Influence of risk perceptions and social context on Working for Water herbicide sprayers' Personal Protective Equipment (PPE) compliance in the Western Cape of South Africa

Masters mini-dissertation
Master of Public Health (General track)

Candidate: Federico Andrade Rivas (ANDFED001)

Supervisor: Dr H-A. Rother

Submitted: January 31st/2013

School of Public Health and Family Medicine
Faculty of Health Sciences
University of Cape Town
Cape Town
South Africa

DECLARATION

MPH (General Track) Mini-Dissertation

I _____ Student No._____ declare that the work that I have submitted is my own and where the work of others has been used (whether quoted verbatim, paraphrased or referred to) it has been attributed and acknowledged.

Signature: _____

Date: _____

ABSTRACT

The exposure of workers and farmers to herbicides in middle- and low-income countries is an important public health issue with a significant negative impact on their short- and long-term health status. Besides the possible acute effects, long term exposures to low doses of herbicides leads to accumulation in the body which might lead to chronic health effects. The exposure to herbicides of substances is associated with different types of cancers, Parkinson's, insulin resistance, obesity and endocrine disruptions. Maternal exposure to herbicides have been associated with the prevalence of small-for-gestational-age and foetal gastroschisis. Farmers and workers from low-income countries are at greater risk of exposure given the spraying techniques used, deficient risk communication tools and the inadequate or lack of Personal Protective Equipment (PPE) use. In addition, underlying factors such as poor nutrition and immune system status might increase the risk to develop acute or chronic illness related to herbicide exposure.

The Working for Water (WfW) programme was launched in 1995 to control invasive alien vegetation while simultaneously contributing to alleviate poverty. The programme, which relies on chemical and hand/mechanical removal mechanisms, is now running in all nine South African provinces and is one of the world's largest programmes addressing removal of invasive alien vegetation. Despite the extensive policy and management efforts of the WfW programme, workers are at risk of harmful exposures to herbicides and therefore new exposure reduction interventions must be implemented. This study is part of a larger project, which is focused on developing a peer-based intervention to improve WfW current prevention strategies.

This dissertation provides baseline data for the intervention through and analysis of workers' and contractors' socio-cultural context and risk perceptions of herbicides use, as well as identified the influence of these variables on PPE compliance. The protocol (Part A) describes the methods used to gather and analyse the data. The structured literature review (Part B) presents the importance of analysing socio-cultural variables and risk perception of herbicides use in order to understand PPE compliance amongst workers and highlights the lack of studies conducted in middle- and low-income countries on the influence of these variables on herbicide exposures and risk reduction.

The article (Part C) explores the complexity of PPE compliance amongst WfW workforce by analysing workers' and contractors' herbicides use risk perception as part of a broader conceptual framework shaped by socio-cultural and contextual factors. The findings showed that safety related behaviours and workers' and contractors' low PPE compliance were influenced by a complex interaction of herbicide use risk perception, gender dynamics, social status and WfW working conditions. Given the complexity of PPE compliance in countries with several economic and social constraints the article

reports the need of not relying solely on PPE promotion, but rather see PPE use as only one the exposure control strategies, and preferred only after elimination, substitution, engineering controls, and administrative controls have been implemented or ruled out. Moreover, in order to be effective, any intervention must be informed by particular characteristics of the socio-cultural context, local perceived risk of perception use, and other broad contextual factors in order to reduce exposures.

ACKNOWLEDGEMENTS

I would like to thank all of the workers and contractors of Working for Water who participated in this study and warmly welcomed us in their daily activities. I would like to thank them for always receiving us with a smile and thanks for the willingness to participate. They made it easier to cope with the challenges of doing this research. The work that they do is inspiring and challenges us to keep finding ways of improving their health and working conditions. I hope this study contributes to that aim.

I would also like to thank Dr Hanna-Andrea Rother for supervising this dissertation. Without her support, patience, insight, and motivation this dissertation would have not been possible. She guided the protocol design and analysis of the data as well as the literature review and article writing. In addition, her role in securing funding and designing the larger project to which this dissertation is part of was crucial. I would also like to thank to the professors of the School of Public Health who, taught us with passion and did their best to teach us the skills needed in the field. Thank to them and the MPH students, for providing an inspiring and enriching learning environment.

It is challenging to engage in the adventure of completing a Master's degree so far away from home. However, this has been an incredible experience which definitely shaped the way that I see the world and my academic life. I would like to thank everyone that made Cape Town a place which I can happily call my second home. And for all those back in Colombia: *¡Gracias por darle sentido a mi vida! Gracias por ser familia, por ser amistad, por ser amor, por ser reto, pero sobre todo: Gracias por ser pasión.*

PART A: PROTOCOL

Contents

1. INTRODUCTION

The negative health effects due to pesticide exposure among workers in low-income countries pose a significant public health problem (1). Workers living in low- and middle-income countries are especially vulnerable to pesticide-related health hazards given the larger number of pesticide poisoning cases presented, the difficulties of implementing prevention strategies, and the high prevalence of underlying factors that increase workers' risk (2–4). The health hazards attributed to pesticide use can be reduced by implementing safety strategies such as the use of Personal Protective Equipment (PPE) (5,6). However, there is a gap between the scientific development of safety strategies to reduce workers exposure to pesticides and the effectiveness of these tools in practice. The low or partial compliance of PPE use is one of the factors affecting the role of PPE in exposure prevention.

Multiple studies have documented the inadequate use of PPE especially in low-income countries (4,5,7–10). Based on the well documented potential hazards of these substances to humans' health and the persistent unregulated and indiscriminate pesticide use in low-income countries, the situation is troubling (10). Workers exposure has increased in recent years given the extensive use of pesticides as a method to control pests for agricultural or environment protection purposes. The latter refers to the use of substances to control pests in order to prevent damage to environmental resources, such as applying pesticides to control alien species that are impacting negatively local ecosystems.

In addition to acute adverse effects on humans such as respiratory, eye and skin illnesses, research also confirms that long term exposure to pesticides is associated with the development of chronic diseases (11). Several types of cancer have been associated with occupational exposure of workers to pesticides, including increased risk of soft-tissue sarcoma, non-Hodgkin's lymphoma, Hodgkin's disease, and prostate cancer (12–14). Also, there is a growing concern about other possible impacts such as neurological impairment, birth defects and endocrine disruption (7,15). Since PPE is a key strategy in reducing pesticide exposure, this study will assess the factors that affect the low PPE compliance among workers from socio-economic poor populations in Western Cape, South Africa.

1.1.Herbicide Use in the Working for Water (WfW) Project

Herbicides are a type of pesticide used to control plants that could harm agriculture production or other environmental services (16). There are different routes of humans' exposure to herbicides, although the most common are through skin absorption and inhalation (7). This contact happens mainly during the spraying of the herbicides, but can also occur in the preparation, loading and mixing process (7). Research suggests that workers from low-income countries are at greater risk of exposure given the spraying technics used, deficient risk communication tools, and the inadequate or lack of PPE use (4,7,17). Additionally, recent investigations highlight other possible underlying factors that might increase the risk to develop acute or chronic illness related to herbicide exposure, such as poor nutrition, immune system status and interaction with other chemicals (3,4). This is particularly problematic in countries such as South Africa in which these factors might be common amongst workers involved with the handling of herbicides, which highlights the need to prevent exposure.

There are some hazards particularly associated with exposure to herbicides. Besides the possible acute effects, research has shown that long term exposure to low doses of herbicides leads to accumulation in the body which might become chronic (16). Exposure to this group of substances is associated with different types of cancer such as adult brain tumours in women (12) and prostate cancer (13). However, possible hazards of herbicides are not limited to cancer. Parkinson's (18), insulin resistance, obesity (19), and possible endocrine disruptions (20) have been also documented. Moreover, studies showed negative effects on new-borns due to prenatal exposure. For example, maternal exposure to herbicides has been associated with the prevalence of small-for-gestational-age (SGA) (21) and foetal gastroschisis (22). However since several human activities depend on the use of herbicides (e.g. intensive agriculture, alien vegetation control, pest plants control), it is important to understand its harmful effects on humans and strategies to reduce them.

In 1995 the Working for Water (WfW) programme, administered by the South African Department of Water Affairs and Forestry, was launched to control alien vegetation while simultaneously contributing to alleviating poverty by providing jobs and training to members of poor communities (23). The main goal of this government-funded programme is to clear water catchments and riparian areas of alien vegetation in order to protect and restore their biodiversity and hydrological functions (23). Meanwhile, WfW aims to empower South Africa's most marginalised communities by creating jobs and providing training in different skills associated with alien vegetation removal (24). Each team is constituted by about 10 workers, who are sourced from the local communities by

contractors. Contractors are in charge of employing workers and guiding them on the right procedures of alien vegetation removal, as well as being responsible for the health and safety of the workers (25). The programme is now running in all nine South African provinces and is one of the world's biggest programmes for addressing the removal of invasive alien vegetation (26). However, there are different ways in which a worker can be exposed to herbicides while mixing and spraying herbicides. In order to reduce the levels of exposure, WfW relies largely on promoting the use of PPE through training sessions, the establishment of guidelines for PPE use and other strategies to enforce PPE compliance. One education strategy that has been implemented is the peer education programme. However, this programme is not focused on health and safety related topics regarding herbicide use.

Even though the WfW programme has been described by some authors as a success (23,26), there are still challenges that must be addressed, especially in the area of worker safety. A pilot study of WfW's herbicide policies and practices (2009-2010), under the principal investigator Dr Andrea Rother (School of Public Health and Family Medicine at the University of Cape Town), identified key aspects that need to be improved to reduce workers exposure to herbicides (27). The first phase of the research was a pilot project assessing occupational risks and exposures to herbicides, and WfW's current prevention practices and policies. The key pilot findings were the following:

- Workers generally did not receive information about the acute and chronic effects of herbicides and were unfamiliar with the importance of preventing long-term low dose exposures and the role of PPE use in this.
- There was a lack of compliance of workers and contractors with WfW's safety procedures.
- The nature of the contracts with WfW often pressured contractors into applying herbicides in conditions not appropriate for spraying in order to meet work deadlines.
- Several problems were found with the PPE. The quality of the PPE was poor, and it needed to be replaced regularly which increased contractor's financial burden. In addition there were identified issues regarding PPE compliance and contractors found it difficult to enforce its use.
- Workers found the PPE unsuitable and "useless" for the environment under which they worked.
- The low pay for workers led to high turnover, resulting in lack of continuity of training, extra cost for contractors to purchase new PPE for new workers, and extra time demands to finish the contract in the allocated time. New workers joined the teams during any moment of the year.

- There were difficulties in putting safety procedures into practice including language barriers, literacy and education levels of workers.

As shown by the pilot study, despite the procedures in place by the WfW programme, workers are at risk of harmful exposures to herbicides and therefore new exposure reduction interventions must be implemented. Additionally, there is a high turnover of the workers involved in herbicide use, which may impact the effectiveness of health and safety training (27). Although a structured industry based training has already been implemented, this might not be well suited to the socio-cultural context and needs of the workers. This could affect workers acceptance of the training and therefore its effectiveness. Moreover, it has been proven that simply delivering information through training is not enough to shape workers safety behaviours, because knowledge does not necessarily determine workers' control over safety practices (28). This is a major challenge when designing an effective intervention to promote PPE compliance and reduce exposures to herbicides. Creative, flexible and culturally appropriate approaches must be followed in order to promote change in the behaviours associated with PPE use.

1.2. The Role of PPE in Exposure Prevention

The strategies used by WfW to remove alien vegetation exposes workers and contractors to different health-related hazards. This study will focus on the issues associated with PPE compliance and technical training on herbicide application. In order to reduce the exposure of high risk populations to herbicides, there are various approaches that can be taken. As shown in Figure 1, the level of intervention ranges from structural changes in the pesticide practices (e.g. policies, restrictions) to the individual use of PPE. It is worth noting that focusing on strategies to promote the use of PPE requires a high level of workers' participation as well as supervision. Moreover, this type of strategy is considered less effective and less sustainable and should therefore be used while higher levels of control can be exercised (Figure 1). However, a big part of WfW's strategy to control workers' and contractors' exposure to herbicides is focused on staff training on PPE use.

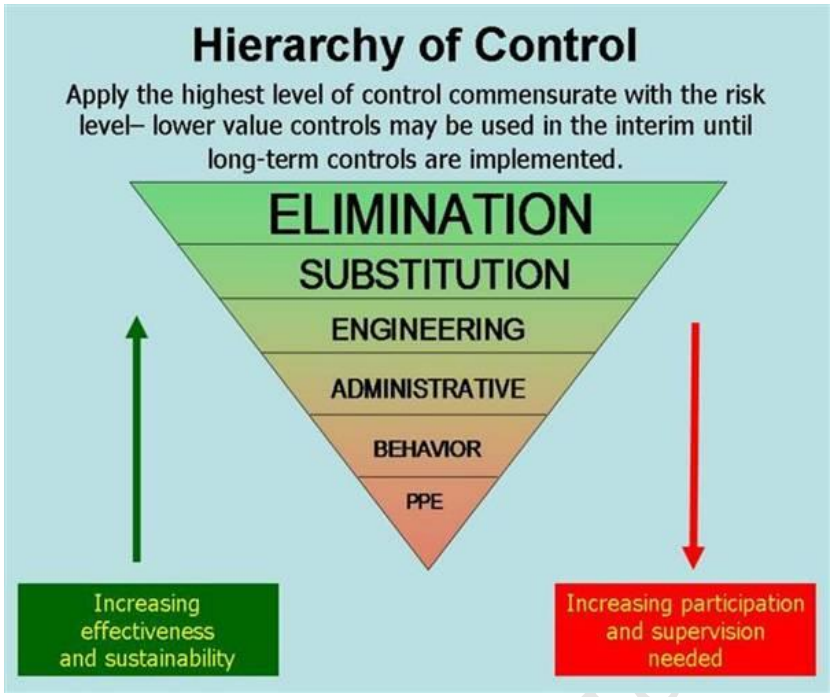


Figure 1 Levels of control to minimize exposure risks (Source: http://www.iohsolutions.com/general/151/)

It is well documented in the literature that the most common route of pesticide exposure for agricultural workers is through skin absorption (11). Therefore, PPE could be considered in theory an effective strategy to reduce the occupational exposure to pesticides. Thus it has been implemented in different low-income settings as a harm-reduction intervention. However, incorrect use of PPE by farmers has been reported in several case studies in Latin America, the Middle-East, Asia and Africa (7). This evidence raises concerns about PPE compliance and the effectiveness of herbicide exposure reduction interventions among workers coming from communities with several socio-economic limitations, such as with WfW's labour force.

The importance of understanding the low level of compliance and inadequate use of PPE can be seen in the growing body of research aimed at understanding the factors associated with it. Some of the variables that have been studied as explanation for the lack of, or limited use of, PPE are: education level, age, work organisation or group, interference of PPE on work, peer-pressure, quality of the risk communication and past health event (29). As stated by Feola and Binder (7) studies conducted to understand PPE use amongst agricultural workers have taken four different approaches:

a) Behaviour is explained in terms of socio-demographic factors (e.g. income, age, education, gender);
b) Research based on the high cost of PPE as a deterrent to PPE use;

c) Studies of external factors such as the design of the labels or the characteristics of PPE; and
d) Emphasis on the cultural values that create a particular risk perception of pesticides' harm and therefore influence the adoption of adequate safety behaviours.

