two thousands and five households in the rice area (Surian) yielded 353 controls. Selection criteria for our exposed cohort included being a married woman farmer, spraying at least 30% of the time, and previous pregnancies that occurred after first starting to use pesticides. Those selected as controls had to be married women farmers with no previous use of pesticides personally or on the part of their husbands. Sprayers and controls were matched by 5-year-age groups to minimize the effect of age on current health (as well as on reproductive health).

Study variables: Direct exposure was measured and defined as contact with pesticides during measuring, mixing and application. This included detailed observations on any (a) skin contact, (b) inhalation through upwind spraying or crosswind exposure from other spray operators, and (c) oral exposure through contaminated hands or mouth contact with the spray nozzle to clear obstructions. Potential water and food contamination in the home was defined as indirect exposure. This was measured by inspecting the pesticide storage conditions in each of the women's households. We assumed that exposure through food residues was equal for both the controls and spray populations because their food products came from the same areas. Therefore, household foods were not tested. To assess extended skin contact with pesticides, we questioned our sprayers about their bathing and laundry practices on two occasions; at home and after the spray session.

Because we wanted to replicate the previous Central Java study, the same panel of 14 signs and 17 symptoms was used to determine acute pesticide poisoning. Each sprayer and control rice farmer was questioned and examined before and after spraying or working for an equivalent time. A few dummy signs and symptoms unrelated to pesticide use (e.g., constipation, abrasions) were added to identify reporting bias. The panel was based on known health effects of the common pesticide chemical families in use, e.g., organophosphates, carbamates and organochlorines that are neurotoxic and pyrethroids and thiocarbamates which are irritants to the skin, eyes, nose, throat and respiratory tract.[4-7]

A health history was taken to identify any chronic diseases and a variety of socio-economic indicators were measures used based on local standards. They included monthly income (local assessment), land ownership and size, vehicle and television ownership and type of household flooring. Highest obtained educational degree was used for education. Means of fecal disposal was used as a sanitation indicator, critical to a variety of infectious diseases, and perhaps an indirect economic measure. The groups were all Minang Kabau so ethnicity was not considered an issue.

Data collectors, training and questionnaires: Two cadres of staff were hired to collect the data. Midwives took the health histories regarding chronic diseases and gathered the socio-economic data (as well as reproductive information described in Part II [Photo 7]). Because we wanted this study to be maximally participatory with immediate educational benefits to the community of women farmers, local women farmers were specifically recruited as the second cadre of data collectors. All had at least a junior high school education. From a group of 35 trained for the census, we chose 20 of the best and brightest. They conducted the field observations and collected the acute health effects data. As experienced farmers, training to collect the field data was straightforward. The interviews to collect information on symptoms were fine tuned with the data collectors on multiple occasions to be sure the terms and methods of questioning correlated with the study definitions (for example, the meaning of the term and how to elicit the symptom of dizziness). To collect data on signs, physical exams were kept simple to identify obvious abnormalities. They underwent intense training at two different times for a total of two weeks. Furthermore, each woman was also observed collecting information from test respondents on at least two occasions before being allowed to start collecting information in the field.

Quality control: Throughout the study each data collector was monitored collecting data four to five times. The study staff monitored 20% of all midwife interviews. Two staff members who had conducted the previous acute effects study in the Central Java study were brought in to monitor the exposure data, each of whom was in turn monitored by the study epidemiologist (HHM). Twenty percent of the Alapahpanjang sprayers were monitored and 10% of the controls. Since there were less observations required of the controls (we only recorded the kind of work performed) and we had twice the population to observe, we felt 10% monitoring was the most practical and feasible choice. Parallel data was gathered by the monitor to validate the findings.

Questionnaires: The questionnaires were first field tested by the study staff, then again during data collector training. Intra-observer variability testing was done twice as a training tool as well as to insure homogeneity between observers; 5–7% among the field data collectors and 0–5% among the midwives. The socio-economic and chronic disease indicators that should not vary over time were also tested for reliability by interviewing respondents with the same midwife two days in a row. The lowest score was 97%.

Data analysis: Each questionnaire was checked by the study team when the form was turned in, then once again before data entry. Each questionnaire was entered into FOXPRO twice by two separate data entry personnel then validated using **EPIINFO 6.** Final quality review was performed by the epidemiologist. Analysis was performed with SPSSPC for Windows.

RESULTS

Exposure

Household storage of pesticides: We found a total of 998 pesticides in the household survey of our spray operator cohorts; 95% of which were used for agricultural purposes (Table 1). On average these families had six pesticides in their homes, with a range of 2-10. A pesticide was handled, thus introducing potential contamination to the user, on average 13 times a week; range 2-30. All but two households kept their pesticides in their original container. The majority (75%) of these) 998 pesticide products were used twice a week.

