Available online at www.sciencedirect.com
ScienceDirect
Environmental Research 102 (2006) 230–236
Environmental Research
www.elsevier.com/locate/envres

Pesticides exposure in Culturama, Brazil—Knowledge, attitudes, and practices

Maria Celina P. Recena[a], Eloisa D. Caldas[b,*], Dario X. Pires[a], Elenir Rose J.C. Pontes[c]

[a]*Chemistry Department, Federal University of Mato Grosso do Sul, 79070-900 Campo Grande, MS, Brazil*
[b]*College of Health Science, University of Brasília, 70919-970 Brasília, DF, Brazil*
[c]*Department of Food Technology and Public Health, Federal University of Mato Grosso do Sul, 79070-900 Campo Grande, MS, Brazil*

Received 27 October 2005; received in revised form 28 December 2005; accepted 11 January 2006
Available online 21 February 2006

Abstract

In this study, the knowledge, attitudes, and practices associated with pesticide use and exposure were evaluated in the agricultural community of Culturama, in the state of Mato Grosso do Sul, Brazil. A standardized questionnaire was completed by 250 farm workers aged $\geqslant 18$ years old. The average age of the studied population was 43.6 years and 17.6% had never been to school. Their farms were small (approximately 30 ha) and family operated and did not utilize advanced farming technology. About 92% of the interviewees had worked directly with pesticides and 59.6% reported typical intoxication symptoms. Only 44.3%, however, believe that they had been intoxicated. A significant correlation was found between hand washing after pesticide application and reporting symptoms ($P = 0.014$). Over 90% of the farmers reported using the organophosphorus insecticide methamidophos. A great majority ($>90\%$) considered pesticides to be harmful to human health, but less than 20% used masks, impermeable clothes, or gloves during pesticide application. These results indicate that special educational programs, legislation promoting the use of safer pesticides, and implementation of personal protective measures are necessary to decrease the pesticide exposure of farmers in Culturama.
© 2006 Elsevier Inc. All rights reserved.

Keywords: Pesticides; Brazil; KAP study; Occupational exposure

1. Introduction

The use of pesticides in agriculture for crop protection and pest control has been associated with environmental contamination and human health problems worldwide (Khan, 1980; van der Hoek et al., 1998; Soares et al., 2003). The exposure of agriculture workers to pesticides is the most relevant occupational hazard of pesticide use, primarily in developing countries (Hurtig et al., 2003; van der Hoek et al., 1998). The latest estimate by WHO (1990) indicated that there might be as many as one million involuntary poisonings worldwide each year and two million people hospitalized for voluntary ingestion of pesticides.

Several studies conducted in Brazil have shown that farm workers are exposed to high levels of pesticides (Faria et al., 2004; Soares et al., 2003; Agostinetto et al., 1998; Delgado and Paumgartten, 2004, Moreira et al., 2002). High rates of pesticide poisoning were found among the rural population of the state of Mato Grosso do Sul, Brazil during the period from 1992 and 2002, mainly in the microregions of Campo Grande and Dourados (Pires et al., 2005a; Recena et al., 2006). One study conducted in 1990 indicated that the majority of the rural populations of Vicentina and Fátima do Sul, cities located in the Dourados microregion, had reported symptoms characteristic of pesticide poisoning (Gonzaga and Santos, 1992).

The use of acutely toxic pesticides associated with a weak or absent legislative framework regulating pesticide use is one of the major reasons for the high incidence of poisoning in some developing countries (Konradsen et al., 2003). Additional factors such as lack of information, low literacy, and education levels of the rural population, poor and inadequate working conditions, inadequate protection during pesticide application, and inappropriate

*Corresponding author. Fax: +55 61 3273 0105.
E-mail address: eloisa@unb.br (E.D. Caldas).

0013-9351/$ - see front matter © 2006 Elsevier Inc. All rights reserved.
doi:10.1016/j.envres.2006.01.007

spraying technology have also been shown to play important roles in the intoxication scenario (Hurtig et al., 2003; Karlsson, 2004).

The objectives of this work were to evaluate the knowledge, attitudes, and practices associated with pesticide use and exposure in an agricultural community of Fátima do Sul, in the state of Mato Grosso do Sul, Brazil.