Furthermore, Feola and Binder argue that only some studies have investigated in depth the social norms of the particular settings (7). Moreover, compliance with PPE recommendations appears to be highly context specific, which means that it is necessary to understand the particular social setting in order to assess properly the factors that influence PPE use (7,29). Therefore, this study aims to assess particular social and cultural factors that shape WfW workers behaviour regarding PPE compliance. These findings will add to the literature analysing the influence of cultural and social norms on workers PPE compliance.

1.3. The Role of Risk Perceptions and Social Context on PPE Use

Individuals' behaviour is a central topic regarding human health-related issues. Therefore, a range of models have been proposed to explain behaviour and changes on individuals' practices. These models can be applied in order to understand WfW workers' PPE compliance, given that the effectiveness of PPE in controlling exposure depends on the active participation of individuals. Behavioural change models aim to assess how people make choices and how these are shaped by the other variables. These models are based on the general idea that humans decide what to do, depending on the extent to which they expect that their choices are going to produce a result that they consider valuable (30). Therefore, the perception about the risks and benefits of the different practices (e.g. herbicides perceived risk and PPE as an exposure control) plays a crucial role in understanding human behaviour.

The Social Cognitive Theory (SCT), introduced by Bandura, includes in its model the interaction between persons, their environments and the psychosocial determinants of behaviour (31). As stated by Bandura (32), the model relies on a core set of six determinants:

a) Knowledge (About health risks and benefits of different practices)
b) Perceived Self-efficacy (Control over health habits)
c) Outcome expectations (Cost and benefit of different health habits)
d) Goals (Aims, as well as plans and strategies for realising them)
e) Perceived facilitators

f) Social and structural impediments (Aspects that hinder the changes that person seeks)

SCT predicts that the performance of a particular behaviour (e.g., PPE use, PPE cleaning, smoking while spraying pesticides) depends on the perception of control over the outcome, limited external barriers and confidence in one's skills and abilities (31). The six determinants of the SCT model are influenced by different factors related to both individual and social characteristics. One component that is taken into account in most of health behaviour theories, including STC, is humans' risk perceptions (33). This concept can be broadly understood as the person's capacity to interpret a potentially hazardous situation based on previous experiences and beliefs (34). Risk perception is an important part of the SCT model and evidence from meta-analysis strongly suggests the existence of a relationship between risk perception and health behaviour (33). Therefore, this concept is relevant to this study because it can be used to understand workers PPE compliance and explore different aspects that might shape workers health-related behaviours.

In order to provide explanatory frameworks for risk perceptions, a range of approaches have been proposed. One of the most influential theories from this perspective is the Cultural Theory (35) in which risk is viewed as culturally and historically embedded (36). Under this paradigm, people's understandings and reactions to risk (such as health effects from herbicide exposures) can be explained on the basis of the socially rooted values and belief to which the individual adheres (37). Although cultural theory can be useful to understand certain case studies, this model has some limitations acknowledged by the author and other researchers (38). Some of the limitations of the theory are its reduced capacity to understand individual variation regarding choices and the static typology which lacks capacity to show process of change (38). Despite these inherent limitations, using cultural theory to understand WfW workers and contractors herbicides risk perceptions will allow the social and cultural characteristics of the group to be assessed in relation to their safety behaviours. Moreover, it will provide insights into how group dynamics shape individual behaviours that might be detrimental to workers' and contractors' health.

More recently, risk perception researchers, influenced by social and cultural paradigms, have identified complex approaches which have been effectively applied in different health-related fields. Quality and access to obstetric services (39), effectiveness of malaria-during-pregnancy interventions (40) and studies regarding the association of HIV with gender power relations (38) are some of the examples of recent innovative research based on the social and cultural levels. Additionally, this approach has also been applied to studies assessing the exposure of farmers to pesticides. Using qualitative and participatory strategies, Peres et al. (8) analysed the risk perception of pesticide

handling by rural farm workers on Rio de Janeiro State (Brazil). The authors reported that the main individual and group factors shaping risk perception were strongly influenced by the local culture and social context. The labour organisation and individual protection strategies generated to justify pesticides handling practices were found to be associated with local perceptions of health, power, gender and values (8).

The understanding of workers' and contractors' perceptions of herbicide use (including risk) should be one of the pillars of pesticide exposure research and subsequent designing of exposure prevention interventions, especially in countries with complex cultural and social challenges. In addition, the communication of the risks associated with the use of pesticides (e.g., in training programmes) should be based on a previous understanding of local workers' risk perceptions (34). Therefore, this study will provide insight into PPE compliance from the socio-cultural perspective to better understand WfW workers' perceptions of herbicides and safety behaviours, and inform exposure reduction interventions.

1.4. Gaps in the Literature

Given the specific context of the WfW programme, it is necessary to develop culturally sensitive strategies to improve PPE compliance, which must be based on evidence and rigorous research. Therefore, research must consider the workers' risk perceptions of herbicides exposure and how they are associated with behavioural change and PPE compliance. Additionally, it must identify those particular cultural aspects that might enhance the acceptability and effectiveness of interventions aiming to improve workers PPE compliance. Several studies have assessed the use of and exposure to pesticides in low-income settings (5,8–10,29), as well as highlighted the importance of understanding the specific social context where the interventions are going to be implemented. Despite the acknowledgment in peer reviewed articles that these types of studies are needed in order to improve PPE compliance and workers safety behaviours, there are limited examples in the literature reporting in-depth qualitative studies in the pesticides field. Therefore, exposure reduction interventions continue to be designed without an understanding of the socio-cultural context, which reduces their likelihood to have an effect on workers' safety behaviours.

Although some pesticide safety, risk perception and risk communication studies have been conducted in South Africa amongst farmers (10,17,42) , none, to the knowledge of the author, have been done with WfW workers or any other large scale alien vegetation removal project. Even though WfW is one of the largest alien vegetation removal programs in the world, there have not been any studies conducted to understand the association between risk perception, cultural and social

context, and PPE compliance amongst its workers. WfW has particular organisational characteristics that shape the power, gender, and social relations presented in the working groups that might differ from the ones reported for farmers. In addition, the studies previously conducted in South Africa focus on agricultural pesticide use amongst farmers, while this study will be conducted with a labour force using herbicides under a different working context and objectives.

In addition, only some risk perception studies have investigated in depth the classified social norms and cultural context of the study population (7). There is still limited understanding in middle- and low-income countries of how risk information is transferred between peers and the role that they might have in workers training processes and understanding of risk (7). This study will aim to understand the cultural values that promote a particular risk perception of herbicides hazards. In addition, it will also analyse the social context and the influence of social norms on PPE compliance, focusing on how the relationships between peers promote certain behaviours regarding PPE use.

This study will contribute to better understanding workers' herbicide risk perception in a massive alien removal vegetation programme, as well as provide interesting insights regarding herbicide risk perception in low-income settings. Developing knowledge about a particular work setting characterised by high mobility, high turnover and a culturally diverse workforce will add valuable insights to the literature focused on pesticides research. In addition, this research will specifically assess the exposure to herbicides as well as PPE compliance in a specific setting in which workers are expected to follow WfW protocols and have control over the type of herbicides or PPE used.

2. RESEARCH AIM, OBJECTIVES AND QUESTIONS

2.1. Research Aim

The main aim of this research is to understand the link between WfW contractors' and workers' risk perception of herbicide use and their PPE compliance. The influence of socio-cultural factors on PPE compliance, such as power relationships, status and gender will also be analysed. In addition, contractors and peers' influence on safety practices of workers will be also studied, including the role of peers in the training process of new and old workers.

2.1.1. Research Purpose

The findings of this study will inform a health and safety intervention to be implemented by a larger study (Described further in section 3.2).

2.2. Objectives

To address the research aim, this study has the following objectives:

1. To identify WfW workers' and contractors' exposure to herbicides and PPE compliance during spraying and alien vegetation removal.
2. To document WfW workers' and contractors' health and safety risk perceptions regarding herbicide use.
3. To identify socio-cultural factors that influence workers' and contractors' PPE compliance.
4. To identify the role of contractors and peers on health and safety training of new workers joining after the initial induction training was conducted.

2.3. Research Questions

This study will focus on answering two main questions supported by secondary questions related to workers' and contractors' herbicide exposure, PPE compliance, herbicide use risk perception and herbicide-related training.

Main research questions

- How do contractors' and workers' risk perceptions of herbicide use influence their practices regarding PPE use?
- What socio-cultural factors influence WfW workers' PPE compliance and practices?

Secondary research questions

Exposure

- What are the different ways in which WfW workers and contractors are exposed to herbicides during spraying activities? Which routes of exposure to herbicides are significant in the WfW context?

PPE compliance

- Do workers and/or contractors make use of the PPE provided and follow the WfW standard use procedures? Is the use of PPE enforced or encouraged by contractors or other workers? If so, how? How does peer pressure affect the way that PPE is being used by WfW's workers?
- Which particular socio-cultural aspects could influence contractors' and workers' PPE compliance?

Herbicide use risk perception

- Do workers and/or contractors perceive the use of herbicides as a possible hazard for their own health? How is this perceived risk compared with other perceived risks associated with their job? Does the use of herbicides worry the workers and/or contractors in terms of its possible effects on human health? Do workers and/or contractors consider their job risky? What aspects of it?
- How much control do workers believe they have over avoiding any possible harmful health effects from herbicides? What activities do workers believe they can conduct to reduce harmful health effects of herbicides? What solutions do workers suggest or use to promote safe herbicide use?
- Which particular socio-cultural aspects could influence worker's risk perception of herbicide use?

Training: knowledge and practices translation

- What is the role of peers and contractors in the training process of workers? At what stages is the training provided for new and old workers? What is the actual training process followed for new workers?
- What is the role of contractors in terms of promoting health safety practices to reduce harmful health effects of herbicides?
- How could risk perceptions be addressed in training interventions to promote better health and safety practices for exposure reduction?

3. METHODS

3.1. Research Design

Given the in-depth understanding necessary to answer the research questions proposed, a qualitative study of WfW workers and contractors will be conducted. Most of the fieldwork activities will take place in Cape Town at sites in which workers and contractors are conducting the spraying activities. The sites that will be visited are part of the Table Mountain National Park. Additional information will be gathered at other facilities (e.g. WfW training facilities). The methodological approach and theory will be based mainly in anthropology research strategies. The tools that will be used to gather the data are direct observation, visual material collection and questionnaires. The

study will be conducted from November 2011 till December 2012 and the fieldwork activities are planned from February 2012 till November 2012.

3.2. Background to Research

3.2.1. Context of Larger Study

This study is part of the broad project "*Herbicide exposure prevention study for Working for Water – Using Peer Education to Promote Health and Safety amongst a highly mobile workforce*" under the principal investigator Dr Andrea Rother. Building on the findings of the first phase, which started in 2009, the second phase of the study is focused on piloting a peer-based intervention to improve current WfW prevention strategies. Workers' exposures to herbicides will be measured using non-biological monitoring methods before and after the intervention. The intervention will be assessed in terms of its effectiveness regarding exposure reduction and workers' acceptability of the tools implemented. The intervention will make use of the peer educators already identified by WfW and provide them with tools to reinforce the group training regarding safety and herbicides handling. As part of the larger project, this proposed research will provide baseline data for the intervention by providing insight into workers' and contractors' risk perception and socio-cultural context, as well as identifying the influence of these variables on PPE compliance. This is key data in order to improve WfW exposure prevention strategies as well as to provide an understanding of the social context within which the workers function.

3.2.2. Boundaries between dissertation and larger study

The research team in charge of the larger study will use the data from this study to inform the interventions to reduce the workers' exposure to pesticides. The larger project follow-on study will focus on behavioural controls to see if exposure can be reduced by means of improved individual behaviour regarding herbicides handling safety practices. The qualitative information collected will provide insight into risk perception, training practices, knowledge transfer and socio-cultural aspects of the groups. This information is relevant in order to produce an efficient intervention with a high level of acceptability by the workers. This study will also involve collection of baseline information regarding workers' and contractors' exposure to herbicides and identifying relevant risk perceptions (Figure 2).

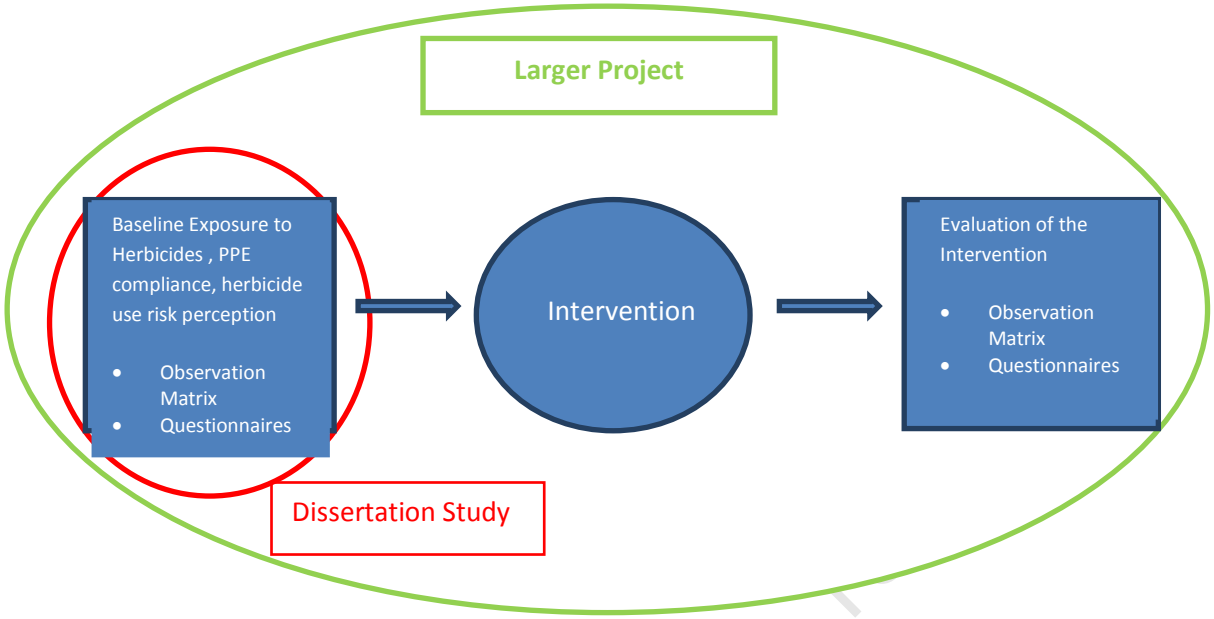


Figure 2. Study in the context of the larger project

3.3. Study Population and Sampling Strategy

The research population consist of workers currently part of the WfW program. The workers are sourced by the contractors from local communities near where the alien removal takes place. The study sample will be recruited from teams working near Cape Town in the Western Cape Province. Two full WfW contract teams (approximately 10 people) will be selected from sites where WfW are engaged in herbicide use activities. Contractors must ensure that workers and teams meet WfW criteria (25):

- Only one worker can be employed from each household.
- Workers selected have to be unemployed
- Try to include workers with disabilities
- More than half of the team must be women.
- More than 20% of the workers must be youth (between ages of 18-25)
- Workers should be sourced from local communities and live close to the site.
- Not to employ workers who receive and old-age pension.

The teams will be selected from the North area in the Western Cape using purposive sampling.

3.4. Data Collection

The data will be collected by trained Xhosa and/or Afrikaans speaking fieldworkers. They will receive training, organised by the larger project, which will cover herbicide spraying and exposure, as well as data collection strategies. Fieldworkers will be familiarised with health and safety related topics regarding herbicides and WfW training material. Additionally, they will be provided with observation guides (Appendix A). An anthropologist will be present most of the times to observe and support fieldworkers, as well as to provide feedback during the observation process. This will allow exploration of new categories and topics to come out during the research process. Groups will be observed working in different sites and using different herbicide spraying methods. Each member of the team will complete a consent form (Appendix B) on the first day fieldwork begins and any new members joining the team during the research will be asked to sign a consent form.