Close to a third (30%) of the spray operators did not store their pesticides above ground level to keep them out of the reach of children. Over a quarter (26%) stored them in the same room as water and food, leading to potential contamination. Close to another quarter of these houses (24%) had at least one leaking pesticide container. It therefore appeared that about a quarter of the respondents and their families potentially have an indirect source of pesticide poisoning.

TABLE 1. Pesticide Storage Among Sprayers

Households (n = 161)	n	%
Average number of pesticides found/household	6 ± 2.1 (2-10)	
• 2-4 pesticides	37	23
• 5-7 pesticides	77	48
• 8-10 pesticides	47	29
Total times a pesticide is handled per week	13 ± 5.7 (2-30)	
• <10 x	42	26
• 10-20 x	106	66
• >20 x	13	8
Pesticides	(n = 998)	
Number of pesticides that are used:	(n =. 998)	
• Once a week	76	8
• Twice a week	751	75
• ≥ Three times a week	171	17

By contrast a small proportion (18%) of the rice farmer households had a pesticide on the premises, the majority of which were Mosflya (51%) or Baygonb (36%) used for domestic mosquito control. This helped confirm the absence of pesticide use among our controls and negligible indirect exposure. No leaking containers were found, and all pesticides were stored away from food and water supplies with the exception of two households. Twenty-two of these houses did not have child safe storage.

Amounts of pesticides handled during the previous week: Almost all the women had sprayed since the previous week (87%). Among those that sprayed, the mean weekly frequency was close to two times (1.6) (Table 2). Few had sprayed more than three times a week. Close to three tanks were used per spray operation; rarely only one tank (9%). Based on the woman's tank size (the majority 14 liters) we calculated the weekly liters to which each woman was exposed. On average women handled 69 liters of pesticides per week; the range quite large at 14-392 L.

Observed amount of pesticide use: Most of the women respondents (68%) were using pesticides for dry shallot farming, 6.2% of which were mixed with other crops. The remainder of the cohort was spraying various combinations of potato, garlic, chili and cabbage crops.

Slightly less tanks (2) were used during our observations compared to what they reported as their previous week's use, 69% applying less

TABLE 2. Weekly Amounts of Pesticide Use

	n = 161	%
Times sprayed in the last week (mean, STD, range)	1.6 times ± 0.7 (1-5)	
• none	21	13
• 1 x	70	44
• 2 x	58	36
• 3-5 x	12	7
Tanks per spray operation (mean, STD, range)	2.9 tanks ± 1.2 (1-7)	
• 1 tank -	12	9
• 2 tank	47	34
• 3 tank	48	34
• > 4 tank	33	24
Liters per week (mean, STD, range)	69 liters ± 56 (14-392)	
• < 50 liters	63	45
• 50-1001iters	53	39
• > 100 liters	24	17

than two tanks (Table 3). An average of 30 liters was handled with the range of 14 to 70 liters per spray operation.

Observed exposure times were on average close to one hour but had wide variation; from as little as 10 minutes to three hours and 45 minutes. Because women have multiple other responsibilities their spray patterns were erratic.

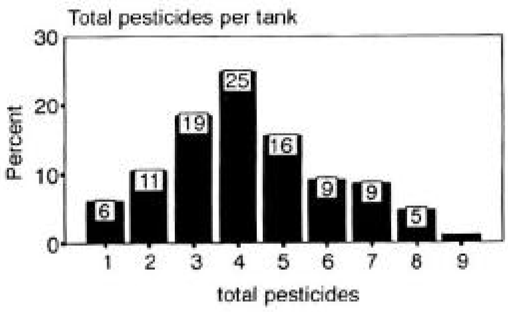
Types of pesticides used: Over half the women used a pre-mixed pesticide concentrate (55%). On average four pesticides were mixed together per tank. Only 17% used one to two formulations and 40% used a high of five to nine different products in one tank (Figure 1).

Among the 161 women spray operators, 878 products were used.

TABLE 3. Observed Amounts of Pesticide Use

	n=161	%
Tanks per spray session (mean range)	2 tanks (1-5)	
• 1 tank	44	27
• 2 tanks	67	42
• 3 tanks	34	21
• 4-5 tanks	16	10
Liters per spray session (mean, SDT, range)	30 liters ± 13.5 (14-70)	
• < 20 liters	44	27
• 20-40 liters	58	42
• > 40 liters	49	30
Average hours spent in spraying/session	56 min ± 45 (.10-3.45 hrs)	
• < 30 min	61	38
• 300- < 60 min	56	35
• ≥ 1 hour	44	27

FIGURE 1. Number of pesticides used per tank



Of these the majority were insecticides and fungicides; 48% and 30%, respectively. The remaining products were fertilizers and surfactants (21%).

If we are to look at tanks as opposed to total products used, all women used some type of insecticide. Only 17% used one alone. Over three quarters of the group (76%) used two to four insecticides in one tank (Table 4). Fungicides were widely used-82% had at least one formulation in their tank, 63% used two or more and almost a third used from three to six.

