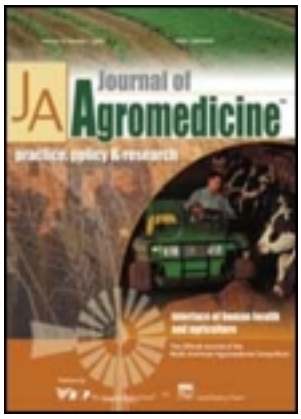

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Pesticide Use Practices in Rural Armenia

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Pesticide Use Practices in Rural Armenia

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ABSTRACT. Pesticide use can have adverse effects on both human health and the environment. Inappropriate use of pesticides increases the health risk to those who work with or live around pesticides. Educational programs for agricultural workers on the proper use of pesticides and personal protective equipment coupled with pesticide regulations are important tools to reduce the associated health risks. The authors conducted a survey ($N = 2336$) on pesticide use practices in the Ararat Valley of Armenia in 2000–2006. This study was a cross-sectional design. A multistage sampling method was implemented in the selection of the study population. The authors developed a questionnaire containing 173 questions to evaluate demographic characteristics, health conditions, and details of pesticides use practices. The intensity of pesticide use was high; 82.8% of respondents used them. More than 150 brand names of pesticides were in use. Unregistered, obsolete, expired, and banned compounds were found in active use. Poor compliance with the basic rules of pesticide safety was found throughout the study population, with 21.3% using gloves and only 11% using respirators. The agricultural workers' knowledge of the toxic properties of these pesticides as well as basic hygienic norms was very low. In some instances, the number of agrichemical applications to crops, particularly cucumbers and melons, reached 40 applications during the growing season. Better protection and training of pesticide users in Armenia is needed.

KEYWORDS. Education, health, personal protective equipment, pesticide, safety

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INTRODUCTION

During the Soviet era, Armenia was a region of extensive pesticide use. The average application of pesticides per hectare reached 35 kg and exceeded the Soviet Union's mean burden by up to 20–25-fold. Based on the level of soil contamination with pesticides, Armenia was considered a "hot spot" for potential pesticide exposure and the accompanying health effects.[1,2] Soviet Armenia had strong regulation concerning the use and application of pesticides. The availability of pesticides through importation, distribution, and application was controlled by the state's specialized enterprise "Armselkhozkhimia" (Armenian agrichemistry). Armselkhozkhimia had a centralized administrative structure that followed the Soviet model by which they employed, trained, and properly equipped crop protection specialists and pesticide applicators. Pesticide applicators were well trained and individually licensed.

Official statistics indicated a dramatic decrease in pesticide importation and use during post-Soviet era. Importation is the only source of pesticides in Armenia, as it does not have a pesticide manufacturing industry. Armenia imported ~458 tons (worth $1.5 million US dollars) in 2004, and ~1705 tons between 1999 and 2004.[3] These amounts are clearly less than the 13,930 tons used in 1989–1991 (data on the 1989–1991 period were provided by former "Armagrichemistry," but were not officially published).

Since the early 1990s, Armenia has faced pesticide use risks typical for developing countries, including a wide assortment of pesticides on the market, poor knowledge of basic safety rules, poor compliance with rules, and low availability of medical care. Developed countries have a history of dumping old and obsolete pesticides into third world countries. In some cases, these pesticides have been sent as international humanitarian aid. For example in 1989, 6 million dollars worth of pesticides were sent to Poland as a gift from European Economic Community (EEC) countries. Twelve of the 32 brands sent in this gift had been banned in their source countries.[4,5] From 1997 to 2000, the United States exported 3.2 billion pounds of pesticides worldwide, with approximately 65 million pounds of pesticides that were either banned or severely restricted in the United States.[6]

Pesticides cause about 3–3.5 million cases of acute poisonings globally every year, with the majority of these cases occurring in the developing world.[7] Faria et al.[8] reported the agricultural workers' poisoning rate in Brazil as high as 2.2 per 100 pesticide contacts. Another study by the same group on Brazil reported that 12% of agricultural workers who had contact with pesticides reported at least one episode of acute intoxication in their lifetime.[9] Social factors including low literacy and low education levels increase health risks from pesticides.[9–18]

This study aimed to evaluate the demographic characteristics, self-reported health status, and pesticide use practices of the rural agricultural population of the Ararat Valley of Armenia.

