

# Knowledge and attitudes in the rural Western Cape towards pesticides in water sources

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## Abstract

There is a need for pesticide water monitoring in South Africa and for community awareness with regard to chemical contamination of rural water sources.

The results of two descriptive studies in the rural Western Cape are reported. One assessed water usage and the knowledge, attitudes and practices in relation to water of farm residents (229 participants from 60 farms) in the Slanghoek Valley, Hex River Valley and Grabouw (KAP) and the other (monitoring capacity survey), investigated water usage and the capacities of rural communities (63 farm residents from 16 farms in three local authorities and 8 environmental health officers (EHOs) from 7 local authorities) to conduct monitoring of pesticides in rural water sources.

Most farm residents in both surveys identified protected sources such as groundwater from springs and boreholes (30 to 60%), and water from mountain dams (40 to 65%), as the most important sources for drinking and other domestic purposes. Many (> 40%), however, also reported farm dams. For use in the field (both drinking and other), potentially contaminated sources (river, subsurface drains, dams) were more frequently reported. Forty-eight percent of participants also reported swimming in farm dams. Other water sources reported included municipal, rain and canal water. In the monitoring capacity survey, 27 % reported using untapped water. About a third of respondents in the KAP survey reported living within 10 m of the nearest site of spraying and many used pesticides at home for pest control (41%) and in the garden (33%). While almost all participants (> 90%) in both surveys were aware that pesticides and polluted water could be harmful, many did not identify health effects (20%) especially chronic effects (91%) or reported no training (37%) in health effects. In all 7 districts surveyed in the monitoring capacity survey, water sources on farms are tested by EHOs. Only 3 (37%) respondents felt that there were enough persons conducting water monitoring in their area. Only 1 respondent reported that pesticides were monitored, and only in request to a complaint. Three state laboratories, that did not have the analytical capacity to conduct routine pesticide water monitoring at low (< 0.1 mg/ℓ) detection limits, were identified as conducting water analyses.

The study found that farm residents in the Western Cape are potentially exposed to pesticides through various environmental routes including water. This emphasises the need to monitor water for pesticides in the Western Cape, but in order to do this, human and laboratory resources and capacities to conduct routine pesticide water monitoring need to be increased.

**Keywords:** pesticide knowledge, water, pollution, monitoring capacity

## Introduction

South African water pollution control legislation has changed substantially in recent years. Following a consultative process involving the publication of a White Paper on a National Water Policy for South Africa (Department of Water Affairs and Forestry, 1997), and a Draft White Paper on Integrated Pollution and Waste Management for South Africa (Department of Environmental Affairs and Tourism, 1998), Parliament enacted the National Water Act in 1998 (Department of Water Affairs and Forestry, 1998). One of the principal changes contained in the Act is the move toward management of water resources on a catchment basis, based on "demand" rather than supply, and emphasising greater conservation of water resources through measures such as an appropriate pricing system. The Act also emphasises public participation and provides for greater community involvement in water management

structures. Additionally, the Department of Water Affairs and Forestry's (DWA) White Paper recognises the lack of access of millions of South Africans to a safe water supply.

However, despite the importance of the agrochemical industry in the South African economy (National Department of Agriculture, 1998; Torres et al., 2000) and high levels of pesticide usage in the country (London and Myers, 1995a; b) relatively little monitoring of rural water sources in SA has taken place with regard to pesticide pollution (London et al., 2000). Thus, in addition to a probable lack of knowledge and capacity, opportunities for rural farming communities to participate in water catchment management are limited by the lack of data on pesticide pollution. Nonetheless, studies have increasingly begun to report on pesticide pollution arising from farming activities in SA. Weaver (1993) found atrazine present in water entering irrigation systems in the Northern Cape, resulting from runoff from maize farming. London et al. (2000) found consistent pesticide pollution of surface- and groundwater including drinking water in three rural Western Cape agricultural districts in 1996-1997. The polluted drinking water was identified mostly in dams and boreholes used by rural communities, but also in two major dams contributing to municipal