Pesticide chemical families: The chemical family by which the pesticide can be categorized will dictate in part the known human health effect. For instance, some of the most hazardous are those that affect the nervous system. Organophosphates and carbamates suppress the enzyme acetylcholinesterase, responsible for breaking nerve transmission once impulses have reached their target muscles, organs or glands. The organochlorines have a more generalized central nervous system effect, can be stored in body fat over long periods of time, and are easily absorbed through the skin. The other less hazardous chemical families such as pyrethroids and thiocarbamates are irritants to the skin, mucous membranes, respiratory tract and eyes.[4] Therefore to understand the potential health effects and hazards for women spray operators, we present the pesticides by chemical family.

TABLE 4. Type of Pesticides Used Per Tank

	n = 161	%
Insecticides	161	100
• one alone	28	17
• two	56	35
• three	43	27
• four	23	14
• five-seven	11	7
Fungicides	131	82
• one alone	48	37
• two	45	34
• three	26	20
• four-six	11	9
Surfactants	68	42
Fertilizers	88	55
• one alone	62	71
• two-three	37	29

Twenty-five women (15.5%) used an organochlorine and another 20% used a carbamate (Table 5). Organophosphates were used by over half the women (58%). Close to 20% used more than one, potentially doubling to quadrupling the neurotoxic dose. The presence of at least one neurotoxic pesticide in the women's tanks was found in threequarters of the sample (75%).

The less toxic pesticides were used at a high rate; pyrethroids in 65% of the tanks, thiocarbamates (59%), and others listed by own miscellaneous chemical family were present in 51%. These non-neurotoxin mixtures represent 25.5% of the tanks.

Pesticide WHO hazard levels used: Two pesticides that are classified by WH0[8] as extremely and highly hazardous-Difolatan *(captafol)* and Tamaron *(metamidofos)*-were in use by the women; 3.1 and 8.7%, respectively (Table 6). Almost all were using a class II or moder-

TABLE 5. Pesticides by Chemical Families

	n-161	%
Organochlorines (Oc)	25	15.5
Organophosphates (Op)	93	57.8
• one alone	61	37.9
• wot	27	16.8
• three-four	5	3.1
Carbamates (Carb)	34	19.8
• one alone	30	18.6
• two	2	1.2
Pyrethroids	105	65.2
• one alone	84	52.2
• two or more	21	13.0
Thiocarbamates	95	59.0
• one alone	70	43.5
• two or three	25	15.5
Others	82	50.9
• Triadimeton	28	17.4
• Triazol	27	16.8
• Urea	14	8.7
• Thiophthalimide	9	5.6
• Teflubenzuron	2	1.2
• Chlorothalonil	2	1.2
Combinations of chemical types		
• At least one neurotoxin/tank (Op or Carb or Oc)	120	74.5
• No neuro-toxins	41	25.5

TABLE 6. WHO[1] Hazard Levels of Pesticides Used in Women's Tanks

	n = 161	%
Ia-Extremely hazardous	5	3.1
Ib-Highly hazardous	14	8.7
II-Moderately hazardous	157	97.5
• none	4	2.5
• one	33	20.5
• two	61	37.9
• three	42	26.1
• four-six	21	13.0
III-Slightly hazardous	48	29.8
O-Unlikely hazard if used under 'normal conditions'	141	87.9
Mixtures (Highest Hazard Level in Tank)	n = 161	%
• Ia-extreme	5	3.1
• Ib-high	13	8.1
• II-moderate	142	88•2
• < Class II (extreme, high, or moderate)	160	99.4
• > Class II (slight or unlikely hazard)	1	0.6

[1] International Programme of Chemical Safety. The WHO Recommended Classification of Pesticides by hazard and Guidelines to Classification 1996-1997. WHO/PCS/96.3.

ately hazardous (97.5%) insecticide and 77% used two or more simultaneously. Looking at mixtures, all but one spray operator had at least one class Ia, Ib or II insecticide in her tank.

The complete list of 52 products used by the women is presented in Table 7. These represent the total 688 pesticides used by the 161 women.

Handling practices and direct exposure: Almost all the women measured and mixed pesticides with a spoon or other instrument, as opposed to directly into the tank (95 and 92%, respectively). As a result, all woman had direct skin exposure while preparing their solutions to spray. All wetted their hands during the process, half their feet and a few (11%) their legs (Table 8). Furthermore, almost all had some body contact with the pesticide during spraying (Photo 1). While few tanks had noticeable leaks (5%), commonly residual liquid from mixing was left on the top that eventually spilled down onto the women's clothing while spraying. Therefore their backs, loins, and legs become heavily exposed during spraying.

All the women sprayed upwind, and 89% had significant respiratory exposure either from their own spray reaching the level of their heads or from a neighboring spray operator.