2. Materials and methods

This was a cross-sectional knowledge, attitudes, and practices study among farm workers in Culturama, district of Fátima do Sul city, state of Mato Grosso do Sul, Brazil. This region has small rural properties (30 ha), which were established in 1958 by a Federal settlement program (Prefeitura municipal de Fátima do Sul, 1988). The study population—618 male farmers $\geqslant$18 years of age—was determined based on the Culturama rural population (800 individuals) and on the proportion of males $\geqslant$18 years living in the rural area of Fátima do Sul district (77.3%) (IBGE, 2004).The sample size was selected to support 50% prevalence, 95% confidence limits, and a 5% maximum error of the estimate. A sample size of 237 individuals is required to meet these statistical constraints, but 250 participated in the study to account for nonresponses. The farms were selected randomly within the Culturama region and 1 individual per farm (farmer $\geqslant$18 years of age) was invited to participate in the study.

A questionnaire based on standard questionnaires obtained from other studies conducted in Brazil (Faria, 1997; Araújo, 1998) was prepared and tested with eight local workers, who did not participate in the final study. The suggestions from this group were included in the final standardized questionnaire, which included objective questions related to the workers and the farms, attitudes and practices related to pesticides, symptoms following pesticide application, and knowledge of the impact of pesticide use on human health and the environment. Trained local health personnel administered the questionnaire during an interview, after an oral explanation of the study's objectives. Informed consent was obtained from all participants. The study was conducted according to international guidelines for the protection of human subjects and ethical considerations and took place from August to December 2004.

In this study, we considered as intoxicated all agricultural workers who reported adverse symptoms due to the use of pesticides. Among those individuals, those who believed themselves to have been intoxicated by pesticides were reported as self-reported intoxication (Faria et al., 2004).

Data from the questionnaire were transferred to an Epiinfo Software, 2000 (Epidemiological Program Office, CDC, Atlanta, Georgia) statistical package. χ^2 or Fisher test was used to verify possible associations among the variables of the study, at 5% significance level ($P \leqslant 0.05$).

3. Results

3.1. Profile of the study population

Table 1 shows the general profile of the 250 farmers interviewed in the study and whether they owned, rented, or were employees on the farm where they worked. The average age of the individuals was 43.6 years and 58.4% were from 31 to 50 years old. Most had less than 8 years of education (83.2%) and 17.6% had never been to school. In this study, 230 farmers (92%) stated that they were involved with pesticide spraying during their work in the fields, with half of them having worked with pesticides for over 20 years.

Most of the agricultural workers or their children (77.6%) owned the properties where they worked. Others rented the land or were employees; 67.2% lived on the properties where they worked and 53.2% had been involved in agricultural labor for over 10 years. Many individuals worked on other properties as contracted workers (11.6%) or assisting their neighbors without any labor bond (35.2%).

Table 1
Social and demographic characteristics of the farmers who participated in the study

Characteristics	Number of individuals (%)	Intoxicated individuals[a]	P[b]
Age (years)			0.220
18–20	7 (2.8)	1	
21–30	21 (8.4)	11	
31–40	81 (32.4)	48	
41–50	65 (26.0)	41	
51–60	49 (19.6)	31	
61 or over	22 (8.8)	13	
No answer	5 (2.0)	4	
Education (years)			0.883
0	44 (17.6)	25	
<5	87 (34.8)	52	
5–7	77 (30.8)	47	
8 or over	39 (15.6)	21	
No answer	3 (1.2)	4	
Years of pesticide use			0.129
1–9	39 (15.6)	18	
10–19	62 (24.8)	39	
20–40	115 (46.0)	76	
41 or over	14 (5.6)	7	
No answer	20 (8.0)	9	
Residence on the farm			0.419
Yes	168 (67.2)	96	
No	75 (30.0)	47	
No answer	7 (2.8)	6	
Years living on the farm			0.084
0	82 (32.8)	53	
⩽9	35 (14.0)	20	
10–19	31 (12.4)	18	
20–29	39 (15.6)	22	
30–39	50 (20.0)	24	
40–50	13 (5.2)	12	
Property relationship			0.578
Owner	194 (77.6)	116	
Renter	45 (18.0)	25	
Employee	11 (4.4)	8	
Work on other property			0.523
Yes, helping	88 (35.2)	52	
Yes, as contracted worker	29 (11.6)	20	
No	127 (50.8)	73	
No answer	6 (2.4)	4	

[a]Individuals who reported symptoms.
[b]The category "no answer" was not considered.