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TABLE 1 Sampling and participation in the two surveys					
Dates and site	Sample type	Population (N)	Sample (n)	Participating farms/ local authority	Participating subjects
<b>Survey in Slanghoek, Hex River and Grabouw</b>					
June 1997: Slanghoek Valley	All farms in Slanghoek Valley	18	18	12	7 farm owners 3 managers 12 spray operators 9 farm workers 9 non-farm workers
October 1999: Grabouw/ Vyeboom	Farms on which water sampling was conducted	5	5	2	2 managers 2 spray operators 2 farm workers 2 non-farm workers
	Random sample	145	40	29	7 owners 23 managers 29 spray operators 28 farm workers 25 non-farm workers
October 1999: Hex River Valley	Farms on which water sampling was conducted	6	6	4	2 managers 3 spray operators 3 farm workers 3 non-farm workers
	Random sample	147	40	13	5 owners 10 managers 14 spray operators 16 farm workers 13 non-farm workers
TOTAL		321	109	60	19 owners 40 managers 60 spray operators 58 farm workers <u>52 non-farm workers</u> 229 participants
<b>Study of capacities within rural Western Cape to monitor water</b>					
September 2001	Random sample	93 LA's	12 LA's (60 staff members, 5 from each LA)	7 LA's	8 EHO's
October 2001	Convenient sample, access arranged by EHO		36 farms (3 farms in each LA), 180 farm residents (5 from each farm)	16 farms from 3 LA's	7 owners 28 managers 6 spray operators <u>20 farm workers</u> 63 participants

supplies. Recently, azinphos-methyl and endosulfan resulting from orchard runoff, were also detected in the Lourens River (Schultz, 2001). In a study of indigenous fish species in South African rivers (CSIR, 1996), which included the Berg River in the Western Cape, the maximum whole fish load of organochlorines reached high-risk levels in worst-case scenarios (fish eaten daily all year round).

These studies emphasise the need for pesticide water monitoring in South Africa, and point to the importance of community awareness with regard to chemical contamination of rural water sources.

This paper reports the results of two surveys conducted within an investigation of potential pesticide pollution of rural water sources (London et al., 2000; London et al., 2002). One study was conducted to meet the objective of assessing the practices of farm residents in relation to water as part of a major study investigating pesticide water pollution in three agricultural areas in the Western Cape, and the second investigated the capacities of rural communities to conduct monitoring of pesticides in rural water sources. The latter was part of a project aimed at developing environmental monitoring methods for pesticides in rural waters, to support implementation by local communities (London et al., 2002).

## Methods

Both studies were descriptive cross-sectional in design and conducted in the rural Western Cape. Study one (farm resident knowledge, attitudes and practices (KAP)) was conducted on farms in the Slanghoek Valley,

Hex River Valley and Grabouw, three intensive agricultural areas in the Western Cape. The latter two areas were chosen as sites for intensive sampling for pesticide pollution (Dalvie et al., 2003) while the survey in the Slanghoek Valley was conducted as an

Districts	Towns	Population	Persons testing water (n)	Water sources monitored	Number of times per annum	
					Regular	Pesticides
Boland District Municipality	Robertson, Bonnievale, Ashton	21000	EHO (3)	Municipal sources, canals dams	Variable	On request
Boland District Municipality	Stellenbosch	31000	EHO (2)	Boreholes, dams, rivers	52	On request
Overberg	Caledon	60000	EHO (6)	Boreholes, dams, rivers	43	On request
West Coast	Moreesberg, Malmesbury, Reibeeck West, Darling, Porterville	22000	EHO (5)	Boreholes, canals, roof water	52	On request
Oostenberg	Brakenfell, Kuilsrivier	79000	EHO (4)	Boreholes, dams	4	On request
Drakenstein	Saron, Wellington, Paarl, Gouda	150000	EHO (14)	Boreholes, dams	75	On request
Breederivier	Rawsonville, Touwsrivier, De Doorns, Worcester	110000	EHO (NR)	Piped water	43	On request
Witzenberg	Ceres	31000	EHO (2)	Household water	Bacteria:12 pH: 365	When suspect*