TABLE 7. Complete List of Products Used by Women Spray Operators

Brand Name	n	%	WHO Class	Common name	Chemical Family
Difolatan 4 P	5	0.7	Ia	captafol	thiophthalimide
Tamaron 200 LC	14	2.0	Ib	metamidofos	organophosphate
Fastac 15 EC	3	0.4	II	alfa cypermetrin	pyrethroid
Buldox 25 EC	4	0.6	II	beta cyfluthrin	pyrethroid
Baycarb 500 EC	1	0.1	II	BPMC (fenobucarb)	carbamate
Hopcin 50 EC	2	0.3	II	BPMC (fenobucarb)	carbamate
Kiltop 500 EC	1	0.1	II	BPMC (fenobucarb)	carbamate
Sevin 85 S	1	0.1	II	carbaryl	carbamate
Padan 50 SP	80	11.6	II	cartap hydrochloride	thiocarbarnate
Dursban 20 EC	18	2.6	II	chlorpyrifos	organophosphate
Ripcord 5 EC	37	5.4	II	cypermethrin	pyethroid
Decis 2,5 EC	22	3.2	II	deltamethrin	pyrethroid
Basudin 60 EC	32	4.7	II	diazinon	organophosphate
Diazinon 60 EC	20	2.9	II	diazinon	organophosphate
Thiodan 35 EC	25	3.6	II	endosulfan	organochlorine
Sumialfa 25 EC	1	0.1	II	esfenvalerate	pyrethroid
Dharmasan 600 EC	1	0.1	II	fentoat (phentoate)	organophosphate
Elsan 60 EC	25	3.6	II	fentoat (phentoate)	organophosphate
Regent 50 SC	23	3.3	II	fipronil	pyrazole
Matador 25 EC	1	0.1	II	lambda cyhalortin	pyrethroid
Corsair 100 EC	2	0.3	II	permethrin	pyrethroid
Ambush 2 EC	59	8.6	Ii	permethrin	pyrethroid
Curacron 500 EC	4	0.6	II	profenofos	organophosphate
Baygon	3	0.4	II	propoxur	carbamate
Baythroid 10 UVL	1	0.1	II	cyfluthrin	pyrethroid
Larvin 75 WP	5	0.7	II	thiodicarb	carbamate
Marshal 200 EC	1	0.1	II	carbosulfan	carbamate
Orthene 75 SP	17	2.5	III	acephate	organophosphate
Fujiwan 400 EC	2	0.3	III	isoprothiolane	unknown
Pruvit PR 10/56 WP	8	1.2	III	propineb oxadixyl	thiocarbamate + oxadixyl
Bayleton 250 EC	28	4.1	III	triadimeton	triadimeton
Ingrovol 360 F	3	0.4	O	captan	thiophthalimide
Orthocide 50 WP	1	0.1	O	captan	thiophthalimide
Derosal 60 WP	6	0.9	O	carbendazim	unknown
Delsene MX 200	1	0.1	O	mancozeb + carbendazim	thiocarbamate + benzimidol
Atabron 50 EC	5	0.7	O	chlorflurazuron	urea + trdluorementil
Daconil 500 F	1	0.1	O	chlorothalonil	chlorothalonil
Rubigan 120 EC	1	0.1	O	fenarimol	unknown
Cascade 50 EC	9	1.3	O	flufenoxuron	urea
Anvil 50 SC	1	0.1	O	hexaconazole	triazol
Rovral 50 WP	24	3.5	O	iprodione	iprodione
Amconil 75 WP	1	0.1	O	chlorothalonil	chlorothalonil
Dithane M-45 80 WP	24	3.5	O	mancozeb	thiocarbamate
Manzate 200	2	0.3	O	mancozeb	thiocarbamate
Trineb 80 WP	5	0.7	O	maneb	thiocarbamate
Topsin M 70 WP	2	0.3	O	methyl thiophanate	carbamate + benzimidazol
Sandofan 10/56 WP	1	0.1	O	oxadixyl + mancozeb	thiocarbamate
Antracol 70 WP	124	18.0	O	propineb	thiocarbamate
Folicur 250 EC	26	3.8	O	tebuconazole	triazol
Nomolt 50 EC	2	0.3	O	teflubenzuron	urea + organoflur
Agrimec	1	0.1	?	abamektin	unknown
Midic 200 F	2	0.3	?	tebufenozida	unknown
	TOTAL	688			

TABLE 8. Direct Exposure

	n=161	%
Skin Exposure		
Skin contact during measuring or mixing	161	100
• Hands	160	99
• Legs	17	11
• Fee	82	51
Body contact during spraying	146	91
• Shoulders	89	55
• Hands	40	25
• Arms	25	16
• Neck	4	3
• Back	136	85
• Loins	125	78
• Legs	19	88
• Feet	26	16
Respiratory Exposure		
• Spraying upwind	160	99
• Wind particulate exposure for any reason	144	89
GI Exposure		
• Blows out nozzle with mouth contact	35	22
• Touches mouth during spraying	17	11
• Eats/drinks or smokes during session	0	0

The major source of potential gastro-intestinal (GI) exposure was direct contact with the nozzle in an attempt to blow out an obstruction. This occurred among 22% of the sprayers. No women were observed smoking, eating or consuming beverages with contaminated hands during the operation. However, 11% were observed touching their mouths, providing a route for pesticides to enter the GI tract.