3.2. Symptoms reported and pesticides used in the properties

Among the 250 interviewed individuals, 149 (59.6%) reported adverse symptoms after the use of pesticide

(intoxicated). Of those 149 individuals, 66 (44.3%) considered themselves to have been intoxicated (self-reported intoxication). Fig. 1 shows the main symptoms reported by the intoxicated individuals. Sixty-three of them (42.3%) reported two symptoms and 20 reported three symptoms. Twenty individuals stated that they felt adverse but unspecified symptoms. The most frequent symptom reported was cephalea (77 individuals or 51.7% of 149 intoxicated individuals), followed by dizziness (48 individuals), and vomiting (42 individuals). Less than half of the agricultural workers who reported cephalea (29 individuals) identified this symptom as characteristic of pesticide intoxication (self-reported intoxication). On the other hand, all individuals who reported diarrhea and more than 50% of the individuals who reported vomiting, dizziness, and stomach discomfort considered themselves intoxicated. Other symptoms reported by the agricultural workers were loss of appetite, fatigue, blurred vision, burning face, fever, body itching, spots on the body, and ringing in the ears.

No significant correlation ($P>0.05$) was found between reporting of symptoms and age, education level, years of pesticide use, or residence at the farm (Table 1). Although not significant at the confidence level considered, the relations between reporting of symptoms and number of years of pesticide use and of residence at the farm presented the highest correlations among the parameters evaluated ($P = 0.129$ and 0.082, respectively).

Table 2 lists the pesticides most often used on the properties included in the study. Over 90% of the individuals reported using pesticide products containing the organophosphorus insecticide methamidophos as active ingredient. The next most frequently used active ingredients were the organophosphorus monocrotophos and profenophos and the carbamate carbofuran. Among the herbicides, glyphosate was most frequently mentioned (76.4%), followed by 2,4 D and trifluralin.

3.3. Knowledge, attitudes, and practices with regard to the use of pesticides

Almost all the interviewees considered pesticides to be poisonous (97.2%) and even used the word "poison" to identify them, instead of other terms such as agrotoxic, crop protector, or pesticide (Table 3). Agrotoxic is the legal term used in Brazil to designate these compounds. Over 90% of the individuals considered pesticides harmful. The studied population was also aware of who was most at risk

Table 2
Pesticides most used by the farmers and their toxicological class

	Number of individuals (%)	Toxicological class[a]
Insecticide		
Methamidophos	229 (91.6)	Ib
Monocrotophos	124 (49.6)	Ib
Cypermethrin/ profenophos	70 (28.0)	II
Carbofuran	38 (15.2)	Ib
Cypermethrin	6 (2.4)	II
Endosulfan	3 (1.2)	II
Herbicides		
Glyphosate	191 (76.4)	U
2,4 D	116 (46.4)	II
Trifluralin	115 (46.0)	U
Imazaquin	3 (1.2)	U
Ant killers		
Sulfluramid	13 (5.2)	III
Others[b]	6 (2.4)	

[a]Ia, extremely hazardous; Ib, highly hazardous; II, moderately hazardous; III, slightly hazardous; U, unlikely to present acute hazard in normal use (WHO, 2002).

[b]Insecticides: methomyl and deltamethrin; herbicides: linuron, chlorimuron, and paraquat.

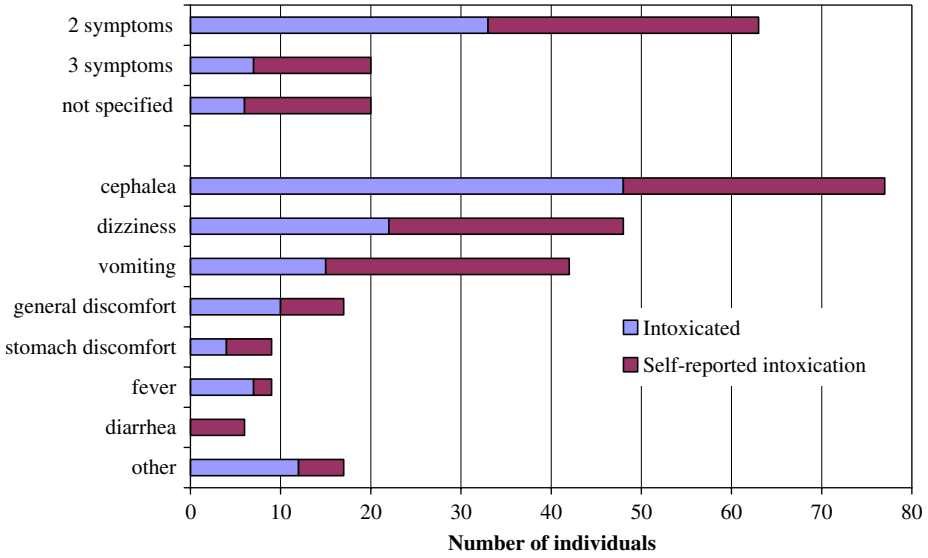

Fig. 1. Symptoms related to pesticides use reported by 149 farmers of Culturama.