METHODS

We conducted a survey in the Ararat Valley of Armenia. This region is known for its intensive agricultural production and high pesticide application rates. Yerevan State Medical University research ethics board approved this research.

This study was of a cross-sectional design. The data were collected during 2005–2006. The observation period was 5 years, from 2000 to 2005. A multistage sampling method was implemented in the selection of the study population. First, 26 settlements were selected randomly out of the 186 eligible agricultural settlements in the Ararat Valley. Second, each settlement was allocated a number of eligible respondents in proportion to the number of persons in that settlement. Third, the allocated numbers of households were selected randomly from each settlement. Fourth, one person from each household was selected as a respondent. If both spouses stated personally applying pesticides, the spouse with an earlier birthday was chosen. The total number of selected persons was 2401, and the total number of persons who responded was 2336 (97% response rate).

We developed a questionnaire containing 173 questions to evaluate demographic

characteristics, health conditions, and details of pesticides use practices. We used questions from existing surveys, including the Keokuk County Rural Health Study.[19] Seven trained interviewers completed face-to-face interviews using the structured questionnaire.

This report provides descriptive information on pesticide use in Armenia, demographic characteristics of study participants, agricultural holdings, animals and crops raised, pesticides used, pesticide application equipment, personal protective equipment (PPE), reentry period, preharvest period, and other pesticide use practices. Respondents were asked to name each pesticide they had used any time in the past. For the past 5 years, respondents were asked to name each pesticide and the quantity used annually. Respondents were categorized as pesticide users if they had used any pesticides in the past 5 years.

Data were entered into a Microsoft Access database and analyzed using Microsoft Excel and SAS version 9.1.[20] The statistical methods included comparison of sample means using the *t* test and comparison of proportions of respondents using the chi-square test.

RESULTS

Table 1 contains the demographic characteristics of our study population. From 2336 respondents, 72.1% were male and 27.9% were female, with an age range of 16–96 years with mean of 48.8 (men 48.5, women 49.8). The respondents' main occupations consisted of farming (74.3%), office work (14.5%), and other, including retirees and students (11.2%). Pesticide use was more common among (1) those in the 40–49 age group vs. other age groups; (2) males vs. females; (3) agricultural workers vs. office workers and others; (4) largest holdings vs. mid-sized and smallest; (5) those with rented land vs. others; and those with (6) cattle, (7) small animals and hogs, (8) orchards, (9) vineyards, (10) grains, and (11) vegetables vs. those who did not have these production characteristics.

The majority of the study population owned land. Typical to Armenia, agricultural holdings were small—average 6985 m^2 (standard error [*SE*] $\pm$ 163), median 5900 m^2, and range 200–180,000 m^2 (18 hectares). The average field areas were 6556 m^2 (*SE* $\pm$ 237) for grains, 4110 m^2 (*SE* $\pm$ 257) for melons, 2143 m^2 (*SE* $\pm$ 86) for vineyards, 2115 m^2 (*SE* $\pm$ 69) for vegetable gardens, and 1855 m^2 (*SE* $\pm$ 74) for orchards. These small land holdings cannot produce high quantities of either crops or animals, and as a result only six individuals self-assessed their income as high and 51.4% assessed it as low.

Pesticide use is a very common practice in Ararat Valley. Out of 2336 respondents, 1738 (75.1%) reported regular applications every year during the past 5 years, and 179 (7.7%) used them from time to time, totaling 1917 classified as pesticide users (82.8%). Among those who applied pesticides, most commonly used pesticides were insecticides (96.8% of households), then fungicides (74.0%), and last, herbicides (41.9%). Those who did not use pesticides were older than those who used them (average 50.5 vs. 48.5 years of age; $p = .007$). Further, 66.9% of those who applied pesticides washed their clothes after each application, and 74.1% reported washing them separately from other clothes.