There are different types of data required in order to identify the worker's potential exposure to herbicides during spraying and alien vegetation removal. Firstly, the activities performed by workers during a work shift where herbicide exposures may occur need to be understood. This will provide information regarding different ways in which the workers may get exposed as well as identify specific practices that could lead to acute or chronic health effects. Three different data collection instruments will be used to document worker's practices that may be associated with herbicides exposure: a questionnaire, ethnographic observation and media material (photo and video) analysis. Should issues arise from the ethnographic observations or questionnaires that require further questioning/investigation focus groups may be held with workers or contractors.

Additionally, the types of herbicides used during the site observation, possible health effects, and associated risks will be documented. Fieldworkers will collect this information both from the labels on herbicide containers and from reports proved by contractors and workers. A literature review will be conducted to identify the potential risks associated with each active ingredient or formulation.

3.4.1. Questionnaire

A questionnaire assessing general and herbicide risk perception, herbicide-related training, health status and herbicide use will be administered to workers and contractors (Appendix C), as part of the larger project research. The questions for this study to assess workers' exposures will include questions regarding health status (Q 73-92, workers questionnaire) and herbicides use (Q 53-72, workers questionnaire). In addition, information about knowledge, attitudes/beliefs, practices, and perceptions about health effects and risks associated with the herbicides use will be collected. This information will be collected through the following sections of the questionnaire (Appendix C):

- General risk perception associated with the job (e.g. In your current job, what would you say is the most dangerous thing you do and why?)
- Health effects perception (e.g. Do you think that the herbicides used by Working For Water can make you sick?)
- Herbicides perception (e.g. Do you worry about possible dangers when working with or near herbicides?)

The data collected with the questionnaires is self-reported and subject to recall and social desirability bias. Recall bias refers to the systematic error that might be introduced if the data gathered relies on participants' memories of past events. Depending on several factors, such as disease experience, persons tend to remember certain exposures or practices more than others. On the other hand, social desirability bias is defined as the influence of societal (e.g. experts, trainers, supervisors) expectations on participants' answers. Workers receive training and might have knowledge of what is considered by experts as a good practice and base their answer on it. Therefore, these data will be contrasted with information that shows how workers actually perform in practice. These issues associated with the self-reported nature of the questionnaires will be addressed by comparing the information obtained with the other two data collection tools (i.e. ethnographic methods and media material analysis). It will also be considered in the data analysis and acknowledged when presenting the results.

3.4.2. Ethnographic Methods

Ethnographic methods, which include observation and interviews, will be applied in order to document the practices of workers through field observations of the activities that involve herbicides mixing and use. Fieldworkers will join the WfW's teams at the beginning of a shift and gather the data in field notes format, written when the events are taking place or as soon after is possible. An observation guide addressing seven key areas will be pasted into field workers journals and completed for each site visit (Appendix A). The seven key areas of observation are as follow:

a) Transport of herbicides to site
b) Storage of herbicides at site
c) Mixing herbicides
d) Spraying of herbicides
e) Eating and resting on site
f) Cleaning up after spraying and using herbicides
g) Any accidents with herbicides?
h) Other

The guide presents the main areas and activities, informed by theory and the pilot project, which could create or increase the exposure of contractors and workers to herbicides. However, fieldworkers will not only capture information in relation to these seven areas, but other aspects of the working context and other possible routes of exposure. The fieldworkers will expend time on site observing workers and contractors which will allow them to document different social and cultural variables that may be related with their risk perceptions associated with the job in general as well as related to herbicide use.

Contractors and workers have several logistical constraints as they only receive their payment once the job at the site is finished. Giving this time limitation organising individual extended interviews would negatively impact on workers and contractors daily working activities. Therefore, as suggested by Cabrera-Orozco (43) the Periodically Divided Interviews (PDI) strategy will be used. Casual questions will be posed to selected members of the group and recorded as soon as possible in field notes. Rather than organising specific interviews, the researchers will use the existing socialising spaces (e.g. lunch time, discussions) to gather deeper information on risk perceptions and the socio-cultural context. The PDI questions will be informed by the feedback from previous observations and data obtained with the group, as well as the literature review regarding pesticides farmers or workers' risk perception. Emerging social and cultural categories that might be associated with workers' and contractors' risk perceptions of herbicide risks will also be analysed and studied further depending on their relevance for the research.

New team members will be identified at the beginning of the daily activities and observed during working hours. Their interactions with contractors and other members of the team, as well as their herbicides handling practices, will be documented. The role and influence of contractors and peers on their work will also be part of the observation focus. Different strategies used by the group to introduce the new member to the field work will be recorded. In addition, targeted questions to contractors and new workers (PDI) will be used to gather information regarding the training process. Furthermore, former workers will also be interviewed about their personal experience of the training process and the introduction to the job on field that they received. This information will allow conceptualising the training process from workers' and contractors' perspective.

After observation is complete, fieldworkers will type in the field notes. The typed and original versions of the journals will be used to provide feedback on the observation process and also as data of the observed possible exposures.

3.4.3. Media material (pictures and video)

The use of video and photography is an emerging research and intervention tool in social sciences such as anthropology, especially in United States and, more recently, in the UK (44). Some features that make it an interesting research strategy are that "visual images capture the context as well as the action of an event; they can be interpreted by multiple viewers; and the eye of the camera often freezes moments the human eye ignores" (45). These features allow documentation of social events and easier extraction of verbal and non-verbal communication, making it a good tool for capturing emotions (45). Moreover, the use of media tools has proven to be useful for gathering data regarding perceptions and experiences (46) which might provide information about the value and acceptability given by a community or individual to a particular topic or event. Additionally, visual research tools can be used as a means to overcome potential issues that may hinder the investigation process in low-income or complex social settings, such as language (47) and cultural (46) barriers. Therefore, it has become a part of the field of anthropology promoting an emerging subdiscipline called visual anthropology.

As stated by Ray and Smith (48) there are three major benefits of using media research technics:

- Aspects of social reality and details can be captured with more accuracy and with less distortion than other methods.
- Information can be captured in real time reducing problems with recall bias
- It provides the possibility to researchers to include different voices by involving participants in the collection and analysis of the material.

The characteristics and benefits of using pictures and videos as data collection tools suit the objectives of the present study. These methods will support the other strategies used to gather information about workers' risk perception of herbicides use, as well as help to overcome challenges such as cultural and language barriers

Media material (pictures and videos) documenting workers' and contractors' practices will be produced. These pictures and videos will be produced on normal working days and during groups' regular activities. The elements and scenarios to be documented in the media material will be informed by the literature regarding practices that increase the exposure to pesticides. Other relevant scenarios and behaviours to be filmed/photographed are expected to emerge from the observation. This will help identify relevant categories and compare with those identified in the

literature and the analysis of ethnographic observation data. Workers' and contractors' participation is welcomed in case of noticing motivated individuals and if the impact on the working activities is low. However, given the characteristics of the workers' jobs and time constraints it is expected that the majority, or all, of the material will be produced by the observers (i.e. fieldworker and anthropologist).

In spite of the proven efficiency of video and photography as a research tool (45,48), the use of this methodology is not widespread. There are not, to the knowledge of the author, any studies regarding workers' herbicide risk perception that included videos and photos as a core tool of its research strategy.

3.5. Data Analysis

Initial analytical categories will be drawn from the literature review regarding farmers risk perception of pesticide use and its relation with SCT of behavioural change. In addition, the findings of the larger project's first phase will also be used to identify these categories. The main categories identified will be used as a guide to code data collected through the methods previously described.

The information of secondary objectives 1 and 2 will provide data of workers' and contractors' practices and their risk perception regarding herbicide use. In addition, socio-cultural information gathered through the qualitative tools previously described will also be analysed (Objective 3). The data collected for secondary objective 4 will add to understanding the influence of peers on workers' and contractors' herbicide use practices. Data will be imported into a qualitative software for data management, structuring and analysis (QSR Nvivo 10, 2012) and themes will be identified through content analysis. In light of the theory and the fieldwork findings, possible ways in which risk perception and the specific socio-cultural context interact will be explored. Emerging social and cultural categories that might be associated with workers' and contractors' risk perceptions of herbicide risks and PPE compliance will also be analysed and studied further.

In order to analyse the media material collected, a content and thematic analysis will be conducted. The content analysis will identify those physical elements and herbicide exposure-related practices present in photographs and videos and create an inventory. This information will add more detail to the data registered on the field notes regarding herbicides exposure. In addition, the thematic analysis will help to identify relevant categories and compare with those identified in the literature and the analysis of ethnographic observation data.

3.5.1. Hawthorne Effect[1]

The pilot study revealed that the Hawthorne effect occurred while using white female fieldworkers. After employing black Xhosa speaking anthropology students the effect was significantly reduced. Although it is impossible for the fieldworkers to be completely invisible, three approaches will be in employed in for addressing the Hawthorne effect:

a. Using black Xhosa and Afrikaans speaking fieldworkers
b. Fieldworkers will be present with the study team for a few days prior to observing so that the workers get used to their presence.
c. We will acknowledge this in the analysis of the results.

4. ETHICAL CONSIDERATIONS

The larger study entitled: "*Herbicide exposure prevention study for Working for Water – Using Peer Education to Promote Health and Safety amongst a highly mobile workforce*" was granted ethics approval (HREC REF: 445/2011) by the University of Cape Town Human Research Ethics Committee (HREC) (Appendix D). Freely given informed consent will be obtained from every participant prior to the participant undergoing any study procedures. The informed consent process will take place in a language understood by the potential participant (predominately Xhosa) and the participant can choose which language the informed consent process can take place in. All informed consent documents will be provided in the three main official languages pertinent to the area namely English, Afrikaans and Xhosa. The documents translated from English will be back translated. The study participant will be given a signed copy of the informed consent document and the investigator/designate will keep one copy in the investigator file. Participants who refuse to participate will be respected and not observed. The document will explicitly inform participants about the media material collection and ask for their consent. Participants that refuse to be part of the videos or pictures will not be filmed or photographed. In case they appear in any of the media material collected (e.g. group pictures) the material will be identified and separated. If the material

[1] The Hawthorne Effect is a phenomenon that produces changes in the behaviour of subjects that are part of a study or assessment. These changes in the behaviour are a response to subjects' knowledge of their participation in a study and the presence of researchers that would not be there under normal circumstances.

needs to be used it will be edited so the participants that did not give their consent do not appear or cannot be recognised.

Study participants will participate during working hours as permission has been granted from WfW for teams to take part in the study during this time. Participants will be informed that the purpose of the study is to improve working conditions and that they will not be penalized if found working unsafely, but corrected, removed from the dangerous circumstance, and/or trained in the safe procedure.

5. TIME SCHEDULE

	2011 Nov	Dec	2012 Jan	Feb	Mar	April	May	June	July	Aug	Sept/Oct/Nov/Dec
Literature review											
Observation Guides and piloting											
Fieldworkers Training											
Fieldwork Observation/interviews											
Questionnaires											
Data Analysis											
Results											
Discussion/Write up/Corrections											

6. REFERENCES

1. Mancini F, Van Bruggen AHC, Jiggins JLS, Ambatipudi AC, Murphy H. Acute pesticide poisoning among female and male cotton growers in India. Int J Occup Environ Health. 2005;11(3):221–32.

2. Kesavachandran CN, Fareed M, Pathak MK, Bihari V, Mathur N, Srivastava AK. Adverse health effects of pesticides in agrarian populations of developing countries. Rev Environ Contam Toxicol. 2009;200:33–52.

3. Holtan N, Warwick M, Bomier B. What physicians can do to reduce occupational and incidental pesticide exposure: a guide to best practices. Minn Med. 2008;91(9):31–5.

4. Nweke OC, Sanders WH. 3rd. Modern environmental health hazards: a public health issue of increasing significance in Africa. Environ Health Perspect. 2009;117(6):863–70.

5. Hunt LM, Tinoco-Ojaguren R, Schwartz N, Halperin D. Balancing Risks and Resources: Applying Pesticides withouth Using Protective Equipment in Southern Mexico. In: Hahn RA, editor. Anthropology in Public Health. Bridging differences in culture and society. New York: Oxford University Press; 1999.

6. Remor AP, Totti CC, Moreira DA, Dutra GP, Heuser VD, Boeira JM. Occupational exposure of farm workers to pesticides: Biochemical parameters and evaluation of genotoxicity. Environ Int. 2009;35(2):273–8.

7. Feola G, Binder CR. Why don't pesticide applicators protect themselves? Exploring the use of personal protective equipment among Colombian smallholders. Int J Occup Environ Health. 2010;16(1):11–23.

8. Peres F. Percepción de Riesgo de los Agricultores con Respecto al Uso de Pesticidas en un Área Agrícola del Estado de Rio de Janeiro, Brasil. Cienc Trab. 2007;26:164–71.

9. Blanco-Muñoz J, Lacasaña M. Practices in pesticide handling and the use of personal protective equipment in Mexican agricultural workers. J Agromed. 2011;16(2):117–26.

10. Naidoo S, London L, Rother HA, Burdorf A, Naidoo RN, Kromhout H. Pesticide safety training and practices in women working in small-scale agriculture in South Africa. Occup Environ Med. 2010;67(12):823 –828.

11. Protano C, Guidotti M, Vitali M. Performance of Different Work Clothing Types for Reducing Skin Exposure to Pesticides During Open Field Treatment. B Environ Contam Tox. 2009;83(1):115–9.

12. Samanic CM, De Roos AJ, Stewart PA, Rajaraman P, Waters MA, Inskip PD. Occupational Exposure to Pesticides and Risk of Adult Brain Tumors. Am J Epidemiol. 2008;167(8):976 –985.

13. Boers D, Zeegers MPA, Swaen GM, Kant I, van den Brandt PA. The influence of occupational exposure to pesticides, polycyclic aromatic hydrocarbons, diesel exhaust, metal dust, metal fumes, and mineral oil on prostate cancer: a prospective cohort study. Occup Environ Med. 2005;62(8):531 –537.

14. Bassil Kl, Vakil C, Sanborn M, Cole DC, Kaur JS, Kerr KJ. Cancer health effects of pesticides. Can Fam Physician. 2007;53(10):1704–1711.

15. Brouwers MM, van Tongeren M, Hirst AA, Bretveld RW, Roeleveld N. Occupational exposure to potential endocrine disruptors: further development of a job exposure matrix. Occup Environ Med. 2009;66(9):607 –614.

16. Dich J, Zahm SH, Hanberg A, Adami HO. Pesticides and Cancer. Cancer Cause Control. 1997;8(3):420–43.

17. Rother HA. South African farm workers' interpretation of risk assessment data expressed as pictograms on pesticide labels. Environ Res. 2008;108(3):419–27.

18. Costello S, Cockburn M, Bronstein J, Zhang X, Ritz B. Parkinson's Disease and Residential Exposure to Maneb and Paraquat From Agricultural Applications in the Central Valley of California. Am J Epidemiol. 2009;169(8):919–26.

19. Lim S, Ahn SY, Song IC, Chung MH, Jang HC, Park KS, et al. Chronic Exposure to the Herbicide, Atrazine, Causes Mitochondrial Dysfunction and Insulin Resistance. PLoS ONE. 2009;4(4):e5186.

20. Phillips KP, Tanphaichitr N. Human Exposure to Endocrine Disrupters and Semen Quality. J Toxicol Env Health, Part B. 2008;11(3-4):188–220.