Table 3
Knowledge of the farmers with regard to the potential harm of pesticides to humans and the environment, number of individuals (%)[a,b]

Pesticides are poisonous	243 (97.2)
Name used to designate pesticides	
Poison	242 (96.8)
Agrotoxic	85 (34.0)
Crop protector	58 (23.2)
Praguicide/pesticide	2 (0.8)
Pesticides are harmful to the health of	
The general population	230 (92.0)
The agricultural workers who apply them	226 (90.4)
Other agricultural workers	171 (68.4)
People who consume the crops	159 (63.6)
Farm residents	137 (54.8)
Residents of cities near the farm	52 (20.8)
Pesticides are harmful to	
The environment in general	238 (95.2)
Rivers	220 (88.0)
Air	158 (63.2)
Soil	143 (57.2)
Vegetation	64 (25.6)
Well water	36 (14.4)
Water from a semi-artesian well	14 (5.6)

[a]In the questionnaire, the word agrotoxic (*agrotóxico*) was used when referring to pesticides.
[b]More than one option could be given by each respondent, the percentage is calculated based on 250 individuals.

Table 4
Attitudes and practices by the farmers with regard to the use of pesticides, number of individuals (%)

Hours working in the field during growing season	
2–7	43 (17.2)
8–10	160 (64.0)
$\geqslant$11	41 (16.4)
No answer	6 (2.4)
Days, per month, working with pesticides	
2	70 (28.6)
3–10	146 (59.6)
11–20	20 (8.1)
>over 20	9 (3.7)
Type of applicator	
Costal sprayer + open tractor	92 (36.8)
Costal sprayer	80 (32.0)
Open tractor	72 (28.8)
Other	6 (2.4)
Storage of pesticide products	
On the farm outside the home	239 (95.6)
In the home	6 (2.4)
No answer	5 (2.0)
Leftover pesticide solution	
Used in another application	136 (54.4)
Stored outside the home	89 (35.6)
Disposed on the soil	13 (5.2)
Other	7 (2.8)
No answer	5 (2.0)
Empty pesticide containers	
Stored in the house	136 (54.4)
Incinerated	35 (14.0)
Brought to a pesticide container disposal facility	21 (8.4)
Left in the field	19 (7.6)
Local waste containers	17 (6.8)
Buried	14 (5.6)
Reused	3 (1.2)
No answer	5 (2.0)
Pesticide application equipment washed	
Close to the home	141 (56.4)
In the field	56 (22.4)
Using water from the water well	33 (13.2)
Using water from the river	6 (2.4)
Other	9 (3.6)
No answer	5 (2.0)

from pesticide exposure, as they consider the pesticides to be more harmful to the workers who deal directly with these compounds (90.4%) and less harmful to the residents who are far from the agricultural zone (20.8%). Over half of the individuals (63.6%) stated that consuming food treated with pesticides might be harmful to one's health.

A great majority of the agricultural workers considered pesticides harmful to the environment (Table 3), mainly to rivers (88.0%), air (63.2%), and soil (57.2%). Only a few of them (14.4%) believed that pesticides could compromise the quality of ground water supply (for wells). Indeed, 216 (75.5%) indicated that they use the water from the wells in their daily activities, including cooking (data not shown).

Table 4 summarizes the attitudes and practices with regard to pesticide use by the individuals in the study. At least 32% of the individuals used costal sprayer (manual application) and over 36% used both costal sprayer and open-cabin tractor for pesticide application. Most of the individuals reported working 8–10 h a day during the growing season, with pesticide application occurring on 3–10 days each month. Almost all farms (95.6%) had an extra room outside the farmhouse for storage of the pesticide products, and only six individuals reported storing these products inside their homes.

The majority of the individuals indicated that they used leftover pesticide solutions on another crop the same day, but about 35.6% of them kept it in the storage room for later use. A minority reported that they disposed of leftover pesticide on the field (Table 4). In most cases, the farmers disposed the empty pesticide containers within the farm (54.4%) by incineration, burying, leaving it in the field, or reutilization for other purposes (e.g., for food and water storage). On some farms, the empty containers were taken to the local waste containers (6.8%) or to a pesticide container disposal facility (8.4%). Equipment used to apply the pesticides was washed with a water hose near the house (56.4%) or in the field, using water from the river or from the wells.