A broad assortment of pesticides was used by our study population. A total of 2093 respondents named at least one pesticide brand or type they had used sometime in the past (includes time prior to 5-year observation period). The total number of names or descriptions reported was 8314. The names included several unknown ones, giving sometimes just a description or purpose of use, such as against mites, rotting, etc. After analysis, 157 unique brand names of pesticides were identified. The most common ones are presented in Table 2. Other commonly used products included Karate (lambda-cyhalothrin; pyrethroid insecticide), Ridomil (fungicide), Decis (pyrethroid insecticide), Omite (organosulfite acaricide), Chlorophos (organophosphate insecticide), Arcerid (fungicide), Antracol (fungicide), Keltan (organochlorine insecticide), Fosalon (organophosphate insecticide), Dursban (chlorpyrifos; organophosphate insecticide), Zineb (fungicide), TMTD (tetramethylthiuram disulfide, fungicide), and Stomp (pendimethalin;

TABLE 1. Characteristics of the Study Population by Pesticide User Status

Characteristics	Pesticide use in past 5 years						*p* value*
	Users		Nonusers		Total		
	n	%	*n*	%	*n*	%	
Age					2308		.0008
16–29	152	80	38	20	190	8	
30–39	319	85	57	15	376	16	
40–49	702	86	113	14	815	35	
50–59	378	81	91	19	469	20	
60–69	216	82	47	18	263	11	
70 and over	144	74	51	26	195	8	
Sex					2315		<.0001
Female	462	72	176	28	638	28	
Male	1455	87	222	13	1677	72	
Education					2304		.08
Primary	58	72	22	28	80	3	
Noncomplete secondary	278	83	58	17	336	15	
Secondary	888	84	166	16	1054	46	
Secondary, special	424	82	92	18	516	22	
Noncomplete higher	61	88	8	8	69	3	
Higher	202	81	47	19	249	11	
Occupation					2301		.002
Agricultural worker	1446	84	267	16	1713	74	
Office worker	256	77	77	23	333	14	
Other	206	81	49	19	255	11	
Total arable land area					2315		<.0001
0–3999 m^2	618	74	217	26	835	36	
4000–7999 m^2	620	86	97	14	717	31	
8000 m^2 and over	679	89	84	11	763	33	
Land rented from others					2315		.003
Yes	288	89	37	11	325	14	
Self-reported income					2264		.06
Low	952	82	210	18	1162	51	
Lower than average	294	83	61	17	355	16	
Average and higher	643	86	104	14	747	33	
Cattle on the holding					2315		.002
Yes	712	87	109	13	821	35	
Small animals and hogs					2315		.005
Yes	245	89	31	11	276	12	
Orchards					2315		<.0001
Yes	922	87	132	13	1054	46	
Vineyards					2315		<.0001
Yes	634	88	84	12	718	31	
Grains					2315		<.0001
Yes	844	87	131	13	975	42	
Vegetables					2315		<.0001
Yes	1411	88	190	12	1601	69	

*p values are based on chi-square tests of pairwise comparison.

herbicide). The official list of registered pesticides in the Republic of Armenia contains about 180 brand names. Our sample (N = 2336) of households reported using a total of 10,500 kg of pesticides on the average annually during the 5-year (2000–2005) observation period (Table 2). Organophosphorus pesticides represented about 20% of all pesticides by mass and frequency of use. The most common herbicides were 2,4-D and its different salts.

TABLE 2. List of Most Often Used Pesticides in Ararat Valley Households

Brand name	Frequency of persons naming a substance		Quantity of substance used	
	n	%	kg	%
Metaphos (parathion-methyl)[1]	1099	13.22	1250	11.86
Phosphamid (dimethoate)[1]	1021	12.28	935	8.87
Arrivo (cypermethrin)[2]	740	8.90	670	6.35
Bayleton (triadimefon)[3]	638	7.67	693	6.58
Cuprosan (mix Zineb/cuprum oxychlorine)[3]	627	7.54	1695	16.08
2,4-D and derivates[4]	303	3.64	648	6.15

Note. 1 = organophosphorus insecticide; 2 = pyrethroid insecticide; 3 = systemic fungicide; 4 = systemic herbicide.