EHO: Environmental Health officer\* The respondent in Ceres when reporting on the number of times water was tested for different quality criteria, said that water is only tested when pollution is suspected. NR: Not reported

exploratory study early in the project to field-test the questionnaire. Because data in the Slanghoek Valley survey were collected using the same questionnaire and trained interviewers as in the main study and because of the high participation rate amongst farms (Table 1) and the fact that the majority of questions in the questionnaire were answered, the results are combined. All farms in the Slanghoek area were surveyed (n = 18). For the other two study areas, two sampling strategies were used. One arm selected a random sample of 40 farms from each study area based on a listing obtained from the producers' associations (n = 147 in Hex River and n = 145 in Grabouw/Vyeboom) in those areas. In addition to the random sample, the farms on which water sampling took place (n = 5 in Grabouw and n = 6 in Hex River Valley) were also included in the survey. Sampling and participation in the survey is described in Table 1.

Access to farms was arranged through the local producers' organisations. For each farm, interviews were sought with the owner or manager, one pesticide applicator, one farm worker (non-applicator), and one farm resident not working on the farm. Liaison with the farm owner or manager meant that the workers participating in the study were not randomly selected. Interviews explored water usage (sources at home and in the field for drinking and non-drinking purposes), contamination of water sources, drift, domestic use of pesticides or containers and knowledge of, and training in pesticide safety. Interviews were conducted in Afrikaans and administered by the project co-ordinator and students from the

Peninsula Technikon (Pentech) Department of Health Sciences. Surveys took place in 1997 and 1999.

For the second study (monitoring capacity survey), a survey of farm workers and local authority management, was planned. A sample of 12 Western Cape local authorities including 8 municipalities and 4 district councils was randomly selected from a total population of 93 obtained from the Western Cape Local Government Organisation. The sample included the municipalities of Ashton, Bonnievale, Bredasdorp, Caledon, Grabouw, Klawer, Oostenberg, and Overberg and the district councils of Plettenberg Bay, Central Karoo, West Coast and Bree River. For every local authority it was planned to select 5 officials and 5 farm personnel each from 3 farms for participation in the survey (Table 1). Separate questionnaires were developed for local authority officials and farm workers by environmental health students from Pentech supervised by 2 senior researchers from Pentech and one from UCT. The questionnaire for local authorities included questions on district demographics, current water monitoring on farms in the district and knowledge of pesticides and training received, while the questionnaire for farm personnel included questions on water usage on the farm, water monitoring on farms and knowledge of pesticides and their dangers.

The survey was conducted during September and October 2001 by 9 trained environmental health students from Pentech supervised by 2 senior researchers from Pentech and one from UCT.

Purpose	Source reported*	Slanghoek	Grabouw/ Vyeboom	Hex river	All farms
		n=12	n=31	n=17	n=60
Drinking	Mountain dam	50%	74%	65%	67%
	Spring/borehole	58%	55%	76%	62%
	Rainwater entrapment	8%	1%	0%	3%
	Farm dam	8%	71% <sup>s</sup>	23.5%	45% <sup>s</sup>
	River	8%	10%	0%	7%
Domestic use other than drinking	Storage dam	50%	74%	65%	67%
	Spring/borehole	58%	55%	76%	67%
	Rainwater entrapment	8%	1%	0%	3%
	Farm dam	8%	71% <sup>s</sup>	23.5%	45% <sup>s</sup>
	River	8%	10%	0%	7%
Field ablutions	Storage dam	25%	90%	71%	72%
	Spring/borehole	58%	35%	77%	52%
	Rainwater entrapment	0%	3%	0%	2%
	Farm dam	8%	80% <sup>s</sup>	35%	53% <sup>s</sup>
	River	50%	10%	0%	15%
	Sub-surface drain	17%	0%	6%	5%
Recreation	Swimming in farm dam	66.7%	29%	29%	48%

\* Reported as supplied for the farm. Percentages are not mutually exclusive as respondents may report more than one source.