Table 5 shows the safety procedures utilized during pesticide handling and application. The majority of the individuals stated that they followed the label instructions, observed the wind direction, and chose an appropriate time for application. Around 80% of the individuals reported

Table 5
Safety procedures adopted by the farmers and the correlation with reporting of symptoms

	Number of individuals (%)[a]	Intoxicated individuals	*P*
Followed the product label			0.652
Yes	180	105 (58.3)	
No	65	40 (61.5)	
Observed the wind direction			0.631
Yes	228	134 (58.8)	
No	17	11 (64.7)	
Chose the time for application			0.449
Yes	232	136 (58.6)	
No	13	9 (69.2)	
Wore boots			0.411
Yes	89	50 (56.2)	
No	156	96 (61.5)	
Wore gloves			0.226
Yes	39	20 (51.3)	
No	206	127 (61.7)	
Wore hat			0.362
Yes	196	114 (58.2)	
No	49	32 (65.3)	
Wore impermeable clothes			0.753
Yes	23	13 (56.5)	
No	222	133 (59.9)	
Wore mask			0.690
Yes	45	28 (62.2)	
No	200	118 (59.0)	
Wash hands after application			0.014[b]
Yes	228	132 (57.9)	
No	17	15 (88.2)	
Showered after application			0.153
Yes	238	140 (58.8)	
No	7	6 (85.7)	
Changed clothes after application			0.208
Yes	234	138 (59.0)	
No	11	9 (81.8)	
Avoided eating during application			0.076
Yes	214	123 (57.5)	
No	31	23 (74.2)	

[a]Five farmers did not answer.
[b]Prevalence rate: 1.52 (1.24–1.87; IC 95%).

wearing hats, but less than half wore boots (36.6%) and even fewer wore masks (18.4%), gloves (15.9%), or impermeable clothes (9.4%). Most of them (>87%) reported washing their hands, changing clothes, and showering after working with pesticides, and they avoided eating during pesticide application. When the safety procedures adopted by the individuals was correlated to reports of symptoms, we found a significant correlation ($P = 0.014$) between hand washing and symptoms (Table 5). Of the individuals that reported not washing their hands, 88.2% were intoxicated, while of those who did wash their hands, 57.9% reported intoxication symptoms. Although not significant at the confidence level considered, avoiding eating during application had the second highest correlation with reporting of symptoms ($P = 0.076$).

4. Discussion

Gonzaga and Santos (1992), in a study carried out in 1990 in the same region where the present work was conducted, showed that 35% of the 148 agricultural workers evaluated were between 21 and 30 years of age and almost 90% of them were farm owners. The profile of the agricultural population of the region found in the present study, older and with fewer farmers owning their properties, reflects the emigration process from agricultural to urban areas, which has been occurring in the region over the past 15 years (FETRAF, 2005). The educational background of the farmers in the region, however, has not changed significantly. According to Gonzaga and Santos (1992), 85% of the workers had less than 8 years of education in 1990 and among them, 16.9% had never been to school. Low levels of education in agricultural communities has also been observed in other regions of Brazil (Oliveira-Silva et al., 2001; Moreira et al., 2002; Delgado and Paumgartten, 2004; Faria et al., 1999; Soares et al., 2003), Ecuador (Hurtig et al., 2003), Spain (Garcia et al., 2002), and Ethiopia (Mekonnen and Agonafir, 2002).

Populations with little formal education might be at higher risk when using pesticides, possibly due to difficulties in understanding the use instructions and safety procedures included on the product labels. Although trained technical personnel can provide use instructions and safety procedures, this information is not necessarily understood by the growers and/or incorporated into their daily agricultural practices (Guivant, 1994). According to Peres and Rosemberg (2003), beliefs, habits, and moral values of the technicians and farmers influence significantly the communication between these two groups and can compromise the implementation of good agricultural practices by the farmers.

In this study, less than half of the 149 individuals who reported symptoms after using pesticide considered themselves intoxicated by these products. Yassin et al. (2002) found a higher incidence of self-reported intoxication among younger workers and suggested that this population might express themselves better during the interviews. Some studies found that an applicator that experienced symptoms or illness that led to a visit to a health care provider was more likely to remember the event than others who did not seek care (Keim and Alavanja, 2001; Lichtenberg and Zimmerman, 1999).