Each household used an average of 5.04 brand names of pesticides, ranging from 1 to 30 (median 5). The total annual use amount varied from 100 g to 100 kg, with median 5.0 kg and mean 6.9 kg. The mean loading was 12.6 kg of pesticides per hectare.

The agricultural workers purchased pesticides mainly in specialized stores (77%), although the proportion of those who bought them from street vendors and traveling merchants was also large (28%) (sum exceeds 100% because some indicated more than one source of pesticides). Less than half of agricultural workers (47%) considered pesticide expiration dates. Some still used old stocks from the Soviet period. Among pesticides in use were many old, unregistered, or obsolete ones. As many as 290 households (12.4%) reported still using dichlorodiphenyltrichloroethane (DDT), which was banned in Armenia long ago. Interestingly, 257 of respondents used it in agriculture and 33 in household use.

Respondents were not familiar with the concept of reentry period (time from pesticide application to the time when it is safe to enter the field). Only 319 respondents (16.6%) reported waiting at least 1 day, and few of them waited 2–3 days before entering into treated fields for performing work activities.

Another important issue (especially for consumers) is the preharvest period (time from pesticide application to the time when crops/produce are safe to harvest). From 1932 interviewed people who reported personally applying pesticides in the past 5 years, 130 stated harvesting the same day after pesticide application. Others waited 1–2 or 3–5 days before harvest and only 18% waited 20 days before harvest. Preharvest periods vary by pesticide and crop, typically ranging from 7 to 30 days (Table 3).

The number of applications varied by crop with the fewest applications for grain: one application of herbicides, usually 2,4-D or its derivates. Applications were most frequent for melons and cucumbers, reaching 20–40 per season. Multiple sequential applications of single fungicides, insecticides, and acaricides as well

TABLE 3. Length of Preharvest Period; Days Between Last Pesticide Application and Harvest

Days	*n*	%	Cumulative %
0	130	6.73	6.73
"Yes"*	52	2.69	9.42
1	100	5.18	14.60
2	144	7.45	22.05
3	295	15.27	37.32
4	122	6.31	43.63
5	143	7.40	51.04
6	18	0.93	51.97
7	305	15.79	67.75
10	159	8.23	75.98
14–15	123	6.37	82.35
20–25	118	6.11	88.46
30	168	8.70	97.15
40+	55	2.85	100.00
Total	1932	100.00	100.00

Note. The responses to preharvest period could not be linked to specific pesticide. Preharvest periods vary by product, typically ranging from 7 to 30 days.
*Answered "Yes, few days" but were not able to specify how many days.

as tank mixes were sprayed. The mean number of applications in orchards was 3.26 (*SE* ± 0.075), vineries 3.84 (*SE* ± 0.080), and vegetable gardens 5.25 (*SE* ± 0.132). The number of days of contact with pesticides (spraying) was 7.7 on the average, range 0–150 days. Each application lasted an average of 2.05 (*SE* ± 0.4) hours; median 1.75 hours and range 12 minutes to 12 hours. During this time, agricultural workers sprayed pesticides on 2500 (*SE* ± 39) m^2, range 50–70,000 m^2.

Agricultural workers used various application equipment for pesticides (Table 4). Handmade and improvised tools such as brooms and plastic bottles were especially utilized by women. Even when using tractors, the proportion of manual work was high from handling hoses, pipes, and sprayer wands. Agricultural workers rarely used personal protective equipment during application. Most respondents did not utilize separate pesticide application clothes. Only 9.3% (female) and 11.5% (male) of agricultural workers used respirators, mostly self-made masks or medical bandage masks (not adequate for proper protection). Relatively often people used headwear and gloves, but special shoes and coveralls were rare. Only 4.9% of males and 4.7% of females had a set of protective clothing including headwear, gloves, and separate pesticide application clothes. The frequency of using PPE was associated with education level.