Protective clothing: Most women (78%) used some sort of head covering as is the tradition of the Minang Kabau culture (Table 9) (Photos 1-6). Very few used protective eye wear (2%) or masks (1%); one of the two masks was soaked by the end of the spray session. Gloves were rarely worn as well; only one of which was made of impermeable material. Since all had soaked gloves after the operation, only one had adequate protection. Few used footwear and of these only 4% were made of waterproof rubber. Furthermore, 94% were noted to have wet feet by the time they finished spraying. While close to one-half (47%) wore long pants protecting their legs, almost all were soaked by the time the spray operation ended (98%). Because

PHOTO 1

Alahanpanjang is cool, many women wore double layers to cover their upper bodies and arms. This was the case for 40% of the sprayers. So while close to all (98%) had wet shirts, probably those with double layers had some upper body skin protection.

Laundry and bathing hygiene: A good proportion (78%) of women were observed bathing on site directly after completing the spray operation, most of which consisted of hands and feet. While 80% said they planned to bathe immediately, only 58% reported the same on the household survey. So we assume this latter proportion is a more realistic estimate and that a little over 30% have extended dermal pesticide exposure after the spray session. Another 31% said they usually bathe within two hours. Furthermore, only 55% used freshly laundered clothes during the spray session which is close to the estimated 60% of

TABLE 9. Clothing

	n=161	%
Head covering	125	78
Glasses	3	2
Mask (cotton)	2	1
• wet after spraying	1	1
Gloves (one rubber)	3	2
• wet after spraying	3	2
Footwear	17	11
• rubber boots	7	4
• shoes	1	1
• sandals	9	6
• wet feet after spraying	151	94
Long pants	76	47
• wet pants after spraying	158	98
Arms covered	138	86
• double layer	64	40
• single layer	74	46
• none	23	14
• wet shirt after spraying	158	98

PHOTO 2. Mixing Pesticides with Bare Hands

PHOTO 3. Pouring Pesticide Mixture into Backpack Spray Tank

PHOTO 4. Examining for Tremors

PHOTO 5. Examining for Staggering Gait

PHOTO 6. Examining for Skin Lesions

whom on household survey said they laundered their spray clothing after each operation. So over a third of all women would have continued skin exposure using heavily contaminated clothing during subsequent spray operations. Most did launder their spray operation clothing separately from the family laundry (89%) offering some protection to other family members.

Acute Effects

The women spray operators experienced a whole host of complaints after spraying compared to how they felt before the session (Table 10). To identify reporting bias all women were asked before the observation if they believed pesticides could make them ill. All answered

TABLE 10. Acute Signs and Symptoms Among Sprayers

	Pre-spray		Post-spray		Significance		Excess
	n	%	n	%	x2	p.value	%
Signs (mean)	0.96	1.96					1.0
Tremor	13	8.1	58	36.0	43.0	0.0000	28.0
Eyelid twitching	38	23.6	73	45.3	33.0	0.0000	21.7
Excessive sweating	3	1.9	31	19.3	26.0	0.0000	17.4
Red eyes	24	14.9	24.2	-	7.3	0.0071	13.0
Runny nose	35	21.7	50	31.1	-	0.0007	10.6
Cough	33	20.5	47	29.2	-	0.0001	8.7
Staggering	2	1.2	11	6.8	-	0.0117	6.2
Diarrhea	4	2.5	4	2.5	-	1.0000 ns	.6
White/scaling or red rash	2	1.2	3	1.9	-	1.0000 ns	1.2
Loss of consciousness	0	-	0	-	-	-	-
Convulsions	0	-	0	-	-	-	-
Vomiting	0	-	0	-	-	-	-
Blisters	0	-	0	-	-	-	-
Abrasions	0	-	0	-	-	-	-
Symptoms (mean)	2.5		6.2				2,5
Dry throat	25	15.5	116	72.0	83.5	0.01100	58.4
Tired	56	34.8	144	89.4	84.1	0.0000	55.3
Chest pain	28	17.4	87	54.0	50.2	0.0000	39.1
Numbness	38	23.6	93	57.8	46.3	0.0000	36.6
Eye stinging/itching/burning	23	14.3	61	37.9	28.5	0.0000	26.7
Blurred vision	52	32.3	92	57.0	57.1	0.0000	24.8
Shortness of breath	16	9.9	49	30.4	27.7	0.0000	21.7
Dizzy	31	19.3	62	38.5	42.3	0.0000	21.1
Nausea	8	5.0	41	25.5	29.2	0.0000	21.1
Excessive salivation	14	8.7	38	23.6	17.6	0.0000	16.8
Sore throat	15	9.3	35	21.7	12.1	0.0005	15.5
Burning nose	11	6.8	32	19.9	14.8	0.0001	14.9
Muscle cramps	6	3.7	27	16.8	14.8	0.0001	14.9
Headache	51	31.7	62	38.5	-	0.3470 ns	10.6
Stomach pain	19	11.8	32	19.9	-	0.0106	11.2
Constipation	6	3.7	20	12.4	-	0.0005	9.3
Itchy skin	1	.6	10	6.2	-	0.0039	5.6