Symptoms reported by the individuals in this study, such as cephalea (headache), dizziness, abdominal pain, and vomiting, are typical of exposure to pesticides, including the organophosphorus and carbamate insecticides (Smit et al., 2003). Kamel et al. (2005), in a cohort study conducted with 18,782 pesticide applicators in the USA, found a

greater symptom count associated with cumulative use of insecticides, mainly organochlorine and organophosphorus, than with other pesticide classes. The reported neurological symptoms associated with organophosphorus exposure included headache, fatigue, and dizziness. Organophosphorus and carbamate insecticides inhibit the enzyme acetyl cholinesterase, responsible for the hydrolysis of the neurotransmitter acetylcholine (Ecobichon, 1996). These insecticides, many classified as highly hazardous (WHO, 2002), were also responsible for most of the intoxications that occurred in the state of Mato Grosso do Sul between 1992 and 2002 (Recena et al., 2006; Pires et al., 2005b). Restriction on the use of highly toxic pesticides had been considered by some authors an important factor to decrease intoxication events (Konradsen et al., 2003; van der Hoek et al., 1998). Associated with the use of highly toxic pesticides, the use of low-technology application equipment by the growers, such as costal sprayers, may enhance the risk of exposure. Factors such as lack of information, tradition, and low cost may lead the growers to prefer those applicators (Garcia, 2001).

Individuals in this study participated in a familiar agriculture system characterized by small properties, ownership of the productive process, and labor provided by family members, occasionally complemented by paid work (PRONAF, 2005). In this system, all property residents may be exposed to the pesticides either directly during manipulation or indirectly during their proximity to the field area (Garcia and Almeida, 1991). In Culturama, the houses on most farms are located just a few meters away from the field, which increases the potential exposure of individuals not directly involved with agricultural activities, including children.

Despite the fact that the great majority of the population of this study had a clear perception that pesticides could harm their health, the use of personal protective devices (PPD) during pesticide application was not a common practice in the region. This low use of PPD has also been observed in other rural communities in Brazil (Delgado and Paumgartten, 2004; Oliveira-Silva et al., 2001; Waichman et al., 2002; Agostinetto et al., 1998) and other countries (Gomes et al., 1999; Mansour, 2004; Salameth et al., 2004; Garcia et al., 2002). Some studies have also shown that knowledge of the toxic potential of pesticides does not directly reflect the use of protective devices (Yassin et al., 2002; Martinez et al., 2004). Many factors might account for this apparent reckless attitude regarding self-protection by the farmers. The high cost of PPD was identified in some studies as an important factor restricting their use (Alves Filho, 2001; Yassin et al., 2002; Agostinetto et al., 1998). Other authors, however, have not found any relationship between PPD use and family income (Garcia et al., 2002). PPD can cause discomfort, mainly in hot weather, which occurs frequently in this region. Faria et al. (2000) reported that in southern Brazil, which has a moderate climate, over 50% of the agricultural workers reported using boots, hats, gloves, masks, and thicker or impermeable clothes during pesticide application.

Among all the safety procedures adopted by the farmers, including the use of PPD, only washing hands after pesticide application showed a significant correlation with reporting symptoms. Most of the individuals who adopted this practice did not report symptoms. Avoiding eating during application also showed an important correlation with symptoms. These results show that ingestion is an important route of exposure to pesticides in this population.

5. Conclusions

The use of highly toxic insecticides by the growers of Culturama, in the state of Mato Grosso do Sul, Brazil, applied using low-technology equipment and no individual protection, indicates that this population may be at high risk of pesticide exposure. Although this population recognizes the potential harm of pesticides to human health and the environment, transforming this knowledge into practical actions, resulting in a lower level of exposure, might prove a complex task. Educational and technical support that takes into account cultural and socioeconomic aspects of the population are required to change the scenario observed in this study. In addition, governmental actions, such as interdiction and/or restrictions on the use of more toxic pesticides and enforcement of good agricultural practices including the use of safety equipments, are needed to decrease the pesticide exposure of the agricultural population.

Acknowledgment

We thank Carol R. Johnson for kindly revising the English language.

References

Agostinetto, D., Puchalski, L.E.A., Bezerra, A.J.A., Botton, M., 1998. Assessment of agro-chemical spraying methods and personal protective equipment used by potato growers in the municipality of Pelotas. Rev. Bras. Saúde Ocup. 24, 67–74.