<sup>s</sup> In Grabouw, many respondents reported farm dams as the water source for drinking and other domestic purposes because many farms in this area store water in these farm dams

Distance from household		Slanghoek	Grabouw/ Vyeboom	Hex River	All respondents
		n=40	n=120	n=69	n=229
Nearest sprayed Orchard / vineyard	< 10 m	58%	30%	30%	35%
	10 - 50 m	33%	52%	45%	46%
	> 50 m	10%	17%	25%	18.5%

## Ethics

All participants in the study were guaranteed of confidentiality, and participation in the field surveys took place only after respondents had the study fully explained to them, and were able to give informed consent. Care was taken by the researchers to ensure that no farm workers suffered any adverse consequence as a result of their participation in the study. Co-operation of key stakeholders in the study areas was crucial to the progress of the projects. (London et al., 2000). Feedback of results of the first survey was given in a workshop of stakeholders held at Nietvoorbij Institute (Stellenbosch) during 2001.

## Results

### Study participation

#### *Farm resident KAP*

Two hundred and twenty nine subjects (from 60 farms) of which 8% were farm owners, 18% managers, 26% spray operators, 25% non-spraying farm workers who were not operating spray equipment and 23% other farm residents, participated in the survey. The response rate was 55% for farms and 42% for participants.

#### *Monitoring capacity survey*

Sixty-three subjects including 7 owners (11%), 28 managers (44%), 6 sprayers (10%) and 22 (35%) other workers participated in the second survey of Western Cape districts. The subjects were drawn from 16 participating farms from the Boland, West Coast and Overberg areas. The response rate was therefore 44% for farms and 35% for farm workers. The farms were near 7 towns, which included Bonnievale, Grabouw, Malmesbury, Paardeberg, Riebeeck Kasteel, Riebeeck Rivier and Robertson. Although the second project aimed to survey various local officials involved in water monitoring, only 8 EHOs

from 7 districts could be interviewed (Table 1). Local authority staff other than health personnel were reluctant to participate, perhaps because they viewed water quality as a health matter. As a result, no town clerks, executive officers, or engineers were surveyed as intended. The districts surveyed included 21 towns with a total population of 503 000 estimated by the participating EHOs (Table 2).

### Water sources

Water sources reported for domestic uses

in the KAP survey are summarised in Table 3.

Groundwater from springs and boreholes, and water from relatively pristine mountain sources were identified as the most important source for drinking water for the farming community in the Western Cape. Farm dams are, however, also important sources. Many of these farm dams drain surface water from rivers, either alone or mixed with mountain sources or groundwater. Relatively few farms are dependent solely on surface water for drinking. Sources of water for domestic purposes closely mirror those for drinking. For use in the field (both drinking and other), potentially contaminated sources (river, sub-surface drains, dams) are used

more frequently, particularly in the Slanghoek area. In the Grabouw area, water from the Groenland Water Scheme is stored in farm dams for drinking on many farms. Thus, water sources used for drinking on farms appear to be mainly from protected sources, while non-drinking usage and usage while in the field appears to make use of more surface water albeit at low frequencies.

The results were similar for the 2001 survey which found that on 16 farms in the Boland, West Coast and Overberg municipalities, the water sources reported were mountain dam (44%); dam or river (44%); boreholes (25%); rain (19%); municipal supply (19%); canal (13%); spring (6%); and irrigation (6%).

In the second survey, 68% (n=60) of farm residents reported having taps in the house, while 27 % reported using untapped water.