ns = not statistically significant

affirmatively. There was also an excess of the non-pesticide associated complaint of constipation post spray among 9% of the sprayers. Therefore, it is likely that there was some bias in reporting symptoms.

More reliable were the observed signs. There were an excess of signs post spray with the exception of diarrhea. We found few skin lesions which would be chronic and no severe neurologic sequelae from spraying (seizures, loss of consciousness) or vomiting.

The excess proportion of cases represents those likely related to pesticides in that they appeared after the spray operation. Note these values are not simply a product of proportions after versus before the operation because a few women actually had some signs and symptoms resolve after spraying. The exceptions to this which clearly points to pesticides were blurred vision, tremors, muscle fasciculation (eyelid twitching), pruritus (itching skin) and cough.

Women after spraying had a mean excess of 2.5 symptoms and one sign. The bulk of the group (68%) experienced two to five new symptoms post spray operation, while 19% had six or more symptoms (Figure 2).

Even with symptom reporting bias, the evidence of signs demonstrates consistent findings. A little over a third (35%) had at least one sign of pesticide poisoning after completing spraying, 21% had two to three signs, and 10% had over three signs. Looking at signs and symptoms together, the bulk of the respondents had from two to six signs and symptoms of pesticide poisoning (Figure 3).

Associations to exposure: Stratification and regression analysis was applied to the acute effects and exposure variables to search for associ-

FIGURE 2. Numbers of symptoms experienced after spraying

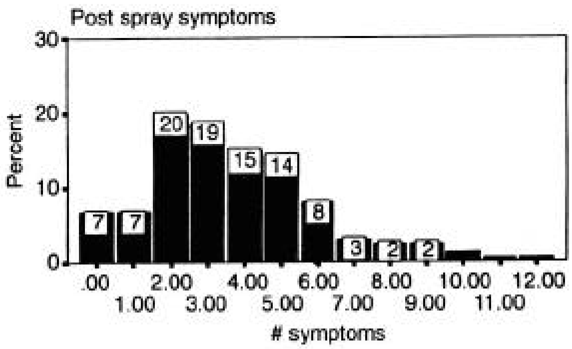
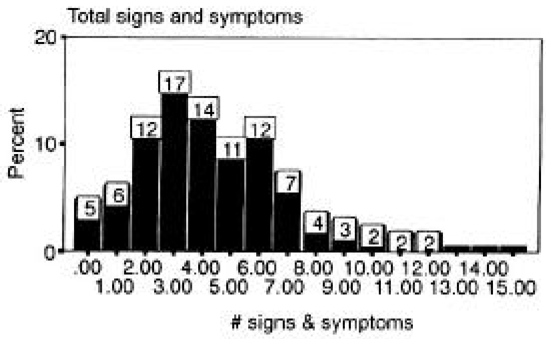


FIGURE 3. Total signs and symptoms



ations. The dependent variable signs and symptoms were screened one by one, by chemical family effects clusters (i.e., neurologic, ENT, etc.), by a panel of only those that were significant when compared to controls (see below), and by total signs and symptom frequency groups. The independent variables tested were the weekly amounts of pesticides used, the observed amounts applied, number of pesticides used, chemical families and physical exposure. No risk factor associations could be made. This might be explained because exposure was uniformly significant for the entire cohort especially in terms of skin and respiratory contamination, the neuro-toxic pesticides used, WHO hazard levels, and lack of protective clothing.

Comparisons to controls: To further evaluate which signs and symptoms could be associated with pesticides we compared the above findings to that of the age matched rice farmer controls. All of the reported symptoms among the sprayers were significant with the exception of headaches, fatigue, and pruritus. Rice farmers work in water and commonly complain of itching. Headache and fatigue are non-specific complaints that could be associated with any hard labor in the sun. The complaint of throat dryness was relatively high in the controls which could be explained by thirst and working in the hot sun.