Alves Filho, J.P., 2001. Proteção ao trabalhador. Proteção. Ago/2001, pp. 62–69.

Araújo, A.C.P., 1998. Importância da análise de resíduos de praguicidas para ações de saúde pública: estudo da cultura do tomate do estado de Pernambuco. Ph.D. Thesis, USP—Faculdade de Saúde Pública, São Paulo, Brazil.

Delgado, I.F., Paumgartten, F.J.R., 2004. Pesticide use and poisoning among farmers from the county of Paty do Alferes, Rio de Janeiro, Brazil. Cad. Saúde Publica 20, 180–186.

Ecobichon, D.J., 1996. Toxic effects of pesticides. In: Klaassen, C.D. (Ed.), Casarett and Doull's Toxicology, fifth ed. McGraw Hill, New York.

Faria, N.M.X., 1997. Saúde do trabalhador rural, Master Dissertation. Epidemiology. Universidade Federal de Pelotas, RS, Brazil.

Faria, N.M.X., Facchini, L.A., Fassa, A.G., Tomasi, E., 1999. A cross-sectional study about mental health of farm-workers. Rev. Saúde Pública 33, 391–400.

Faria, N.M.X., Facchini, L.A., Fassa, A.G., Tomasi, E., 2000. The rural labor process and health in the Southern Brazilian mountains: a descriptive study. Cad. Saúde Pública 16, 115–128.

Faria, N.M.X., Facchini, L.A., Fassa, A.G., Tomasi, E., 2004. Rural work and pesticide poisoning. Cad. Saúde Pública 20, 1298–1308.

FETRAF. Federação dos Trabalhadores na Agricultura Familiar, 2005. Available at http://www.agroline.com.br/agronotícias/notícia.php?id=639.

Garcia, E.G., 2001. Segurança e saúde no trabalho rural: a questão dos agrotóxicos. FUNDACENTRO, Ministério do Trabalho e do Emprego, Brazil 182pp.

Garcia, E.G., Almeida, W.F., 1991. Exposição dos trabalhadores rurais aos agrotóxicos no Brasil. Rev. Bras. Saúde Ocup. 72, 7–11.

Garcia, A.M., Ramirez, A., Lacasaña, M., 2002. Prácticas de utilización de plaguicidas en agricultores. Gac. Sanit. 16, 236–240.

Gomes, J., Lloid, O.L., Revitt, D.M., 1999. The influence of personal protection, environmental hygiene and exposure to pesticides on the health of immigrant farm workers in a desert country. Int. Arch. Occup. Environ. Health 72, 40–45.

Gonzaga, M.C., Santos, S.O., 1992. Avaliação das condições de trabalho inerentes ao uso de agrotóxicos nos municípios de Fátima do Sul, Glória de Dourados e Vicentina-Mato Grosso do Sul -1990. Rev. Bras. Saúde Ocup. 76, 42–46.

Guivant, J.S., 1994. Perception of the great Florianópolis (SC) legume farmers about the risks created by pesticides. Rev. Bras. Saúde Ocup. 22, 47–57.

Hurtig, A.K., San Sebastian, M., Soto, A., Shingre, A., Zambrano, D., Guerrero, W., 2003. Pesticide use among farmers in the Amazon basin of Ecuador. Arch. Environ. Health 58, 223–228.

IBGE. Instituto Brasileiro de Geografia e Estatística, 2004. Sistema IBGE de Recuperação Automática, SIDRA. Available at http://www.sidra.ibge.gov.br.

Kamel, F., Engel, L.S., Gladen, B.C., Hoppin, J.A., Alavanja, M.C., Sandler, D.P., 2005. Neurologic symptoms in licensed private pesticide applicators in the agricultural health study. Environ. Health Perspect. 113, 877–882.

Karlsson, S.I., 2004. Agricultural pesticides in developing countries – a multilevel governance challenge. Environment 46, 22–41.

Keim, S.A., Alavanja, M.C.R., 2001. Pesticides use by persons who reported a high pesticide exposure event in the agricultural health study. Environ. Res. 85, 256–259.

Khan, S.U., 1980. Pesticides in the Soil Environment. Elsevier Scientific, Amsterdam 240pp.

Konradsen, F., van der Hoek, W., Cole, D.C., Hutchinson, G., Daisley, H., Singh, S., Eddleston, M., 2003. Reducing acute poisoning in developing countries—options for restricting the availability of pesticides. Toxicology 192, 249–261.