#### Potential risk of pesticide pollution of water sources

About a third of respondents in the KAP survey reported living within 10 m of the nearest site of spraying (Table 4) and this percentage was higher in Slanghoek (58%). Seven (11%) respondents reported that pesticides from pesticide spray had within the preceding 6 months drifted into their homes (Table 5), and similarly the percentage was highest in Slanghoek (18%).

Other opportunities presented for multiple sources of exposure appear to be high (Table 5). A sizeable number of respondents including both farmers and farm workers, used pesticides, either for domestic pest control or for home gardening, and about half of the farm workers reported obtaining these pesticides from the farm store. However, reuse of pesticide containers was low, reported by only 9% of farm residents, and this was always reported as being for the purpose of serving as a garbage bin.

In the KAP survey, awareness of the hazards of pesticides was reported as high, with farm workers scoring slightly higher than farm owners or managers (Table 5). While all respondents (n=59) in the survey of monitoring capacity knew that using polluted water

**TABLE 5**  
**Risk activities, knowledge and attitude toward pesticides on farms reported by farm residents in the Slanghoek, Hex River Valley and Grabouw areas, 1997 and 1999**

Risk	Respondents			
	Slanghoek (n = 40)	Grabouw/Vyeboom (n = 120)	Hex River (n = 69)	All respondents (n = 229)
Reported spray drifting into home				
All subjects	18%(n = 31)	13%(n = 119)	4%(n = 69)	11.9%(n = 218)
Farmers	20%(n = 5)	14.3%(n = 7)	0%(n = 5)	11.8%(n = 17)
Farm workers	23%(n = 26)	12.5%(n = 112)	6.4%(n = 64)	11.9%(n = 201)
Use of pesticides at home for pest control				
All subjects	30%(n = 40)	48%(n = 118)	36%(n = 69)	41%(n = 227)
Farmers	57.1%(n = 7)	57.1%(n = 7)	0%(n = 5)	42%(n = 19)
Farm workers	24.0%(n = 33)	47.3%(n = 111)	39%(n = 64)	41%(n = 209)
Use of pesticides for home garden				
All subjects	13%(n = 40)	42%(n = 118)	29%(n = 69)	32.6%(n = 227)
Farmers	42.9%(n = 7)	57.1%(n = 7)	40%(n = 5)	47%(n = 19)
Farm workers	6.1%(n = 33)	40.5%(n = 111)	28.1%(n = 64)	31%(n = 218)
Of those using pesticides, what proportion obtain pesticide from farm				
All subjects	33%(n = 16)	58%(n = 76)	51%(n = 35)	53%(n = 127)
Farmers	80%(n = 5)	20%(n = 5)	50%(n = 2)	16.7%(n = 12)
Farm workers	36.4%(n = 11)	60.6%(n = 71)	51.2%(n = 33)	55.7%(n = 115)
Use of pesticides at home in past 6 months				
All subjects	92.3%(n = 13)	62%(n = 64)	50%(n = 32)	54.6%(n = 109)
Farmers	100%(n = 5)	60%(n = 5)	0%(n = 2)	66.7%(n = 12)
Farm workers	87.5%(n = 8)	52.5%(n = 59)	56.7%(n = 30)	56.7%(n = 97)
Reuse of pesticide container at home				
All subjects	15%(n = 39)	12%(n = 18)	0%(n = 67)	9%(n = 226)
Farmers	85.7%(n = 7)	42.9%(n = 7)	0%(n = 5)	15.8%(n = 19)
Farm workers	18.8%(n = 32)	9.7%(n = 11)	0%(n = 62)	8.2%(n = 207)
Knew pesticides were dangerous to their health				
All subjects	88% (n = 40)	93% (n = 120)	94% (n = 69)	92% (n = 229)
Farmers	70% (n = 7)	84% (n = 7)	94% (n = 5)	85% (n = 19)
Farm workers	93% (n = 33)	96% (n = 113)	94% (n = 64)	95% (n = 210)

could be very harmful, less than 20 % reported that chemicals could pollute water or identified long-term effects such as cancer (Table 6). Twenty per cent (n=56) said that they didn't know the effects caused by pesticide-polluted water, and many farm workers (37%) also said they were not informed or trained with regard to the health effects of pesticides (Table 6). Those reporting that they were informed or trained on the health effects of pesticides, scored