Significant neurologic signs emerged in the sprayers compared to the controls. These included staggering gait (Photo 5), muscle fasciculation (eyelid twitching) and tremors (Photo 4). Relative risks could not be calculated for the former two as there were no controls observed to have these signs. Red eyes, runny nose, and cough-all commonly associated with the irritant effects of pesticides-were all demonstrably associated with the sprayers compared to the controls. Cholinesterase suppression and subsequent glandular over-stimulation could cause nasal hyper-secretion as well.

The high relative risks (e.g., burning nose -53.2, sore throat -18.5, muscle cramps -10.6, and red eyes -23.3) and wide confidence intervals are explained by the lack of similar symptoms in the controls (Table 11).

The sprayers also had significantly more signs, symptoms and total signs and symptoms compared to the controls.

While reporting bias could in part explain the symptoms (with constipation, our dummy symptom, emerging as significant) the trends and significance of the measurable signs reliably document that pesticide poisoning is indeed occurring among our spray operating cohorts.

TABLE 11. Comparison to Controls

	Alahanpanjang Post Spray (n = 161)	Surian Post Work (n = 357)	Relative Risk	95% Confidence Interval	Significance
Signs	1.0 (± 1.2)	.13 (± .4)	mean difference 0.9		0.000
Eyelid twitching	22.0	0.0 .	undefined	-	S
Staggering	6.2	0.0	undefined	-	S
Red eyes	13.0	0.6	23.3	5.5-98.1	S
Runny nose	10.6	0.8	12.6	3.7-42.3	S
Tremor	28.0	2.8	10.0	5.2-19.3	S
Cough	8.7	0.6	15.5	3.56-67.4	S
Diarrhea	0.6	0.0	undefined	-	NS
Excessive sweating	17.4	11.2	1.6	.99-2.4	NS
White/scaling or red rash	1.2	0.6	2.2	.3-15.6	NS
Blisters	0.0	0.3	-	-	NS
Loss of consciousness	0.0	0.0	-	-	NS
Convulsions	0.0	0.0	-		NS
Vomiting	0.0	0.0	-	-	NS
Abrasions	0.0	0.0	-	-	NS
Symptoms	3.7 (± 2.4)	1.4 (± 1.6)	mean difference 2.3		0.000
Burning nose	14.9	0.3	53.2	7.2-39.0	S
Sore throat	15.5	0.8	18.5	5.7-60.3	S
Muscle cramps	14.9	1.4	10.6	4.1-27.4	S
Nausea	21.1	2.2	9.4	4.5-19.9	S
Constipation	9.3	1.1	8.3	2.8-24.7	S
Eye stinging/'itching/burning	26.7	3.6	7.3	4.1-13.3	S
Excessive salivation	16.8	2.5	6.7	3.2-13.8	S
Dizzy	21.1	4.2	5.2	3.4-7.8	S
Blurred vision	24.8	5.6	4.4	2.7-7.3	S
Stomach pain	11.2	4.2	2.7	1.4-5.2	S
Numbness	36.6	14.0	2.6	1.9-3.6	S
Dry throat	58.4	34.5	1.7	1.4-2.1	S
Shortness of breath	21.7	14.3	1.5	1.1-2.2	S
Headache	10.6	6.7	1.6	0.9-2.8	NS
Tired	55.3	52.4	1.1	.89-1.3	NS
Itchy skin	5.6	7.3	0.8	0.4-1.6	NS
Signs & Symptoms	4.7 (± 3.1)	1.5 (± 1.7)	mean difference 3.2		0.000

DISCUSSION

This study demonstrated that small scale West Sumatran female farmers apply pesticides without personal protection in a highly unsafe manner. These are the characteristics of `normal use' in Indonesia and in most of the developing world.[1] Similar practices have been found in Paraguay,[9] Brazil,[10] Malaysia,[11] the Philippines,[12] Sri Lanka,[13] and the West Indies.[14] What was striking in our findings were the number of products that were handled on a weekly basis (13), their human health hazard level (each woman's tank contained either a level Ia, Ib, or II class pesticide), and the fact that these were being handled during continuous growing seasons. This resulted in uninterrupted exposure throughout the year.

These conditions may in part explain the high proportion of what would be classified as mild pesticide poisoning[15] among our cohort, unlike that which was reported in Central Java. The effect could also have been larger because more hazardous pesticides were used. Fifty percent of the shallot farmers in Central Java used a class Ia, Ib, and II pesticide as opposed to all but one woman in our cohort. This and the fairly homogenous exposure practices did not allow us to find a dose response nor identify high risk exposure factors. The smaller sample, 161 observed spray operations compared to over 800 in Java, also reduced our ability to identify some effects. It also may have exaggerated the effects. Furthermore, these women were likely biased in their one time reporting due to their baseline belief that pesticides can cause illness. Regardless of these study limitations, the trend shows substantial mild pesticide poisoning in most of the cohort; validated by many having verifiable signs of neurotoxicity.