Lichtenberg, E., Zimmerman, R., 1999. Adverse health experiences, environmental attitudes, and pesticides usage behavior of farm operator. Risk Anal. 19, 283–294.

Mansour, S.A., 2004. Pesticides exposure–Egyptian scene. Toxicology 198, 91–115.

Martinez, R., Gratton, T.B., Coggin, C., René, A., Waller, W., 2004. A study of pesticides applicators in Tarrant County, Texas. J. Environ. Health 66, 34–37.

Mekonnen, Y., Agonafir, T., 2002. Pesticide sprayer's knowledge, attitude and practice of pesticide use on agriculture farms of Ethiopia. Occup. Med. 52, 311–315.

Moreira, J.C., Jacob, S.C., Peres, F., Lima, J.S., Meyer, A., Oliveira-Lima, J.J., Sarcinelli, P.N., Batista, D.F., Egler, M., Faria, M.V.C., Araújo, A.J., de Kubota, A.H., de Soares, M.O., Alves, S.R., Moura, C.M., Curi, R., 2002. Integrated evaluation of the health impact of pesticide use in a community at Nova Friburgo, RJ. Ciênc. Saúde Coletiva 7, 299–311.

Oliveira-Silva, J.J., Alves, S.R., Meyer, A., Perez, F., Sarcinelli, P.N., da costa Mattos, R.C.O., Moreira, J.C., 2001. Influence of social-economic factors on the pesticide poisoning, Brazil. Rev. Saúde Pública 35, 130–135.

Peres, F., Rosemberg, B., 2003. É veneno ou é remédio? Os desafios da comunicação rural sobre agrotóxicos. In: É veneno ou é remédio? Agrotóxicos, saúde e ambiente FIOCRUZ, Brazil, 384pp.

Pires, D.X., Caldas, E.D., Recena, M.C.P., 2005a. Pesticide poisoning in Dourados, Mato Grosso do Sul State, Brazil, 1992/2002. Cad. Saúde Pública. 21, 804–814.

Pires, D.X., Caldas, E.D., Recena, M.C.P., 2005b. Pesticide use and suicide in the State of Mato Grosso do Sul, Brazil. Cad Saúde Pública 21, 598–605.

Prefeitura Municipal de Fátima do Sul, 1988. Perfil do município de Fátima do Sul. Fátima do Sul, 123pp.

PRONAF. Programa Nacional de Fortalecimento da Agricultura Familiar, 2005. Available at http://www.pronaf.gov.br/quem_somos/perguntas.htm.

Recena, M.C., Pires, D.X., Caldas, E.D., 2006. Acute poisoning with pesticides in the state of Mato Grosso do Sul, Brazil. Sci. Total Environ., in press. (Available on line on May 2005)

Salameth, P.R., Baldi, I., Brochard, P., Saleh, B.A., 2004. Pesticides in Lebanon: a knowledge, attitude, and practices study. Environ. Res. 94, 1–6.

Smit, L.A., van-Wendel-de-Joode, B.N., Heederik, D., Peiris-John, R.J., van der Hoek, W., 2003. Neurological symptoms among Sri Lankan farmers occupationally exposed to acetylcholinesterase-inhibiting insecticides. Am. J. Ind. Med. 44, 254–264.

Soares, W., Almeida, R.M.V.R., Moro, S., 2003. Rural work and risk factors associated with pesticide use in Minas Gerais, Brazil. Cad. Saúde Pública 19, 1117–1127.

van der Hoek, W., Konradsen, F., Athukorala, K., Wanigadewa, T., 1998. Pesticide poisoning: a major health problem in Sri Lanka. Soc. Sci. Med. 46, 495–504.

Waichman, A.V., Rombke, J., Ribeiro, M.O., Nina, N.C., 2002. Use and fate of pesticides in the Amazon State. Environ Sci. Pollut. Res. Int. 9, 423–428.

WHO. World Health Organization, 1990. Public Health Impact of Pesticides Used in Agriculture, Geneva, Switzerland.

WHO. World Health Organization, 2002. Recommended Classification of Pesticides by Hazard and Guidelines to Classification, 2000–2001, Geneva, Switzerland.

Yassin, M.N., Abu Mourad, T.A., Safi, J.M., 2002. Knowledge, attitude, practice, and toxicity symptoms associated with pesticides use among farm workers in the Gaza Strip. Occup. Environ. Med. 59, 387–394.