TABLE 4. Frequency of Using Various Pesticide Application Equipment and Personal Protective Equipment During Pesticide Application (%)*

Application equipment	Males ($n = 1461$)	Females ($n = 400$)	Total ($N = 1861$)
Tractor	55.8	43.2	52.4
Backpack	55.7	41.3	52.3
Manual pump	29.7	43.7	32.9
Improvised tools	3.4	11.6	5.3
Gloves	20.3	25.3	21.3
Apron	2.6	6.5	3.4
Head dress	24.4	22	26.3
Respirator	11.5	9.3	11.0
Overall	2.2	0.5	1.8
Separate pesticide application clothes	24.4	28.3	25.3
No special change of clothes	72.6	69	71.8

*Sum exceeds 100% because respondents indicate more than one type.

DISCUSSION

In the post-Soviet era, the Armenian agricultural industry has undergone many changes. Land reform and the closing of state and cooperative farms have drastically altered agricultural and pesticide use patterns. Many small farms and private producers of agricultural commodities have emerged. The severe poverty of peasant farmers and the small size of farm holdings have limited the use of tractors and other agricultural machinery considered common practice in western countries. Pesticide application is no longer done only by professional applicators, but has become a very common task for the majority of rural peoples with no required training program.

The Ararat Valley of Armenia is predominantly a crop-growing region with small holdings and low income. Pesticides are widely used in the Ararat Valley. We found an assortment of pesticides similar to developing countries, including old, relatively toxic and stable brands.[21,22] Tetramethylthiuram disulfide (TMTD) and Zineb were used as fungicides, which are endocrine disruptors and can affect human reproductive function.[23,24] A significant proportion of respondents used the highly toxic Metaphos, which was used as pesticide and applied frequently during the growing season. Exposure to Metaphos may cause irritation to eyes, skin, and respiratory tract, and it is prohibited for use.[25] The average per-hectare loading of pesticides was 12.55 kg, median 8.33 kg. In the former Soviet period, this indicator reached 35 kg but almost 90% of it was inorganic compounds of copper and sulfur; less toxic and less hazardous pesticides. Intensive multiple applications of pesticides on cucumber, melon, watermelon, and herbs raise concern in regards to residues exceeding acceptable limits.

PPE use in our population was low and was below that in Latin American and African countries.[10,21] Many studies have reported low personal protective equipment (PPE) use,

improper PPE use, and use of nonfunctioning PPE among agricultural workers in developing nations. They lack training on pesticide safety issues, and what training exists is not able to change their behavior and attitudes toward pesticides.[12–15] Insufficient and improper use of PPE is an issue not only for the developing world but developed world as well.[16–18] Only 54–58% of Iowa agricultural workers used gloves during mixing, handling, and loading, and even fewer (25–30%) used them during pesticide application. Other PPE, such as aprons, face shields, goggles, and coveralls, were worn only by few.[16] Perry et al.[17] reported that only 2.5–8.8% of applicators used a complete set of required PPE in Wisconsin, USA. Our study found that only 21.3% of our study population used gloves, and only 11% used a respirator. The lower rate found in this study might be attributable to the general lower education level, shortage of PPE safety training, and different criteria for PPE use. The use of protective clothing was also low and limited to special change of clothes, gloves, and headwear.

The main weakness is that the study did not attempt to validate reports of which chemicals were used. Some erroneous reporting of older "well-known" pesticides may have occurred. The strengths of this study include representative sampling design, exceptionally high response rate, and relatively large size sample. Data collection was conducted via in-person interviews where the interviewers were able to collect relatively complete information from the respondents.

CONCLUSIONS

The intensity of pesticide use remains very high in Armenia. The types of pesticides were typical for developing countries, including old compounds with relatively high application rates, high toxicity, and stable chemical structures. We found a number of unregistered, even banned, and obsolete pesticides. Alarming in our study was the great number of applications (up to 40 for some crops) during one season. Despite the relatively high formal educational level of Armenian agricultural workers, their knowledge and behaviors related to pesticide safety rules remained low. Ignorance of restricted reentry and preharvest periods, number of applications, use of obsolete, unregistered and banned pesticides, and low frequency and inappropriate wearing of personal protective equipment increase not only agricultural workers' personal risks of acute and chronic poisoning, but also increase the health risks for consumers as well. Development of intervention programs to increase the awareness of safety rules and practical information related to pesticides in rural populations is warranted.

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