A critical feature of our study was how we used our results. While studies such as these aim to inform national level pesticide policy and add to the common body of knowledge, there is often little impact on the biggest stakeholder-the end user. Rather than wait for changes and enforcement in pesticide policy that may or may not reach the small village farmer, we chose to return to our study population with our findings without delay.

Through a participatory process the data was presented and discussed with some consensus decision making. All the women sprayers gathered in village meetings and divided into small working groups. With flip charts and a scribe they first had to recall the things we observed or on what issues we interviewed them. From this a list of questions were developed. Next each group took one topic and had to decide and draw pictorially what they thought we had found (e.g., out of 10 women how many would have symptom x, y or z). The small groups then had to present their expected results to the group at large for discussion and concurrence. Finally we presented pictorially (Photos 1-7) our findings with a step-by-step explanation of each exposure hazard and its relationship to the health effect (e.g., how pesticides enter the body, WHO hazard levels, basic chemical families, major signs and symptoms, etc.). Each woman was given a list of the pesticides we found in use by hazard level and basic chemical family (highlighting those banned) and a diagram on a picture of a human body showing all the potential signs and symptoms of pesticide poisoning. Local staff from the Department of Plant Protection followed with a description of how Integrated Pest Management (IPM) could help them use less hazardous products less often as a means to reduce the risks to their health. Each of the five meeting groups decided to gather the following week to organize themselves to start farmer field schools.

PHOTO 7. Conjunctional Pallor Exam of Respondent

During these feedback sessions it became clear the dramatic learning process that occurred among these women and their high motivation for change. As a result, we developed an IPM health component within the farmer field school programs. The objectives were primary prevention of pesticide poisoning which we defined as restricted exposure through low-to no-use of only those products that are the least hazardous (Class III or less). This is because 'safe practices' training cannot guarantee reduced exposure in our setting and too commonly lulls the consumer into a sense of false security. The required safety equipment is also far too hot and expensive for the small scale farmer.

Dividing our research questions into small surveys, we have farmers gather the same simplified data as our study on their fellow pesticide using farmer friends, perform simple analysis and present their findings back to their colleagues in community meetings. This serves as an entry point into IPM as well as a consumer-driven community health education process. Through this action research, the end-users are experientially better informed about the hazards and health effects of indiscriminate pesticide use and can make better decisions about future use with the alternative methods of IPM.

NOTES

a. Mosfly® is *allethrin,* a pyrethroid with a Class III (slight) hazard level according to WHO.

b. Baygon® is propoxur, a carbamate with a Class II (moderate) hazard level according to WHO.

REFERENCES

1. Dinham, B. The Pesticide Hazard, A Global Health and Environmental Audit. Zed Books: London & New Jersey 1993, p. 39.

2. Ibid. p. 57.

3. Kishi M. et al. Relationship of pesticide spraying to signs and symptoms in Indonesian farmers. Scan J Work Environ Health 1995;21:124-33.

4. Ellenhorn MJ, Barceloux DG. Chapter 33 Pesticides In Medical Toxicology: Diagnosis and Treatment of Human Poisonings. Elsevier Publication, New York: 1988. pp. 1069-1108.

5. Morgan, DP. Recognition and Management of Pesticide Poisonings, 4th Edition. United States Environmental Protection Agency: Washington DC. 1989.

6. Plestina R. World Health Organization. Prevention, Diagnosis and Treatment of Insecticide Poisoning. World Health Organization. WHO NBC/84.889. 1984.

7. San Francisco Bay Area Regional Poison Control Center. Ed. Olson KR. Poisoning & Drug Overdose. Appleton & Lange, Norwalk, Connecticut: 1994.

8. International Program of Chemical Safety. The WHO Recommended Classification of Pesticides by Hazard and Guidelines to Classification 1996-1997. WHO/ PCS/96.3.

9. Dinham, B. The Pesticide Hazard . . . p. 126.

10. Ibid. p. 88.

11. Tan, SH. Ramasamy, CH. Ahmad, K. A Comparative Study on the Occupational Exposure of Spray Workers Using Knapsack and Spinning Disc Sprayers. In: Heong K.L. (editor). Pesticides Management and Integrated Pest Management in Southeast Asia, College Park, MD: Consortium for International Crop Protection; 1988: 407-415.

12. Rola AC, Pingali PL. Pesticides, Rice Productivity and Farmers' Health: An Economic Assessment. Manila and Washington DC: International Rice Research Institute and World Resources Institute, 1993

13. Utsch H. Pesticide Poisoning in Rice and Vegetable Growing a Vegetable Growing Area in Sri Lanka [dissertation]. Zurich, CH: Universitat Zurich:1991.

14. McDougall L. et al. Attitudes and Practices of Pesticide Users in Saint Lucia, West Indies. Bulletin of the Pan American Health Organization 1993; 27(1):43-51.

15. Tafuri JR. Roberts J. Organophosphate Poisoning. Ann Emerg Med 1987:16: 193-202.