Variable	Farmers (n)	Farm workers (n)	All participants(n)
1. Knowledge of pesticide pollution Did not know how are pesticides applied Chemicals can pollute water	0%(6) 50% (6)	28% (53) 13%(48)	25% (n=59) 17 % (n=54)
2. Knowledge of pesticide health effects Polluted water can harm humans Identified chronic effects Did not identify health effects	100% (6) 29% (7) 14% (7)	100% (53) 6% (49) 20% (49)	100 % (n=59) 9 % (n=56) 20% (n=56)
3. Training on pesticide health effects A. Not informed or trained about health effects of pesticide Method of training: Farmer's union or co-operative Medical person Pesticide or private company Farm management Municipality Brochures Personal studies B. Time since training < 1 month < 6 month < 1 year C. Follow-up training	n =5 0% 20% 0% 80% Farm management 0% 0% 0% n = 4 0% 0% 25% 40% (5)	n = 35 37% 6% 9% 17% 26% 3% 3% 6% n = 16 6% 31% 38% 28% (29)	N = 40 33 % 13 % 8 % 18 % 20 % 3 % 3 % 5 % n = 20 5% 35 40 29 % (n=34)

Variable	Participants reporting training	Participants reporting no training
1. Knowledge of pesticide pollution Did not know how are pesticides applied Chemicals can pollute water	16% (25) 26% (23)	38% (13) 8% (12)
2. Knowledge of pesticide health effects Identified chronic effects Did not identify health effects	16% (25) 8% (25)	8% (12) 8% (12)

higher than those who reported no training (Table 7). Training and information on pesticides differed amongst respondents with only 10 (29% out of 34) reporting follow-up on training (Table 6).

### Capacities for monitoring pesticide water pollution

#### Local authorities

The results of the interviews with rural EHOs on capacities for monitoring pesticides in rural areas in the survey of Western Cape

districts, are summarised in Table 2. In all seven districts surveyed, water sources on farms are tested by environmental health officers (EHOs). The number of EHOs per district varies according to the population in the area, but it is clear that in some areas such as Oostenberg there are relatively few EHOs for the district population. Only 3 (37%) respondents felt that there were enough persons conducting water monitoring in their area.

The water sources being monitored in the areas include municipal sources, canals, dams, boreholes, rivers and roof water. The typical monitoring procedure is the random collection of a grab water sample, which is then sent to a laboratory. The laboratories mentioned were the State Laboratory in Woodstock (SAIMR), the South African Bureau of Standards (SABS), in Pretoria and the CSIR in Stellenbosch. All the respondents mentioned that water was monitored for bacteria and most (88%) mentioned that chemicals were monitored only on request. Only 1 respondent reported that pesticides were monitored, and only

in response to a complaint.

Monitoring was paid for by the local authority, with one respondent indicating that the farm owner paid if he or she requested testing. However, any testing outside of routine sampling (such as pesticides) was seen as the financial responsibility of the person requesting the testing (e.g. the farmer).

With regard to feedback of results one respondent said that there was feedback to the farmer and the province after every analysis, while three said that there was feedback to the farmer on request only.

#### Farms

Farm personnel from 8 (50%) of 16 farms reported that water was tested on their farms, including testing for chemicals. However, no respondent mentioned water being tested for

pesticides. Testing was reported as being conducted by the farmer (n=3), the municipality (n= 2), private company (1), by the CSIR (n=2), and by the farming co-operative (n=1). Frequency of reported testing varied widely from daily to yearly, depending on what was being tested. Only 2 respondents reported receiving feedback on the results of testing, and they were both managers. Only one farm employee (out of 21) and one manager (out of 12) reported any training in how to test water. Farm employees reported virtually no involvement in water monitoring, especially for pesticides.