21. Ochoa-Acuña H, Frankenberger J, Hahn L, Carbajo C. Drinking-Water Herbicide Exposure in Indiana and Prevalence of Small-for-Gestational-Age and Preterm Delivery. Environ Health Perspect. 2009;117(10):1619–24.

22. Waller SA, Paul K, Peterson SE, Hitti JE. Agricultural-related chemical exposures, season of conception, and risk of gastroschisis in Washington State. Am J Obstet Gynecol. 2010;202(3):241.e1–e6.

23. Turpie JK, Marais C, Blignaut JN. The working for water programme: Evolution of a payments for ecosystem services mechanism that addresses both poverty and ecosystem service delivery in South Africa. Ecol Econ. 2008;65(4):788–98.

24. Buch A, Dixon AB. South Africa's working for water programme: searching for win–win outcomes for people and the environment. Sustain Dev. 2009;17(3):129–41.

25. WfW. Contractor's Manual. Working for Waters, Department of Water Affairs and Forestry; 2003.

26. Richardson DM, Van Wilgen BW. Invasive alien plants in South Africa: how well do we understand the ecological impacts? S Afr J Sci. 2004;100(1-2):45–52.

27. Rother HA, De Souza MA, Patten G. Working for Water Project: Assessing Working for Water Community Workers Herbicide Exposures and Prevention Strategies. Recommendation list. Centre for Occupational and Environmental Health Research (COEHR) School of Public Health and Family Medicine. University of Cape Town of Cape Town; 2010 Dec.

28. Arcury TA, Quandt SA, Russell GB. Pesticide safety among farmworkers: perceived risk and perceived control as factors reflecting environmental justice. Environ Health Perspect. 2002;110(2):233–40.

29. Feola G, Binder CR. Identifying and investigating pesticide application types to promote a more sustainable pesticide use. The case of smallholders in Boyacá, Colombia. Crop Prot. 2010;29(6):612–22.

30. Jeffery RW. How can Health Behavior Theory be made more useful for intervention research? Int J Behav Nutr Phys Act. 2004;1(10):e10–e15.

31. Armitage CJ, Conner M. Social cognition models and health behaviour: A structured review. Psychol Health. 2000;15(2):173–89.

32. Bandura A. Health Promotion by Social Cognitive Means. Health Educ Behav. 2004;31(2):143 – 164.

33. Brewer NT, Chapman GB, Gibbons FX, Gerrard M, McCaul KD, Weinstein ND. Meta-analysis of the relationship between risk perception and health behavior: The example of vaccination. Health Psychol. 2007;26(2):136–45.

34. Moreno AR, Peres F. El estado del arte de la comunicación de riesgos en la región de América Latina. RCyS. 2011;1(1):52–68.

35. Sjöberg L. Factors in Risk Perception. Risk Anal. 2000;20(1):1–12.

36. Boholm Å. The cultural nature of risk: Can there be an anthropology of uncertainty? Ethnos. 2003;68(2):159–78.

37. Boholm Å. Risk perception and social anthropology: Critique of cultural theory. Ethnos. 1996;61(1-2):64–84.

38. Tansey J, O'riordan T. Cultural theory and risk: A review. Health Risk Soc. 1999;1(1):71–90.

39. Riewpaiboon W, Chuengsatiansup K, Gilson L, Tangcharoensathien V. Private obstetric practice in a public hospital: mythical trust in obstetric care. Soc Sci Med. 2005;61(7):1408–17.

40. Pell C, Straus L, Andrew EVW, Meñaca A, Pool R. Social and Cultural Factors Affecting Uptake of Interventions for Malaria in Pregnancy in Africa: A Systematic Review of the Qualitative Research. PLoS One. 2011;6(7):e22452.

41. Quevedo-Gómez MC, Krumeich A, Abadía-Barrero CE, Pastrana-Salcedo E, van den Borne H. Machismo, public health and sexuality-related stigma in Cartagena. Cult Health Sex. 2011;14(2):223–35.

42. Rother HA. Risk perception, risk communication, and the effectiveness of pesticide labels in communicating hazards to South African farm workers. [United States]: Michigan State University; 2005. Available from: http://search.proquest.com.ezproxy.uct.ac.za/docview/305429979 /abstract? accountid=14500

43. Cabrera-Orozco F. Walking to the Sedentarization: Anthropological Study About the Politic Change in a Nomadic Group from the Amazonic Region of Colombia. [Netherlands]: vrije Universiteit; 2009.

44. Pink S. Guest Editor's Introduction: Applied Visual Anthropology Social Intervention, Visual Methodologies and Anthropology Theory. Vis Anthropol Rev. 2004;20(1):3–16.

45. Rosenstein B, Beer Sheva I. Video Use in Social Science Research and Program Evaluation. Int J Qual Meth. 2002;1(3):22–43.

46. Bean J. Beyond Walking With Video: Co-Creating Representation. EPIC 2008;2008(1):104–15.

47. Didkowsky N, Ungar M, Liebenberg L. Using Visual Methods to Capture Embedded Processes of Resilience for Youth across Cultures and Contexts. J Can Acad Child Adolesc Psychiatry. 2010;19(1):12–8.

48. Ray JL, Smith AD. Using Photographs to Research Organizations: Evidence, Considerations, and Application in a Field Study. Organ Res Methods. 2012;15(2):288-315.

PART B: STRUCTURED LITERATURE REVIEW

CONTENTS

1. INTRODUCTION AND OBJECTIVES OF LITERATURE REVIEW

Human exposure to different types of pesticides, including herbicides, has increased in recent years given its extensive use to control pests for agricultural, public health or environmental protection purposes (e.g. protect native species that are being threatened by alien species, protect water sources).The exposure of workers and farmers to pesticides in low-income countries is an important public health issue as pesticides have a significant negative impact on their short and long term health. Furthermore, in the context of several socio-economic issues, the risks associated with pesticide exposure add to other challenges that workers face to support their family and maintain their health. Although 80% of the world's pesticides are used in high-income countries, 99% of deaths due to pesticide poisoning occur in middle- and low-income countries (1). Africa accounts for only 2-4% of the global pesticide market (2), but studies done in African countries frequently stress different pesticide-related safety issues, such as low use of Personal Protective Equipment (PPE) (3), use of unlabelled containers (4), and poor risk communication strategies (5,6). These factors explain part of the concerning difference between high-income countries' and low-income countries' rates of pesticide poisoning.

It has been shown that the health hazards attributed to pesticide use can potentially be reduced by implementing safety strategies such as the use of PPE (7–10). However, studies have also documented the inadequate use of PPE amongst workers and farmers, especially in mid- and low-income countries (5,7,11–14). The main purpose of this study is to understand the link between workers' risk perceptions of herbicide use and PPE compliance amongst Working for Water (WfW) workers. WfW is an extensive alien vegetation control and poverty-relief programme which has been running in South Africa since 1995. This literature review aims is to inform this study using relevant scientific evidence.

The objectives of this literature review were:

- Investigate the current literature regarding PPE compliance, as well as risk perceptions of herbicide use amongst workers and farmers
- Identify and analyse conceptual frameworks useful for understanding the link between risk perception and PPE compliance
- Identify contextual factors that influence workers' and farmers' risk perception of herbicides use and PPE compliance
- Understand health risks relate to herbicide, especially in low-and middle–income countries

2. SEARCH STRATEGY

Peer reviewed articles published in indexed journals were searched using PubMed, JSTOR, Science Direct, SciELO, EBSCOhost and Google Scholar search engines. Four different search areas constituted the main focus[2]:

- Herbicides health risks (Search terms: herbicides exposure; health herbicides; herbicide hazard; risk herbicide; farmer health risk; farmer exposure; health farmer)
- WfW and programmes comparable with WfW (Search terms: WfW; alien vegetation removal herbicide; forestry herbicide health)
- Research or interventions related to pesticides and PPE compliance conducted amongst workers or farmers (Search terms: PPE herbicides or pesticides; PPE use compliance; PPE intervention; intervention herbicides or pesticides; intervention farmer; education herbicides or pesticides; education PPE; education farmer)
- Theory of risk perception. (Search terms: risk perception health; behavioural change health; behavioural change theory; intervention health behaviour change; health behaviour change; risk perception intervention education)
- Pesticides risk perception (Search terms: risk perception pesticides or herbicides; risk perception farmer; risk perception)

In addition, information was collected from the WfW programme manuals as well as research reports from the University of Cape Town (UCT) Centre for Occupational and Environmental Health Research (COEHR). Relevant articles referenced in the literature and studies recommended by experts in the field were also included.

2.1. Quality and Relevance Criteria

The abstracts of the articles found were analysed. The following questions were used as a guideline to assess their relevance for this study:

- Does the article explore variables that might explain PPE compliance?
- Does the study document risk perceptions of workers or farmers?

[2] Most of the search terms were initially searched adding the terms “South Africa”, “developing countries”, “Africa”, “South America” in order to find literature relevant to middle- and low -income countries. Afterwards the search was conducted without these extra terms.

- Does the article refer to research or interventions conducted amongst famers or workers regarding herbicides or pesticides use? Was the study conducted in middle- or low-income countries, or in a context with comparable socio-economic characteristics?
- Does the theoretical framework used provide concepts that are relevant and can be applied to understand WfW's herbicide use?
- Does the conceptual framework used provide relevant insights even if the study was not directly related to pesticides generally or herbicides specifically?
- Does the study provide useful information about the health effects of herbicides exposure and PPE effectiveness?

The full articles considered relevant were reviewed. The rigour and quality of the studies was assessed as suggested by Gilson (15) (i.e. assessing their confirmability, dependability, credibility and transferability). Studies considered of low quality or not relevant were excluded. The articles were imported to a computer references management system (Zotero 3.0.3) which indexed and categorised the documents.

3. SUMMARY OF LITERATURE REVIEW

3.1. The Health Effects of Herbicide Exposures

Herbicides are a pesticide used to control invasive plants that could harm agriculture production or other environmental services (16). The most common routes of humans' exposure to herbicides are through skin absorption and inhalation (12). Besides the possible acute effects, research has shown that long term exposures to low doses of herbicides leads to accumulation in the body which might result in chronic health effects. (16). Exposures to this group of substances are associated with different types of cancer such as adult brain tumours in women (17) and prostate cancer (18). Several studies have specifically focussed on the impact of occupational exposure to herbicides and indicate a positive association between the exposure and overall cancer risk (19,20). However, the possible hazards of herbicides are not limited to cancer. Parkinson's (21), insulin resistance and obesity (22), and possible endocrine disruptions (23) have also been documented. Moreover, studies showed negative effects on new-borns due to prenatal exposure, indicating that maternal exposure to herbicides is associated with the prevalence of Small-for-Gestational-Age (SGA) (24) and foetal gastroschisis (25).

Research strongly suggests that farmers and workers from low-income countries are at greater risk of exposure given the spraying techniques used, insufficient risk communication tools and inadequate or lack of PPE use (6,11,12). Additionally, recent studies highlighted other possible underlying factors that might increase the risk of developing acute or chronic illnesses related to herbicide exposure. Some of these factors are poor nutrition (11), immune system status and interaction with other chemicals (26). Occupational exposure to herbicides has been documented among forestry workers in the USA who face challenging social contexts which increases their exposures and health risks (27,28). For example, workers live in substandard conditions (e.g. houses with limited ventilation, lack of laundry facilities) increasing their risk of exposure to residual herbicides in their cloths and PPE (28). These living conditions are similar to those of the WfW workforce. This is problematic in countries like South Africa in which these underlying factors tend to be common amongst workers and small scale farmers involved with the handling of herbicides.

3.2. Working for Water (WfW) Programme

In 1995 the WfW programme, administered by the Department of Water Affairs and Forestry, was launched to control invasive alien vegetation while simultaneously contributing to poverty alleviation through job creation and skills training. The programme is now running in all nine of South Africa's provinces and is one of the world's biggest programmes for addressing the removal of invasive alien vegetation (29). To address issues related to poverty WfW employs contractors who hire people from the local communities, providing around 20,000 jobs per annum, of which around 50% are given to women (30). In addition to the benefits of providing short-term jobs, WfW aims to create a working environment for skills training that contributes to the empowerment of the local populations. Each worker can be part of the programme for only 24 months over a five year period in order to give opportunities to other unemployed community members. The expectation is that after the 5 year working cycle WfW workers' chances of securing a job elsewhere will increase (31).

Although the WfW programme has been described by some authors as a success (29,32), there are still challenges that must be addressed, particularly in relation to creating more substantial and sustainable social development outcomes (33). In order to improve beneficiaries living conditions, special attention must be given to possible health effects of the programme on the workforce. A pilot study of WfW's current herbicide-related policies and practices (2009-2010) under the principal

investigator Dr Andrea Rother, identified some key aspects that need to be improved to reduce workers' exposure to herbicides (34). The data gathered showed that there are some problems related with PPE, particularly in regards to workers PPE compliance and the quality of the PPE provided (34). The pilot study found that the PPE used is not always appropriate or comfortable and then often not worn correctly. For example, the PPE provided (e.g. gloves, boots) does not always come in small enough sizes for women, or the characteristics of the PPE do not prevent workers from exposure to herbicides (e.g. inappropriate type of gloves, dusk mask rather than respirators) and therefore potentially increases workers' exposure. Some parts of the PPE, such as goggles, caused discomfort while working and therefore were not worn by workers. The pilot study also found that the nature of the contracts with WFW often pressurise contractors to apply herbicides without following WfW safety policies in order to meet tight work deadlines.

WfW workers are sourced by contractors from the communities[3] that are close to where the removal of alien vegetation takes place. Each team consists of approximately 10 workers classified by training and activities they are certified to perform (i.e. general worker, peer educator, herbicide applicator, first aider, health and safety rep and driver). According to WfW standards all workers must receive a basic training that certifies them as general workers (35). The training material provides detailed information of health and safety responsibilities, both for the workers and WfW, and the dangers of herbicides to the environment and to workers (35). In addition, the correct use and type of PPE that should be worn is described (35). Contractors are in charge of employing workers and guide them on the right procedures of alien vegetation removal, and are responsible for the health and safety of the workers (36).

Despite the efforts of the WfW programme to improve their workforce PPE compliance through training, workers and contractors are at risk of harmful exposures to herbicides. Therefore, workers' and contractors' exposure to herbicides must be documented and new exposure reduction interventions implemented. Additionally, there is a high turnover of the workers involved in herbicide use because, in part, of low pay, difficult working conditions and workers leaving for better paid jobs. This turnover may affect the effectiveness of health and safety training (34) as WfW spends time and resources training new workers who may not stay in the programme for long. This is particularly concerning in regards to training in technical skills such as how to use and work safely with herbicides. The current training might not be well suited to the socio-cultural context of the workers, as it was documented in the pilot study that the PPE use training was not conducted in the workers' home language. Moreover, it has been shown that simply delivering information through

[3] WfW criteria for the selection of the workers is explained in section 3.3 of the protocol (Part A of this document)

training is not enough to shape workers behaviours (37). This is a major challenge when designing an effective intervention to reduce exposure to herbicides. Creative, flexible and culturally appropriate approaches must be followed in order to promote change in safety behaviours associated with herbicide use. Although there have been some studies conducted about the ecological and poverty relief goals of the WfW programme (33,38), there have not been, to the knowledge of the author, any studies evaluating the health impacts of herbicide use on WfW workers.

3.3. The Role of PPE in Exposure Prevention

The main and most common strategy implemented to reduce workers' exposure to pesticide is the use of PPE (39). However, the 'hierarchy of controls' (40) approach presents PPE as only one of six exposure control strategies (i.e. elimination, substitution, engineering, administrative, behaviour) and highlights the differences on efficiency and sustainability of the control depending on the level of intervention needed (41). Moreover, it is usually preferred only after the other levels of controls have been implemented or ruled out (42) since PPE interventions require a high level of worker participation and supervision. This is especially difficult to achieve in contexts where workers face several social and economic challenges (such as poverty and substandard living conditions). In addition, several issues with regards to PPE compliance amongst farmers and workers have been documented in other mid- and low-income regions.

Although some studies have been conducted to understand workers' exposure to herbicides (27,28), literature regarding PPE compliance amongst workers of alien invasive plant control programmes is very limited. Therefore, this study is mostly informed by PPE compliance studies with farm workers (5,12,13,43–45). The use of herbicides is common in agriculture. Workers and farmers using small portable pesticides application equipment are more exposed to pesticides than those using mechanised vehicle sprayers (3). Portable methods (e.g. backpack sprayers, hand held sprayers), used by the WfW programme, are also common amongst low-income countries smallholders and workers spraying (3). The dependence on herbicides in tropical countries of Latin America has increased and given the characteristics of crops and terrains, portable spraying methods are widely used (46–49). Studies conducted in Latin America, which are relevant for Africa case, have raised concerns regarding low PPE compliance (43) as well as highlighted the importance of understanding broad socio-cultural and economic factors affecting workers' exposure to herbicides (48). Given the comparable spraying methods, socio-economic barriers, and general health issues, the findings of farm workers regarding PPE compliance can inform this study.

Although several of the issues associated to PPE compliance are specific to each country (3), some key problem areas were identified in the literature. Issues associate with limited access to adequate PPE were often documented in the literature (3,14). In middle- and low-income countries PPE is usually imported and not suitable to local characteristics of the population (e.g. not adequate sizes) and the environment (e.g. hot climates, difficult terrain) (3). In addition, workers and farmers who are not provided with PPE struggle to afford adequate protective equipment (14). However, issues associated with PPE compliance are not only limited to its availability. It has been documented that risk perception of pesticides use amongst workers and farmers influence their PPE compliance (e.g. belief that pesticide only affects weak people) (7,13,50).

PPE is a major part of WfW's strategy to control workers' and contractors' exposure to herbicides, and therefore the factors influencing PPE were assessed in this study. WfW promotes the use of PPE through the following strategies (36,51,52) :

- Guidelines and procedures to make PPE available for workers in the field
- Industry based training on PPE use and care; and
- Disciplinary measures to enforce PPE use

Understanding the challenges of interventions promoting PPE and factors that influence PPE compliance, is relevant for the WfW context. The programme workforce is sourced from low socio-economic level communities similar to those in which low PPE compliance has been reported. In addition, the pilot study raised concerns regarding WfW's workforce PPE compliance.

3.4. PPE Compliance: The Role of Social Context and Risk Perceptions

The 'ecological model' approach, which is often used in public health research, assesses health related issues by taking into account the different factors that can influence health, ranging from specific characteristics of the individual (e.g. psychological, genetic) to broader social, economic, cultural and environmental conditions (53). There is a growing body of research aimed at understanding PPE compliance amongst farmers, and workers and some studies have been conducted on the multiple underlying social and psychological factors influencing compliance (45). The socio-economic context, pesticides risk perceptions, gender dynamics, peers influence, and adherence to local social norms and cultural contexts have been associated with workers' and

farmers' exposure to pesticides and PPE compliance. These explanatory variables should not be understood as isolated factors, as they interact in various ways shaping workers' and farmers' exposure to pesticides and PPE compliance.

3.4.1. Socio-economic vulnerabilities

Seasonal forestry workers in the USA, who are a marginalised population similar to the WfW workforce, face many occupational hazards (27,54), including exposure to herbicides. Hansen and Donohoe described the health issues of this population from a comprehensive perspective by exploring the occupational hazards they face in the context of social, economic, cultural and language barriers (28). For example, workers live in substandard conditions which affect their general health and make them susceptible to other diseases and health hazards (28). The analysis of occupational hazards done by Hansen and Donahoe, takes into account not only the individual exposure of the worker, but also analyses how the socio-economic and cultural limitations of this population (e.g. language barriers, lack of access to health care) increases their risk of herbicide exposures and health effects (28). For example, workers live in substandard conditions (e.g. houses with limited ventilation, lack of laundry facilities) increasing their risk of exposure to residual herbicide in their cloths and PPE (28). The analytical approach used by the authors, is useful for understanding herbicide exposure among transient workers facing several socio-economic limitations as well as herbicides exposure in low-and middle-income countries.

Therefore, it is a relevant perspective for understanding the WfW's case. The analysis of workers socio-cultural and economic limitations could provide insight on PPE compliance, which is necessary to design appropriate and sustainable exposure reduction interventions.

For workers in Latin America, local conceptions of work (48), employment status of workers (55), and health care access barriers (49) have been suggested as factors influencing the exposure of workers to herbicides. The structure of the WfW programme (e.g employment status, payment logistics), and the social context of its workers, present characteristics that have been reported in previous research conducted in Latin America as risk factors that increase the exposure of workers to herbicides. Moreover, WfW faces comparable challenges to prevent workers herbicide exposures as those reported in Latin American, therefore these findings are acknowledged in this study.

3.4.2. Risk Perceptions

This study is part of a larger project which aims to implement an intervention to reduce exposure to herbicides amongst WfW workers by promoting PPE compliance. The intervention will be informed by health behavioural change theories. These theories aim to understand how people make choices and which factors shape their health related decisions, making behavioural change theories relevant to inform health-related interventions that require a change of behaviour to reduce risk. The general idea of these theories is that people decide what to do depending on the extent to which they expect that their choices are going to produce a result that they consider valuable (56). Although an analysis of the different behavioural change theories is out of the scope of this literature review, it is noteworthy that most of these theories include perceived risk of exposure as one of the core factors that promote a change in their behaviour (57). In addition, evidence from meta-analysis strongly suggests the existence of a relationship between risk perception of a potential harm or exposure, and behaviours to prevent this harm or exposure (57). Given that WfW aims to reduce the exposure of its workforce mainly through promoting change in safety behaviours (e.g. correct PPE use), is important to understand workers perceived risk of their exposure to herbicides.

Risk perceptions can be broadly understood as the person's capacity to interpret a potentially hazardous situation based on previous experiences and beliefs (58). In order to provide explanatory frameworks for understanding risk perceptions, various approaches have been proposed. Some studies have been based on the premise that perceived risk is a measurable physiological construct that can be assessed using quantitative psychometric methods (59). Moreover, certain authors have focused their research on measuring the size of the error of 'laypersons' perceived risk (60) and exploring explanatory variables to predict risk perception. This type of approach has been criticised by other researchers as insufficient because social aspects (e.g. moral dimension) are not included in the analysis (59). As stated by Boholm, the concept of risk, by definition, implies values and normative components subjected to negotiation with other individuals (61). Understanding risk perception as part of a broader socio-cultural context is more suitable for this study because it is a useful perspective for understanding multilevel and complex interactions of variables, such as those reported in the literature as factors influencing farmers' and workers' perceived risk of pesticides use (12,13,45,62).

There are two main topics that are frequently addressed in pesticide risk perception research (13) that are useful for understanding WfW workers' PPE compliance. The first topic is the discrepancy in risk perception between experts and 'laypersons' (63). It is noteworthy that some of these studies have been conducted in high-income countries, in which the 'citizens' or 'laypersons' may come from a socio-economic context which provides them with different tools to analyse experts' perception of risk. The difference in perceptions between groups within society should not be defined simply as a function of error by 'laypersons', but rather are influenced by issues such as power, values and trust (64). Citizen's perceived risk of pesticide use (65), risk communication through pesticide labels (6), and the analysis of the implications of an alien plants control programme (66), are some examples of pesticide-related topics assessed by comparing differences between risk perceptions. The second main topic of pesticides risk perception research is assessing the factors that shape people's risk perceptions (13), which was the focus of this study.

Understanding the factors that influence particular risk perceptions of pesticides use has been proven to be a useful tool to design interventions to improve farm workers health, especially in challenging socio-economic contexts (13). Some practices that increase the exposure of workers and farmers to pesticides are based on particular perception of risk, which are influenced by the socio-cultural context. For example, a study conducted in Mexico found that farmers did not use PPE, and therefore were exposed to pesticides, because they considered that pesticides only had health effects on weak or sick people (7). Several other in depth studies have explored farmers' and workers' perceptions and beliefs of pesticide use to understand their pesticide related safety behaviours. Palis et al. (50) analysed Filipino farmers' perceptions and beliefs with regards to illness and pesticides, and how these factors are associated with safety behaviours and PPE compliance. Farmers understood pesticides as both a poison for pests and medicine for plants, leading to mixed perceptions of its impact on humans' health. In addition, farmers' that did not take any precaution against pesticides (e.g. PPE use) considered themselves to have 'strong blood' and therefore immune to the effects of pesticides (50). A similar belief has also been reported amongst farmers in Brazil (13), increasing their exposure to pesticides given their low compliance to safety practices such as PPE use. Another interesting finding of Palis' study is that local definitions of health are based on the individuals' capacity to be able to work, therefore workers and farmers only showed concern about their symptoms if they interfere with their working activities (50).This could lead to extending the period of exposure to pesticides before getting medical attention

Research analysing the socio-cultural context and risk perceptions for the particular case of herbicides is very limited. Herbicides have specific chemical characteristics, health effects, and targeted pests, which might influence people's perceptions of the risk associated with its use. In a study conducted in rural California, Norgaard analysed factors such as institutional trust, proximity to exposure, gender, and race and how these are interconnected with the interpretation of herbicides use amongst three different groups defined by the author as: Karuk tribe, the non-Indian community and the U.S. Forestry Service (66). The study explored race and gender as dynamic social constructions linked to social and economic conditions, poverty, access to information and health care. In addition to describing how different perceptions of herbicide use are shaped, the author suggests that factors including 'economic dependence, lack of control over work and living environments, high poverty, low wages, inadequate health insurance, inadequate access to information, and cultural barriers to political participation' contributed to increase the risk of exposure to herbicides of underserved populations such as workers, farmers or native minorities (66). Norgaard's research provides interesting insights for this study as the population targeted has comparable characteristic and socio-economic challenges that are expected to shape workers herbicides-related risk perceptions and safety behaviours.

The findings of studies associating workers' and farmers' risk perception of pesticides use, PPE compliance, and exposure to pesticides, were relevant to the case of WfW and informed this study fieldwork and analysis. The influence of gender dynamics and social norms on pesticides risk perception and safety practices was analysed further based on the pilot study findings and its documented relevance amongst farmers and workers of mid- and low-income countries.

3.4.3. Gender

The influence of gender dynamics on pesticides risk perceptions has been reported in research conducted in South Africa (62) and other high-, middle- and low-income countries (13,44,55,66). These studies identified several issues associated with pesticides use that are influenced by gender dynamics. For example, studies found that risk perceptions of pesticide use are influenced by social constructions of gender (13,55) that could shape safety practices. For example, Reed et al. (44), studied the association between gender and risk of exposure to pesticides amongst children who performed farm work in Kentucky, Iowa and Mississippi (USA). The study found that boys were at a significantly higher risk of exposure than girls and were more likely to engage in risky behaviours such as not using PPE (44). A similar situation was reported amongst banana plantation workers in

Costa Rica, in which gender roles shaped the knowledge of pesticide health effects (55). The study found that depending on the type of community (i.e. indigenous community, plantation community) women had more or less power on pesticides related decisions. For example, in the indigenous communities, women had their own farms, made decisions related with pesticides, and had as much knowledge as men regarding pesticide use risks (55).

Another example on how gendered risk perception of pesticide use influences PPE compliance and exposure to pesticides was documented by Rother amongst Western Cape farms workers (62). The author found that different cultural and social factors influenced farms workers' perceptions regarding pesticides (62). Western Cape farmers perceived 'others' (e.g. peers, children) to be at higher risk of pesticide exposure than themselves and therefore did not comply with safety practices such as PPE use. In addition, women were considered to have a low risk of exposure given that they predominately do the mixing and not the spraying of pesticides (62). Therefore, there was a low PPE compliance during mixing increasing the exposure of women to pesticides. On the other hand, gender dynamics can also affect men's health. Peres et al. (13) reported that male workers perceived pesticides health effects as only affecting women and children, and therefore had low PPE compliance.

The WfW pilot study found that it is difficult for contractors to source PPE in smaller sizes for the women in their team. In addition, activities like foliar spraying were specially challenging for women. These findings give some initial insights on how gender could influence safety related practices in WfW teams. Although WfW includes in its policies some safety recommendations specifically designed for women (e.g. women must avoid using herbicides during pregnancy), this study attempts to provide a deeper understanding of the influence of gender dynamics on workers risk perception of herbicide use and PPE compliance.

3.4.4. Peers and Social Norms

Research in high-, middle- and low-income countries has also been conducted to understand the influence of peers and social norms on PPE compliance. Studies have shown that farmers' choices regarding PPE use are influenced by their perception of peers' PPE practices (12). Based on their research amongst workers in fruit-growing farms in Canada, Nicol and Kennedy highlighted the importance of considering the influence of the community on pesticide related safety behaviours and found an association between peers practices and farmers PPE compliance (45). The authors

found that farmers' decisions to use PPE were influenced more by their perception of peers' practices than by information received from agencies. Therefore, the study suggested that interventions should be participatory and incorporate member of the community instead of just organising formal training activities regarding pesticide safety practices (45).

A similar association was suggested in a study conducted in Colombia (South America), which investigated potato farmers' reasoning and behaviour regarding PPE use (67). According to Feola et al. (67), social dynamics, such as the tendency to conform to the prescriptive social norms, influences famers' safety decisions such as PPE use. Similar results have also been reported amongst rural farm workers on Rio de Janeiro, Brazil (13). Understanding the possible influence of peers' practices on safety behaviours is relevant to this study since social norms and cultural practices within WfW groups might have an impact on PPE compliance. In addition, it is important to understand how knowledge and norms are transferred between peers in order to inform for interventions aiming to change workers' safety behaviours.

4. IDENTIFICATION OF THE GAPS OR NEEDS FOR FURTHER RESEARCH

Several studies have assessed the use of and exposure to pesticides in low-income settings (5,7,13,14,68), as well as highlighted the importance of understanding the specific social context in which interventions are going to be implemented. Despite the acknowledgment in peer reviewed articles that these types of studies are needed, literature reporting in depth qualitative research seeking to understand workers' and farmers' social norms and cultural context is still limited. This limitation is even greater regarding case studies in low-income and poor socio-economic contexts. A growing body of research has shown that perception and practices regarding pesticides use depend on particular socio-cultural and economic factors. Training, educational tools, and intervention in the pesticides field must be adapted to local values and the socio-cultural context, as well as be informed by a deep understanding of the populations' risk perception of pesticide use. However, as stated by Rother regarding pesticide risk perception, 'more research needs to be conducted with a diverse range of target groups, especially in developing countries' (62) in order to design effective interventions amongst the populations and countries were the exposures and health effects of pesticides are more concerning.

Norgaard's research (66) contributes to an understanding of the complexity of the association between the socio-cultural context and herbicide risk perceptions, however, her research does not specifically analyse the effect of these variables on PPE compliance. Understanding this link is crucial

in order to design effective interventions to improve workers PPE compliance as a mean to reduce their exposure to herbicides. Norgaard's research (66) assessed herbicides risk perception in rural communities and among social minorities, however this has not been done in low-income countries.