## Discussion

The results of the two surveys suggest that contamination of water sources may be an important route of exposure to pesticides for farm residents in the Western Cape. This is consistent with evidence from a survey of farms conducted in Stellenbosch in 1998 which found that just over 50% of respondents used borehole water for daily drinking and 20 % used surface water for drinking (Te Water Naude, 2000). Storage of water in farm dams, in particular, is widespread. This is a concern because water monitoring results in rural Western Cape studies (London et al., 2000; Dalvie et al., 2003; Davies, 1997) have consistently found pesticides in farm dams. Although the presence of pesticides in water in these studies coincides mostly with runoff and irrigation events, there was also some correlation with spraying. The proximity of dams to pesticide spraying may therefore be a route of exposure worth attention and control. Water monitoring results in the Hex River, Grabouw and Piketberg (London et al., 2000; Dalvie et al., 2003) also showed that pesticides were detected in groundwater sources such as boreholes, which are the main source of water for drinking or other domestic purposes in both surveys reported in this paper. Notably up to 18% of farm workers in the KAP survey reported spray drifting into their homes (Table 5), tending to confirm the significance of this mode of exposure. Between 30 and 58% of farm residents live in very close proximity (<10 m) to orchards, vineyards or fields subject to pesticide application, increasing opportunities for direct exposure through drift. Use of untapped water for domestic purposes (27% of farm residents) and the use of unprotected sources in the field (20%) may also enhance potential exposure to pesticides. Swimming in farm dams (16.8%) was lower than in the Dopstop survey (45%) (Te Water Naude, 2000), but may still present an additional source of exposure, albeit of unclear significance. Other environmental sources may be potential exposures to pesticides for farm residents, including use of pesticides at home (of which about a half is obtained from farm sources) and reuse of containers, the latter at low frequency and exclusively as garbage containers. Reuse of containers for water storage did not appear to occur at all. The extent to which environmental exposures contribute to body burden and cause health effects is unclear due to the absence in these studies of comprehensive environmental exposure data and data on biological exposures and health outcomes. Health effects can be acute due to short-term high dose exposure such as poisoning events or chronic due to long-term low dose exposure such as cancers. The former are easier to observe and document than the latter, about which there is uncertainty.

A high percentage of participants in both surveys appeared to be aware that pesticides are harmful with awareness slightly better amongst farm workers than amongst farmers. The positive effects of education reported by some of the employers in the area appear to be borne out by low levels of reuse of containers (9%), which augurs well for public health and occupational hygiene measures needed to control pesticide exposure. However, there was a low awareness that pesticides can pollute water (17%) and little knowledge of the health effects of pesticides (55%). There is therefore a need to educate farm residents about the health effects of pesticides, especially with many participants in the study reporting that they were not trained or informed about this. Of the participants who did receive training, more than 40% did not obtain it from the farm, pesticide company or farming co-operative, thus indicating significant opportunities for involvement in training by employers, employer organisations and trade unions.

Data from the local authorities confirmed the lack of water

monitoring for pesticides in rural areas in this part of South Africa. Currently, water is mainly being monitored for bacterial contamination, at frequencies that vary from once monthly to once yearly, but there is no effective pesticide monitoring taking place in the areas surveyed. Given the use of unprotected water sources and the presence of pesticides in rural waters (London et al., 2000; Davies, 1997; Schultz, 2001), it is clear that water monitoring in many areas needs to be increased.