Pesticide PPE compliance studies tend to mainly focus on farmers and farm workers who might have different motivations to be involved in pest control activities than workers of invasive alien vegetation programmes. Although there are some similarities, WfW workers spray exclusively herbicides, which have specific chemical characteristics, health effects, and targeted pests. These specific characteristics might influence the risk perception of pesticide use. In addition, WfW is a programme with ecological and poverty-relief goals in which workers' expectations differ from those of farm workers. The association between the risk perceptions of herbicide and PPE compliance has not been, to the knowledge of the author, analysed for large-scale alien invasive plant control programs. In the case of WfW, most of the studies are focused on the ecological and poverty reduction effects of the programme, without analysing possible negative effects of the programme such as health effects due to herbicide exposures.

There is little understanding of the association between herbicide risk perceptions and socio-cultural context in South Africa. Some pesticides risk perception studies have been conducted amongst Western Cape farmers (62), but this type of studies have not been done for the specific case of herbicide use and government workers with regards to PPE compliance. Given that WfW is one of the largest alien invasive plant control programmes in the world, it is crucial to understand the different variables that shape workers' herbicide-related safety behaviours in order to design effective exposure reduction interventions and improve on PPE compliance. There have not been any studies conducted to understand the association between risk perception, cultural and social context and PPE compliance amongst WfW workers.

Developing knowledge about a particular work setting characterised by high mobility, high turnover and a culturally diverse workforce will add valuable insights to research on pesticide risk perceptions and socio-cultural factors influencing pesticide exposures. In addition, this research specifically assessed a setting in which workers are expected to follow WfW protocols and have no control on the type of herbicides or PPE used. The findings of this study attempt to address some of the gaps highlighted and to provide information relevant to large scale forestry, biological control and conservation programs using herbicides to remove alien invasive vegetation.

5. REFERENCES

1. Jeyaratnam J, Chia KS. Occupational Health in National Development. Singapore: World Scientific Publishing; 1994.

2. Williamson S, Ball A, Pretty J. Trends in pesticide use and drivers for safer pest management in four African countries. Crop Prot. 2008;27(10):1327–34.

3. Matthews GA. Attitudes and behaviours regarding use of crop protection products—A survey of more than 8500 smallholders in 26 countries. Crop Prot. 2008;27(3):834–46.

4. Ngowi AVF, Mbise TJ, Ijani ASM, London L, Ajayi OC. Smallholder vegetable farmers in Northern Tanzania: Pesticides use practices, perceptions, cost and health effects. Crop Prot. 2007;26(11):1617–24.

5. Naidoo S, London L, Rother HA, Burdorf A, Naidoo RN, Kromhout H. Pesticide safety training and practices in women working in small-scale agriculture in South Africa. Occup Environ Med. 2010;67(12):823–828.

6. Rother HA. South African farm workers' interpretation of risk assessment data expressed as pictograms on pesticide labels. Environ Res. 2008;108(3):419–27.

7. Hunt LM, Tinoco-Ojaguren R, Schwartz N, Halperin D. Balancing Risks and Resources: Applying Pesticides without Using Protective Equipment in Southern Mexico. In: Hahn RA. editor. Anthropology in Public Health. Bridging differences in culture and society. New York: Oxford University Press; 1999.

8. Remor AP, Totti CC, Moreira DA, Dutra GP, Heuser VD, Boeira JM. Occupational exposure of farm workers to pesticides: Biochemical parameters and evaluation of genotoxicity. Environ Int. 2009;35(2):273–8.

9. Protano C, Guidotti M, Vitali M. Performance of Different Work Clothing Types for Reducing Skin Exposure to Pesticides During Open Field Treatment. B Environ Contam Tox. 2009;83(1):115–9.

10. Bull S, Fletcher K, Boobis AR, Battershill JM. Evidence for genotoxicity of pesticides in pesticide applicators: a review. Mutagenesis. 2006;21(2):93–103.

11. Nweke OC, Sanders WH. 3rd. Modern environmental health hazards: a public health issue of increasing significance in Africa. Environ Health Perspect. 2009;117(6):863–70.

12. Feola G, Binder CR. Why don't pesticide applicators protect themselves? Exploring the use of personal protective equipment among Colombian smallholders. Int J Occup Environ Health. 2010;16(1):11–23.

13. Peres F. Percepción de Riesgo de los Agricultores con Respecto al Uso de Pesticidas en un Área Agrícola del Estado de Rio de Janeiro, Brasil. Cienc Trab. 2007;26:164–71.

14. Blanco-Muñoz J, Lacasaña M. Practices in pesticide handling and the use of personal protective equipment in Mexican agricultural workers. J Agromed. 2011;16(2):117–26.

15. Gilson L, editor. Health Policy and Systems Research: A Methodology Reader. Geneva: Alliance for Health Policy and Systems Research, World Health Organization; 2012.

16. Dich J, Zahm SH, Hanberg A, Adami HO. Pesticides and Cancer. Cancer Cause Control. 1997;8(3):420–43.

17. Samanic CM, De Roos AJ, Stewart PA, Rajaraman P, Waters MA, Inskip PD. Occupational Exposure to Pesticides and Risk of Adult Brain Tumors. Am J Epidemiol. 2008;167(8):976 –985.

18. Boers D, Zeegers MPA, Swaen GM, Kant I, van den Brandt PA. The influence of occupational exposure to pesticides, polycyclic aromatic hydrocarbons, diesel exhaust, metal dust, metal fumes, and mineral oil on prostate cancer: a prospective cohort study. Occup Environ Med. 2005;62(8):531 –537.

19. Becher H, Flesch-Janys D, Kauppinen T, Kogevinas M, Steindorf K, Manz A, et al. Cancer mortality in German male workers exposed to phenoxy herbicides and dioxins. Cancer Cause Control. 1996;7(3):312–21.

20. Thörn Å, Gustavsson P, Sadigh J, Westerlund-Hännestrand B, Hogstedt C. Mortality and cancer incidence among Swedish lumberjacks exposed to phenoxy herbicides. Occup Environ Med. 2000;57(10):718–20.

21. Costello S, Cockburn M, Bronstein J, Zhang X, Ritz B. Parkinson's Disease and Residential Exposure to Maneb and Paraquat From Agricultural Applications in the Central Valley of California. Am J Epidemiol. 2009;169(8):919–26.

22. Lim S, Ahn SY, Song IC, Chung MH, Jang HC, Park KS, et al. Chronic Exposure to the Herbicide, Atrazine, Causes Mitochondrial Dysfunction and Insulin Resistance. PLoS ONE. 2009;4(4):e5186.

23. Phillips KP, Tanphaichitr N. Human Exposure to Endocrine Disrupters and Semen Quality. J Toxicol Env Health, Part B. 2008;11(3-4):188–220.

24. Ochoa-Acuña H, Frankenberger J, Hahn L, Carbajo C. Drinking-Water Herbicide Exposure in Indiana and Prevalence of Small-for-Gestational-Age and Preterm Delivery. Environ Health Perspect. 2009;117(10):1619–24.

25. Waller SA, Paul K, Peterson SE, Hitti JE. Agricultural-related chemical exposures, season of conception, and risk of gastroschisis in Washington State. Am J Obstet Gynecol. 2010;202(3):241.e1–e6.

26. Holtan N, Warwick M, Bomier B. What physicians can do to reduce occupational and incidental pesticide exposure: a guide to best practices. Minn Med. 2008;91(9):31–5.

27. McDaniel J, Casanova V. Pines in lines: Tree planting, H2B guest workers, and rural poverty in Alabama. South Rural Sociol. 2003;19(1):73–96.

28. Hansen E, Donohoe M. Health Issues of Migrant and Seasonal Farmworkers. J Health Care Poor U. 2003;14(2):153–64.

29. Richardson DM, Van Wilgen BW. Invasive alien plants in South Africa: how well do we understand the ecological impacts? S Afr J Sci. 2004;100(1-2):45–52.

30. WFW. Working for Waters [Internet]. Department of Water Affairs. [cited 2012 Feb 2]. Available from: http://www.dwaf.gov.za/wfw/

31. WFW. Staff Induction Manual. Manual. Working for Waters, Department of Water Affairs and Forestry; 2008

32. Turpie JK, Marais C, Blignaut JN. The working for water programme: Evolution of a payments for ecosystem services mechanism that addresses both poverty and ecosystem service delivery in South Africa. Ecol Econ. 2008;65(4):788–98.

33. Buch A, Dixon AB. South Africa's working for water programme: searching for win–win outcomes for people and the environment. Sustain Dev. 2009;17(3):129–41.

34. Rother HA, De Souza MA, Patten G. Working for Water Project: Assessing Working for Water Community Workers Herbicide Exposures and Prevention Strategies. Recommendation list. Centre for Occupational and Environmental Health Research (COEHR) School of Public Health and Family Medicine. University of Cape Town of Cape Town; 2010 Dec.

35. WfW. Induction Field Book for workers. 2nd edition. Department of Watter Affairs and Forestry; 2006.

36. WfW. Contractor's Manual. Working for Waters, Department of Water Affairs and Forestry; 2003.

37. Arcury TA, Quandt SA, Russell GB. Pesticide safety among farmworkers: perceived risk and perceived control as factors reflecting environmental justice. Environ Health Perspect. 2002;110(2):233–40.

38. Hope RA. Water, Workfare and Poverty: The Impact of the Working for Water Programme on Rural Poverty Reduction. Environ Dev Sus. 2006;8(1):139–56.

39. Keifer M, Gasperini F, Robson M. Pesticides and Other Chemicals: Minimizing Worker Exposures. J Agromed. 2010;15(3):264–74.

40. Wirth O, Sigurdsson SO. When workplace safety depends on behavior change: Topics for behavioral safety research. J Safety Res. 2008;39(6):589–98.

41. IOH. The Hierarchy of Control [Internet]. Innovative Occupational Hygiene Solutions. 2010 [cited 2013 Jan 10]. Available from: http://www.iohsolutions.com/general/151/

42. Lunt JA, Sheffield D, Bell N, Bennett V, Morris LA. Review of preventative behavioural interventions for dermal and respiratory hazards. Occup Med. 2011;61(5):311–20.

43. Varona M, Tolosa J, Cárdenas O, Torres CH, Pardo D, Carrasquilla G, Frumkin, H. Descripción del uso y manejo de plaguicidas en las empresas de flores afiliadas a Asocolflores. Biomédica. 2005;25(3):377–89.

44. Reed DB, Browning SR, Westneat SC, Kidd PS. Personal Protective Equipment Use and Safety Behaviors Among Farm Adolescents: Gender Differences and Predictors of Work Practices. J Rural Health. 2006;22(4):314–20.

45. Nicol AM, Kennedy SM. Assessment of Pesticide Exposure Control Practices Among Men and Women on Fruit-Growing Farms in British Columbia. J Occup Environ Hyg. 2008;5(4):217–26.

46. Valdez-Salas B, Eva I, García D, Juan M, Rivera C, Gustavo LB. Impacto de los plaguicidas en la salud de los habitantes del Valle de Mexicali, México. Rev. Ecol. Lat. Am. 2000;6(3):15–21.

47. Ecobichon DJ. Pesticide use in developing countries. Toxicology. 2001;160(1–3):27–33.

48. Peres F, Costa J, Meneses K, Lerner R, Claudio L. El uso de pesticidas en la agricultura y la salud del trabajador rural en Brasil. Cienc Trab. 2007;9(26):158–63.

49. Varona M, Henao G, Lancheros A, Murcia Á, Díaz S, Morato R, Morales L. Revelo D, de Segurado P. Factores de exposición a plaguicidas organofosforados y carbamatos en el departamento del Putumayo, 2006. Biomédica. 2007;27(3):400–9.

50. Palis FG, Flor RJ, Warburton H, Hossain M. Our farmers at risk: behaviour and belief system in pesticide safety. J Public Health. 2006;28(1):43–8.

51. WfW. WfW Safety, Health and Environmental Standard. Department of Watter Affairs and Forestry; 2009.

52. WfW. Written safe work procedures planned job observations job specification risk assessments. Department of Watter Affairs and Forestry; 2009.

53. Sallis JF, Owen NG. Ecological models of health behaviour. In: Glanz K, Rimer B, Viswanath K. editor. Health Behavior and Health Education: Theory, Research, and Practice. San Francisco: Jossey-Bass; 2002

54. Sarathy B, Casanova V. Guest workers or unauthorized immigrants? The case of forest workers in the United States. Policy Sci. 2008;41(2):95–114.

55. Barraza D, Jansen K, Van Wendel de Joode B, Wesseling C. Pesticide use in banana and plantain production and risk perception among local actors in Talamanca, Costa Rica. Environ Res. 2011;111(5):708–17.

56. Jeffery RW. How can Health Behavior Theory be made more useful for intervention research? Int J Behav Nutr Phys Act. 2004;1(1):10–10.

57. Brewer NT, Chapman GB, Gibbons FX, Gerrard M, McCaul KD, Weinstein ND. Meta-analysis of the relationship between risk perception and health behavior: The example of vaccination. Health Psychol. 2007;26(2):136–45.

58. Moreno AR, Peres F. El estado del arte de la comunicación de riesgos en la región de América Latina. RCyS. 2011;1(1):52–68.

59. Sjöberg L. A Discussion of the Limitations of the Psychometric and Cultural Theory Approaches to Risk Perception. Radiat Prot Dosimetry. 1996;68(3-4):219–25.

60. Fischhoff B, Bostrom A, Quadrel MJ. Risk Perception and Communication. Annu Rev Publ Health. 1993;14(1):183–203.

61. Boholm Å. The cultural nature of risk: Can there be an anthropology of uncertainty? Ethnos. 2003;68(2):159–78.

62. Rother HA. Risk perception, risk communication, and the effectiveness of pesticide labels in communicating hazards to South African farm workers [Internet] [Ph.D.]. [United States -- Michigan]: Michigan State University; 2005 [cited 2012 Oct 11]. Available from: http://search.proquest.com.ezproxy.uct.ac.za/docview/305429979/abstract?accountid=14500

63. Slovic P, Fischhoff B, Lichtenstein S. Why Study Risk Perception? Risk Anal. 1982;2(2):83–93.

64. Bickerstaff K. Risk perception research: socio-cultural perspectives on the public experience of air pollution. Environ Int. 2004;30(6):827–40.

65. Blok A, Jensen M, Kaltoft P. Social identities and risk: expert and lay imaginations on pesticide use. Public Underst Sci. 2008;17(2):189 –209.

66. Norgaard KM. The Politics of Invasive Weed Management: Gender, Race, and Risk Perception in Rural California. Rural Sociol. 2007;72(3):450–77.

67. Feola G, Schoell R, Binder CR. Identifying barriers and opportunities for transitions towards more sustainable agriculture through system analysis. The case of Vereda La Hoya, Colombia. Proceedings of the IFSA 2010 Symposium [Internet]. 2010 [cited 2012 Aug 25]. Available from: http://ageconsearch.umn.edu/bitstream/117781/2/feola_2010.pdf

68. Feola G, Binder CR. Identifying and investigating pesticide application types to promote a more sustainable pesticide use. The case of smallholders in Boyacá, Colombia. Crop Prot. 2010;29(6):612–22.

PART C: ARTICLE

Influence of risk perceptions, social context, and working conditions on herbicide sprayers' Personal Protective Equipment (PPE) compliance in the Western Cape of South Africa[4]

Abstract

The exposure of workers to herbicides in middle- and low-income countries is an important public health issue with a significant negative impact on workers' health. This study investigated the case of workers employed by Working for Water (WfW), a South African alien vegetation control programme. Despite WfW's protection efforts, workers are exposed to herbicides. This study aimed to understand workers' low Personal Protective Equipment (PPE) compliance by analysing their risk perceptions of herbicide use, working conditions and socio-cultural context. Ethnographic observations, informal interviews, visual media, questionnaires and a focus group were conducted from February to December of 2012. Workers' safety practices and PPE compliance were observed during foliar and spot spraying activities. This study found that low PPE compliance persists despite workers' awareness of herbicide exposure risks. PPE use was found to be influenced by workers' socio-cultural context (i.e. gender dynamics and social status), workers' risk perception of herbicide use, and workers' working conditions (i.e. environmental and logistical). These finding highlighted that given the complexity of modelling PPE compliance in countries with several economic and social constraints, exposure reduction interventions should not rely solely on PPE use promotion and other control strategies should be explored (i.e. elimination, substitution, engineering controls, and administrative controls).

Keywords

herbicide exposures; workers' health; PPE compliance; risk perception; socio-cultural context; working conditions

Introduction

The exposure of workers to pesticides in middle- and low-income countries is an important public health issue with a significant negative impact on workers' short- and long-term health. Although 80% of the world's pesticides are used in high-income countries, 99% of deaths due to pesticide poisoning occur in middle-and low-income countries (1). Africa accounts for only 2-4% of the global pesticide market (2), but studies done in African countries highlight that exposures and poisonings are higher than high-income countries as a result of different pesticide-related safety issues, such as low use of Personal Protective Equipment (PPE) (3), use of inappropriate pesticide mixtures, unlabelled containers (4), and poor risk communication strategies (5,6). Additionally, recent studies have highlighted that some underlying factors, such as poor nutrition (7), immune system status,

[4] The Health, Risk & Society journal recommends using Times New Roman Font 12, single spacing. For readability, Calibri 11 font has been used with 1.5 spacing. In addition, the journal recommends using Harvard as reference style. To keep consistency with other parts of the dissertation Vancouver style has been used. See Appendix E for the Health, Risk & Society journal complete guidelines.

and exposure to other chemicals (8), might increase the risk of developing acute or chronic illnesses related to herbicide exposures. This is problematic in countries like South Africa in which these underlying factors tend to be common amongst workers involved with the handling of herbicides.

Human exposure to different types of pesticides, including herbicides, has increased in recent years due to its extensive use as a method to control pests. This situation is concerning because besides the possible acute effects, research has shown that long term exposures to low doses of herbicides leads to accumulation in the body which might lead to chronic health effects (9). The literature indicates that exposures to herbicides are associated with different types of cancer such as adult brain tumours in women (10) and prostate cancer (11). However, the possible hazards of herbicides are not limited to cancer. Parkinson's (12), insulin resistance, obesity (13), and possible endocrine disruptions (14) have also been documented. Moreover, studies showed that maternal exposures to herbicides are associated with the prevalence of small-for-gestational-age (15) and foetal gastroschisis (16).

Globally, herbicides are commonly used for the control of invasive alien vegetation (17) and control programmes have been documented in various countries with different levels of income (18–22). These programmes aim to prevent major negative economic and ecological effects caused by some invasive plants, such as damage to water resources and biodiversity. However, invasive alien vegetation control programmes can also have a major environmental, social or human health impact(18). These impacts have also been documented in the forestry industry, in which herbicides are widely used to improve the efficiency of tree production by killing species of plants that compete with the newly planted trees (23–25). Occupational exposure to herbicides has been documented among forestry workers in the USA who face a challenging social context which increases their exposures and health risks (26,27). For example, workers live in substandard conditions (e.g. houses with limited ventilation, lack of laundry facilities) increasing their risk of exposure to residual herbicide in their cloths and PPE (26).

South Africa has a long history of issues related to alien vegetation invasion. Several studies and programmes have been initiated in an effort to manage and control invasive plants (28). In 1995 the Working for Water (WfW) programme, administered by the South African Department of Water Affairs and Forestry, was launched to control alien vegetation while simultaneously contributing to poverty alleviation through job creation and skills training. WfW is one of the world's largest programmes aiming to control invasive plant alien species (28). Its approach, which links ecological, economic and social aims, has captured experts' attention around the globe (29). WfW currently conducts over 300 eradication control and management projects, providing around 20,000 jobs per

annum (30), of which around 50% are given to women. WfW aims to provide jobs to the most in need by offering wages below market averages so workers involved in the programme are 'those who cannot get jobs that pay market wages' (21). Therefore, the WfW workforce comes from a challenging socio-economic context, characterised by poverty and sub-standard living conditions as well as several barriers (e.g. inequality, limited skills, legacies of apartheid) to access the benefits of the country's economic growth (21).

Given the extensive scale of the programme, risks of occupational exposures to herbicides are problematic. WfW's principal strategy to prevent or reduce workers exposure to herbicide is through providing and promoting the use of PPE (31). The use of PPE is the main and most common strategy implemented in the world to reduce workers' exposure to pesticides (32) and is perceived as a feasible and least costly control method (33). However, the 'hierarchy of controls' model (34) defines PPE as only one the exposure control strategies, and preferred only after elimination, substitution, engineering controls, and administrative controls have been implemented or ruled out (33). In addition, the effectiveness of PPE use to control exposure is also determined by the availability and quality of the equipment. PPE use requires a high level of worker participation and management supervision to be effective in exposure reduction. Therefore it is important to understand how workers' practices and behaviours around using PPE are shaped.

Health behaviour change theories have been used to analyse compliance and risk reduction health behaviours in a variety of fields such as obesity reduction programmes (36), health promotion through internet programmes (37) and injury prevention (38). Many health behaviour change theories (e.g. Health Belief Model, Protection Motivation Theory) place risk perception as a core concept to understand human health risk behaviours (37). Research indicates that the relationship between the perception of risk and health behaviours is a positive association (39). The role of risk perception on influencing behaviour has also been identified as an important concept to understand workers' and farmers' pesticide safety related practices (18,40–42).

Although research suggests some degree of efficacy of PPE use in reducing individuals' exposure to pesticides (43), PPE can only protect workers when used appropriately (e.g. full PPE use) and when correct PPE is provided (44). In addition, there are concerns regarding the sustainability of PPE promotion for risk reduction given that low PPE compliance has been reported amongst farmers and workers in middle- and low-income countries (5,41,42,45,46). In these countries the PPE available is usually not suitable to local characteristics of the population (e.g. not adequate sizes) and the environment (e.g. hot climates, difficult terrain) (3), affecting PPE compliance. However, issues associated with PPE compliance are not only limited to its availability but also influenced by

pesticides-related local beliefs and practices. It has been documented that risk perceptions of pesticide use amongst workers and farmers influences their PPE compliance (e.g. some believe pesticides only negatively affects weak people) (41,46,47). In addition, pesticides-related safety practices in middle- and low-income countries have been found to be influenced by gender roles (e.g. gendered differences on PPE compliance) (41), tendency to conform to perceived peers practices (48), and working conditions of workers (e.g. employment status) (49,50).

Literature on in depth research seeking to understand workers' and farmers' social norms and cultural context is still limited. This limitation is even greater regarding case studies in poor socio-economic contexts and particularly with herbicides. Given that PPE promotion is a core risk reduction strategy of WfW to control workers exposure to herbicides, the aim of this study was to understand contractors' and workers' PPE compliance issues in the Western Cape of South Africa. A conceptual framework to analyse PPE compliance was developed for this study based on the literature and a previous pilot study (see Figure 1). According to the conceptual framework, the interaction between gender dynamics and social status influences team's PPE compliance and other safety related behaviours through two different pathways. Firstly, gender dynamics and social status influences workers' risk perception of herbicide use. Secondly, gender dynamics and social status affects PPE compliance. In addition, different characteristics of the working conditions, environmental and logistical, influence contractors' and workers' safety behaviours (i.e. PPE compliance) and social interactions.

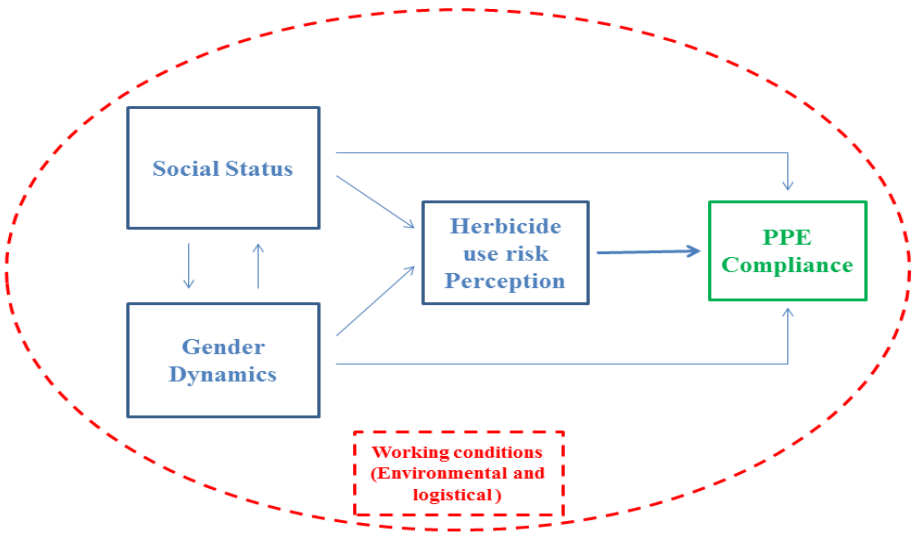


Figure 1. Conceptual Framework of PPE compliance

Methods

This study is part of a larger research project aiming to measure herbicide exposures of contractors and workers employed by WfW, and to implement effective and socio-cultural relevant interventions to reduce their exposures to herbicides. The findings of this study informed these interventions by providing insights regarding risk perceptions, training practices, and the socio-cultural dynamics of the groups. An in-depth understanding of contractors' and workers' socio-cultural context and risk perceptions around herbicide use was sought through a combination of direct ethnographic observation, informal interviews, visual media collection (e.g. video and photographs), questionnaires and a focus group. Data collection was structured so as to have little impact on working activities and was conducted between February and September of 2012. Ethics approval was granted by the University of Cape Town's Faculty of Health Sciences Human Research Ethics Committee (see Appendix D).

Study population

The research participants were 34 workers and 13 contractors currently part of the WfW programme in the Western Cape of South Africa who gave written consent to participate in the research. WfW workers were sourced by contractors from the communities close to where the alien vegetation removal took place. Contractors are responsible for guiding workers on the right procedures of alien vegetation removal and health and safety practices (51). Each team consists of approximately 10 workers who are divided according to the training and the activities they are certified to perform (i.e. general worker, peer educator, herbicide applicator, first aider, health and safety representative and driver). According to WfW standards, all workers must receive basic training that certifies them as general workers, including how to mix and herbicides. The Western Cape teams work in different vegetation areas (e.g. altitude areas on mountain slopes, wetlands).

Using a purposive sample, three teams were recruited in close proximity to the Cape Town urban area. The sites visited were located in the Table Mountain National Park, characterised by steep slopes and a rocky and grassy terrain (with few shaded areas and limited access to water) as well as a variable weather ranging from sunny and dry conditions to high speed winds and heavy rain falls. The project manager of the area provided the contact details of contractors and granted permission for researchers' access. WfW teams are highly mobile and dependent on suitable weather for spraying which caused several logistical constraints that required the research to be flexible. All contractors included in the research were males and the gender ratio (women: men) of the teams

were 7:3, 8:1 and 4:6. Teams were observed during spot spraying (i.e. herbicide is applied using a hand held sprayer directly on the tree stump) and foliar spraying activities (i.e. herbicide is applied on plants leaves using a back pack sprayer). The strategy used to apply herbicides depended on the targeted plants species, age, and density.

Data collection

Data collection was done by the authors and ten trained female and male fieldworkers fluent in two or more of the languages commonly used by workers (i.e. Xhosa, Afrikaans and English). Fieldworkers received training on herbicide use and health effects, and data collection strategies, prior to conducting field observations and administering the questionnaire. The data collection strategies used in this study included ethnographic observation, informal interviews, visual media collection, focus group and questionnaires

Ethnographic observation

Ten visits were made during regular WfW working activities. Groups were observed working in different sites using different herbicide spraying methods (i.e. foliar backpack spraying and spot hand held spraying). The primary author and a female fieldworker spent time (an average of 5.5 hours per visit) on site observing workers and contractors as they applied herbicides and conducted other working activities. Researchers followed a previously piloted observation guide designed by the authors for this study (see Appendix A), which specifically indicated the key areas of focus that needed to be recorded in the field journals (i.e. transport of herbicides to site, storage of herbicides at site, mixing herbicides, spraying of herbicides, eating and resting on site, cleaning up after spraying and using herbicides, accidents with Herbicides). The selection of the focus areas was based on WfW herbicide use policy documents which outline the various measures that workers and contractors need to take to ensure that herbicides are used safely.

Interviews

Contractors and workers had several logistical constraints in terms of being available for interviews. For example, they only receive their payment once the job at the site is finished, resulting in time constraints for organising individual extended interviews as these could impact on their working activities. Therefore, as suggested by Cabrera-Orozco (52) the Periodically Divided Interviews (PDI) strategy was used. Casual questions were posed to selected members of the group in the field and recorded as soon as possible in field notes. Rather than organising specific interviews, the

researchers used the existing social spaces (e.g. lunch time, breaks) to gather deeper information on risk perceptions and the socio-cultural context.

Visual media collection

Photography and video were used during herbicide mixing and application activities in order to capture behaviours that might have been missed in initial analysis done by researchers. As recommended by Bean and Didkowsky et al. (53,54), visual research tools were used as one of the strategies to overcome potential barriers between study participants and researchers (e.g. cultural, linguistic) that were expected to emerge given the complex social settings of the research participants (e.g. poverty, communication barriers given different languages of team members, work time pressure). Only study participants who consented were filmed or photographed.

Focus group

A focus group was conducted with 13 contractors (of which two were women). The aim was to gather data regarding contractors' perception of workers' safety-related behaviours as well as to identify issues with the current WfW training which may impact on PPE compliance. Group dynamics and other non-verbal information (e.g. body language) were documented. The discussion was tape-recorded and transcribed. Given logistical constraints a workers' focus group was not organised.

Questionnaires

Twenty questionnaires were administered (12 females, eight males) as part of a training session on herbicides safety offered by the larger research project. Prior to the training session the fieldworkers and authors administered the questionnaires to each worker and contractor individually in their language of choice. These questions gathered information on general risk perception associated with the job, perceptions of health effects, perception of herbicide use, training process, and herbicides-related safety practices (see Appendix C).

Data analysis

Initial analytical categories were drawn from risk perception and behavioural change theories, and previous relevant studies on pesticide use risk perceptions and PPE compliance. Literature regarding PPE compliance amongst workers of alien invasive plant control programmes is very limited. Therefore, this study is mostly informed by PPE compliance and pesticides use risk perception studies done amongst farm workers. Given the comparable spraying methods, socio-economic

barriers, and general health issues, the findings on farm workers regarding PPE compliance were relevant for this study.

The main themes identified were entered into a code book and imported into a qualitative data software management and analysis programme (i.e. QSR Nvivo 10, 2012) and themes were identified through content analysis. Drawing on theories of PPE compliance and risk perception of pesticides use, as well as the fieldwork findings, the study explored various ways in which risk perception and specific socio-cultural context interact. Emerging social and cultural categories that might be associated with workers' and contractors' perceptions of herbicide risks and PPE compliance were analysed. In order to analyse the media material collected, a content and thematic analysis were conducted (55). The content analysis identified herbicide exposure-related practices to create an inventory. In addition, the thematic analysis of the media material identified relevant categories and compare with those drawn from the literature and the data collected through observation and interviews. The self-reported information gathered through the questionnaires and the focus group was contrasted against the findings from observations.