Environmental health officers (EHOs) are currently the public officials responsible for water monitoring in farming areas and they would probably be responsible should systematic water monitoring for pesticides be implemented in future. A previous study (Rother et al., 2002) evaluating the role of the EHOs in promoting pesticide safety in the Western Cape, found that their role is limited as they lack capacity other than conducting inspections, is reactive in that it depends on notification and is not educational. Although most of the EHOs that participated in this study felt that their knowledge of pesticide health effects was good, the previous study on EHOs (Rother et al., 2002) found that their training was theoretical and lacked practical application. For example, they had a limited capacity in providing instructions on pesticide poisonings and pesticide safety issues in general and also had a limited understanding of the circumstances involved in pesticide poisoning. It is also clear that both the number of EHOs and their skills need to be increased to be effective in water monitoring for pesticides.

It would appear from the farm surveys that the financial responsibility for water monitoring on farms currently is seen to rest with the owner or farming co-operative. Though this may be said to reflect the "polluter pays" principle, various tiers of government also have constitutional obligations to ensure an environment not hazardous to health (Glazewsky, 2000). The survey showed that not all farms have the capacity to monitor water, and it is not clear if those that have existing capacity will be able to monitor pesticides. Most farm personnel that participated in the study are not involved in water monitoring and have not received training nor are they informed about the health effects of pesticides in water. Empowering farm personnel to participate in the control of pesticide pollution of rural water sources needs to be integrated in a co-ordinated national and local governmental approach to pesticide monitoring.

Currently there are 4 state laboratories (State Forensic Laboratory, The South African Bureau of Standards, Agricultural Research Council, the CSIR) available to conduct water analysis for pesticides in rural Western Cape areas, with 2 of these situated in Pretoria. These laboratories are not all set up to maintain equipment to perform pesticide water analysis with high sensitivity and low detection limits. Currently, the cost of using these laboratories for routine monitoring is unaffordable. (London et al., 2002). If full-scale monitoring of pesticides in water is implemented, the resources and capacity of the current state laboratories will have to be improved substantially or the number of laboratories will have to be increased in order to handle the sample numbers.

The survey in Western Cape districts also identified that owners or managers of farms receive little feedback of water monitoring results. This is a serious problem which might deter future participation by communities in monitoring activities.

## Conclusions and recommendations

Water usage for domestic purposes on farms occurs mostly from protected sources, but usage from unprotected sources such as farm dams does occur. Farm residents are potentially exposed to pesticides through various environmental routes including water.

There appears to be regular water monitoring in farming areas, but not for pesticides. Monitoring is conducted by EHOs who reported a good knowledge of the health effects of pesticides, but there is a shortage of staff and skills in many areas. There is at present insufficient analytical capacity in the Western Cape to conduct routine pesticide water analysis. Lack of feedback to owners could be a serious obstacle for future monitoring activities.

The following recommendations are made:

- A national water monitoring programme for pesticides needs to be implemented in South African farming areas and farms. This can be done by intensifying and expanding current water monitoring in rural areas, for example, by collecting water samples weekly from selected groundwater and surface water sites as proposed elsewhere (London et al., 2002). In order to do this, human resources and funding to local authorities for chemical analysis need to be increased, and cost-effective environmental monitoring methods need to be identified. Environmental health officers should be trained in monitoring pesticides and managing a routine surveillance system.
- A manual and guidelines need to be fully developed to inform persons conducting water monitoring on the correct procedures to follow in testing water for pesticide contamination. Local community involvement in participating in, and interpreting results of monitoring, and checking remedial steps to correct water quality, are consistent with current policy directions, and should be encouraged through the development of a user-friendly manual.
- Existing capacity for conducting pesticide analysis should be enhanced.
- Results of any monitoring must be fed back to farmers. A proper management system for handling the data needs to be developed.
- Similarly, farm residents need to be informed that pesticides can pollute water and can affect health, particularly chronic health conditions, which are often delayed in onset, and difficult to link to a hazardous pesticide exposure. Raising awareness could be undertaken by all relevant stakeholders including employers, employer organisations, trade unions, farming co-operatives and pesticide companies. Awareness-raising could be integrated in current health and safety training mandated by occupational health legislation for farm workers in terms of the hazardous chemical substances regulations (London, 1995).

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