Findings and discussion

Workers' and contractors' exposure to herbicides

Study definition of PPE compliance

Practices categorised during the research as PPE 'compliant' or 'non-compliant' were based on WfW criteria outlined in their official policies. A worker using herbicides must wear: 1) protective pants and top 2) hard hat 3) boots 4) rubber gloves (wrist length for spraying, elbow length for mixing) and 5) goggles. In addition, a cape must be worn when back pack foliar spraying and a mask for foliar and spot spraying activities. Study workers and contractors were never observed wearing the full PPE. Therefore, practices regarding each piece of the PPE were documented. It is noteworthy that not all the WfW documents have the exact same description of the PPE that must be used. For example, some documents state that foliar spraying must be done with elbow length gloves while others with wrist length gloves. This disagreement may affect PPE compliance as contractors and workers could not have a standardised reference of the PPE that they must be wearing for each working activity.

Exposures during herbicide spraying and mixing

Despite WfW strict guidelines and mandatory safety training, limited PPE compliance and several risky behaviours around herbicide use were observed during spraying and mixing. Contractors were

found to have the lowest PPE compliance and were often observed mixing and handling herbicides without using PPE other than the protective pants. This contrasts with contractors' knowledge about herbicide health effects and exposure prevention strategies (e.g. PPE use), which were shown to be high in the questionnaires. Therefore, contractors' awareness of herbicides hazards did not necessarily translate into self-preventive practices and other explanatory variables (e.g. gender dynamics, working conditions) should be explored to understand their safety behaviours.

Workers' PPE compliance was also found to be limited. Masks, goggles and elbow length gloves were never worn by the study workers. Most workers did not use the protective top and worked only with a WfW cotton shirt, material that may absorb the herbicide and therefore lead to exposure. The highest PPE compliance was for protective pants, hard hats, boots and gloves. However, according to WfW standards, the gloves used were not appropriate to avoid exposure to herbicides (e.g. absorbent material or not rubber as stipulated in policy). Every team must have a health and safety representative who receives additional training on safety issues and is in charge of reporting, on a monthly basis, any deviations from WfW safety standards (including PPE-related practices). However, health and safety representatives' PPE compliance was observed to be similar to other workers, showing that the participation in training sessions does not necessarily predict PPE compliance.

Figure 2. Workers, including a new worker without prior training, help mixing without wearing with low PPE compliance

The herbicide mixture should be prepare by workers who received prior training on herbicide mixing and are wearing full PPE, which was not always the case (see Figure 2). In addition, during foliar spraying activities workers worked close to each other and were not observed wearing goggles, Masks or rubber gloves (see Figure 3). Therefore, workers were at risk of dermal and respiratory exposure to herbicides coming from peers and their own spray clouds. In the case of spot spraying, hand held sprayers allow for a precise application of the herbicide directly on a stump, which reduces the chances of accidental exposures. Although spot spraying exposures were lower than in foliar spraying, workers were observed handling the hand held sprayer without gloves (e.g. spraying, cleaning or fixing the nozzle), which may lead to dermal exposure to herbicides (see Figure 4).

Figure 3. Foliar spraying. Workers working close to each. Partial PPE use is observed (e.g. short sleeved shirts)

Figure 4. Worker without gloves handling two hand held sprayers

Other risky herbicides-related practices

Workers' and contractors' exposures to herbicides were also documented during activities other than spraying and mixing. Previously exposed PPE was left next to food, clothes, and workers' skin while workers rested (see Figure 5 and Figure 6) Therefore, residual herbicide was also found to be a route of workers' potential exposure. Other practices observed, associated with potential exposure to residual herbicide, were: putting gloves inside protective pants' pockets with personal belongings (e.g. cell phone, toilet tissue), using PPE to lay or rest on (see Figure 6), keeping parts of the PPE on after work (e.g. boots, pants), and not wearing parts of the PPE in order to make the handling of the gear easier (see Figure 4). This is concerning given these practices could be creating exposures through contact with residual herbicide on the PPE. Therefore, even in a scenario of high PPE compliance during mixing and spraying it would be necessary to address risky PPE practices. Future interventions should stress long term hazards and the residual faculty of herbicides.

Figure 5. Worker resting during spraying activities. The red and blue spots in the gloves indicate they have been exposed to herbicides

Figure 6. Worker resting. She kept the cape and gloves on after spraying herbicides during the morning working session

Training issues, new workers and on-site strategies to promote PPE use

Contrary to WfW standards, workers were observed mixing and spraying without prior training. For example, a female worker reported not having attended to any training provided by WfW after more than one year of being involved with the programme. In addition, one worker was observed mixing and spraying herbicides for a period of two weeks before receiving formal training on herbicide-related health and safety issues. One major challenge of WfW training activities is workers' high turnover rate, which not only hampers productivity but makes more difficult to maintain health and safety standards and team morale (31). WfW spends resources and time on training new workers, and contractors must provide extra supervision to them in the field.

On site strategies for supporting new workers are limited as teams face several time constraints. One of the strategies that some contractors reported using was to assign experienced workers to supervise new workers. Although it may be a way of introducing new workers to the job, this is done informally and experienced workers are not provided with education tools or clear standards to accomplish the task. WfW implemented a peer education programme, however, it is not focused on safety issues related to herbicide use and mainly provides counselling to workers in other areas (e.g. HIV, interpersonal violence). According to WfW standards, every morning contractors and health and safety representatives must check PPE and give a safety talk to workers regarding relevant occupational hazards (e.g. sun exposure, exposure to herbicides). However, these activities were not conducted amongst the study teams, and contractors and health and safety representatives were observed to be busy with other several tasks before starting spraying activities (e.g. filling in forms required by WfW). This is concerning especially with regards to untrained new workers, who may not have a proper understanding of the importance of PPE use. Therefore, strategies must be developed to improve new workers support in the field.

Herbicide use risk perceptions

General perceptions

Based on workers' and contractors' observed practices, it was found that the use of herbicides is not perceived as a major concern by the workforce. This finding contrasts with the data collected through the questionnaires, where most study participants reported concern and awareness about herbicide exposures and their health effects. For example, most study participants indicated that wearing gloves was a way of protecting themselves from herbicide hazards, contrasting with the low gloves use observed during mixing activities. Although dye (which is added to the herbicide mixture

as a herbicide marker) on workers' and contractors' hands and arms was often observed, they rarely washed their hands before eating or when finishing their work, and only one person (female worker) was observed using soap. In contrast, 'washing hands' was often reported in the questionnaires as one of the main strategies to avoid dangers to health from herbicides. These findings indicate that workers knowledge about herbicides dangers and preventive strategies do not always lead to safety behaviours or high risk perception of herbicides use.

Herbicide mixing perceptions

Contractors tended to believe that little skill was required for mixing herbicides and that risk from exposures during this task were low. During the informal interviews, contractors and workers never mentioned the exposure to herbicides as an important issue of the herbicide mixing, and only focused on topics related to the quality of the mixture (e.g. type of herbicide, concentration). This suggests a low risk perception of herbicide mixing, which has been reported previously amongst farm workers in the Western Cape (40). In addition, preparing the herbicide mixture for spraying was not seen as a very skilled activity in comparison to the tasks associated with other positions (e.g. health and safety representative, first aider). In an interview, a contractor listed the characteristics that each worker must have so that he or she could be sent for specific training (e.g. first aider, peer educator). When the contractor was asked about his criteria for sending someone to herbicide mixing training, he answered: 'That's easy, I can send anyone. They learn about the mixing'. This statement was confirmed by the data collected during observations, in which many of the workers were observed getting involved in the mixing process even from their first day in the job without prior training (see Figure 2).

Perceptions of other occupational hazards

The data collected showed agreement between self-reported and observed concerns regarding snake bites and accidents (e.g. falling, being hit by a rock). In the questionnaires, participants were asked to rank the different occupational hazards. Being bitten by a snake and having an accident were reported more often and always considered more dangerous than using herbicides. In addition, preventive strategies in the field were observed with regards to avoiding falling and being bitten by snakes. In the field, workers and contractors supported each other, implemented preventive strategies, showed an interest in learning, and discussed safety behaviours regarding falling and avoiding snake bites. Few of these behaviours were observed with regards to reducing exposure to herbicides. In addition to suggesting a low risk perception of herbicides use, these

findings show that the study workforce was willing to engage in prevention practices if their perceived risk of a particular danger was high.

It is interesting to highlight that between January 2007 and July 2012 only two of the 188 incidents reported by WfW were snake bites and none of them occurred in the region were this study was conducted. However, snakes were the biggest occupational danger reported by workers and contactors in the questionnaires. Therefore, the higher perceived risk of snake bites over other occupational hazards is not based on actual snake bites but on beliefs that snake bites are prevalent. According to the questionnaires, workers often associated the use of protective pants and boots as a strategy to prevent snake bites but rarely associated these PPE items with preventing herbicide exposure. Therefore, even though some PPE compliance was high it is possible that workers had other reasons for wearing them and not for preventing herbicide exposures. This is concerning, given that workers and contractors might not handle PPE properly after work (e.g. wash it separately from family clothing, store out of the reach of children, not wear boots inside the house) if they do not perceive certain pieces of the PPE to be associated with herbicides exposure protection.

Perceptions of exposure risks for others

Perceiving risk as something that happens to 'others' has been reported previously in pesticides and other risk perception studies (40,41,56). Study contractors regularly explained safety issues such as falling, being bitten, or having health effects, as something that happens only to workers and mostly used female workers as examples to describe job-related risks. Although contractors have generally worked longer for WfW than workers and have more experience with herbicides and safety related training, they never referred to the possible risks associated to the job as something that might affect them. This low risk perception of herbicide use was also observed in their practices on site (e.g. low PPE compliance, mixing without gloves).

Similarly, health and safety representatives and experienced workers also attributed risks to 'others'. For example, when discussing about different dangers of the job, an experienced 26-year-old male worker noted:

> Some people do not test the pump and the herbicide can go into their eyes. I'm not concerned about myself but for instance the girls ... Snakes are not a problem for me. When you spot one you move away ... people are very scared of snakes. I just advise them if come across to one ... Dogs are dangerous and can sense when they [workers] are scare. I tell girls to stay still. I tell them not to run.

Therefore, contractors, experienced workers, and health and safety representatives framed the occupational risk as something that happens to a 'weaker' other. Associating themselves with lower levels of risk may influence their own safety related practices such as PPE use, as it was seen in this study.

Gender dynamics, risk perceptions and PPE compliance

The influence of gender dynamics on pesticides risk perception has been reported in previous research conducted in South Africa (40) and several high- middle- and low-income countries (18,41,49,57,58). In addition gender differences in PPE compliance have also been documented (57,58). In this study, it was found that male WfW workers have a lower PPE compliance than female workers. Although low PPE compliance and risky herbicide-related practices were observed amongst female workers, the team with the highest observed compliance was mainly comprised of women (90% female workers). In addition, PPE compliance in the other two teams observed was higher amongst women than men. This contrasts with the data captured through the questionnaires where male workers showed an understanding of herbicide hazards and risks closer to WfW standards. Although the results are not statistically significant given the small sample size, the data indicate that male workers are more aware than female workers about the impact of herbicides on human health as well as are more aware of the residual faculty of herbicides. In addition, most male workers responded 'yes' to the question 'do you worry about possible dangers when working with or near herbicides?' Only half of female workers responded 'yes' to this question. There seems to be a difference between workers' statements of intent and their actual practices in the field, indicating that workers' knowledge of herbicide exposures risks do not necessarily influence their safety practices. Therefore, exposure reduction interventions should not rely solely on improving workers' and contractors' herbicides hazards and preventive strategies knowledge. Future interventions should also find strategies for this knowledge to be translated into herbicide-related safety practices.

In this study, it was found that the gender dynamics in the teams influence safety related behaviours and therefore must be taken into account when designing exposure reduction interventions. One pathway in which these gender dynamics influence PPE compliance is by pressurising male workers to adopt risky behaviours in order to adhere to certain models of masculinity or norms in the group. The influence of social constructions of masculinity on men's and women's health has been reported for different public health issues including occupational exposure to pesticides (5,57,59). In this

study it was found that those workers who embraced socio-cultural values that gave them 'leadership' or 'popularity' amongst peers engaged in more risky behaviours than other workers. This 'careless' behaviour was mainly observed in strong, young males, who, for example, did not use a helmet, operated a chain saw while dancing and joking, and did not wear a protective top (see Figure 7). Moreover, it is expected that male risky behaviours are reinforced in an environment such as the one observed within WfW, in which risks are more associated with female or 'weak' workers. Some male workers openly admitted not following the safety rules while making it clear how dangerous and important it was for women to comply with safety practices. In this scenario male workers not only perceive occupational risks as something that happens to 'others', but engage in risky activities as a strategy to improve their status as males in the group. Therefore, it is possible that the low PPE compliance observed amongst male workers is in part explained by their tendency to conform to social constructions of masculinity.

Figure 7. Male workers not wearing helmets and using short sleeved shirts while spraying herbicides. Hand held sprayer hooked into protective pants' pocket.

The influence of gender dynamics on workers' and contractors safety related behaviours and PPE compliance is complex and can act through different pathways and in different ways. Further research needs to be conducted to understand other pathways through which gender dynamics can affect safety behaviours related with herbicide use. However, the data of this study showed that this category is essential to understand WfW's working dynamics and herbicide-related safety behaviours such as PPE compliance.

Social status and PPE compliance

A criterion by which WfW workers are stratified is by their position (see *Study population*). Contractors decide which workers attend specialised training on one of the positions offered by WfW. These tasks require previous specific training and those who perform them receive higher salaries than general workers. It is noteworthy that health and safety representatives work closely to the contractors and have a higher status than other workers. This higher status was perceived both from the contractors and workers. According to the contractors, people aspiring to become a health and safety representative must have certain characteristics that are not usually common to all workers (e.g. read, write, communicate and provide information to the group). It was observed that health and safety representatives had a greater number of tasks and more regular tasks than general workers, peer educators, herbicide applicators, drivers and first aiders. In the questionnaires workers reported health and safety representatives as the second best person within the team through which herbicides safety related training and information should be distributed. Therefore, this position is seen by workers as being held by someone with experience and exemplary in terms of safety related practices (e.g. PPE use) which could influence workers' risk perception of herbicides use and PPE compliance.

The observed low PPE compliance amongst health and safety representatives and contractors raises several concerning issues. It sets an example that might be followed by new or less experienced workers. Feola and Binder's research (42) suggested that one of the strongest predictors of PPE compliance and pesticide-related safety behaviours amongst farmers is their intention to conform with the descriptive social norms of the group. WfW workers may follow a similar pattern, especially when they observe low PPE compliance in the most experienced people of the team. In addition, health and safety representatives and contractors limited PPE use create a dynamic in which low PPE compliance could be seen as a symbol of high safety knowledge and even associated with some kind

of personal immunity to herbicide health effects. It has been documented that farmers that did not take any precaution against pesticides considered themselves to have "strong blood" and therefore be immune to the effects of pesticides (46). It has also been found that farmers' social status partly relied on their health, strength, and capacity to work more effectively which made them tolerate adverse effects of pesticides for long time before deciding to change their safety behaviours such as PPE compliance (48). It is possible that a similar situation is presented amongst the WfW workforce and the aspiration to improve social status is expressed to practices such as low PPE compliance, which may represent experience, strength, and knowledge amongst peers. However, this needs to be studied further.

While particular socio-cultural norms (e.g. gender roles, social status) have been shown to have an effect on PPE compliance and risk perception among WfW workers and contractors, there are other contextual factors, such as logistical and environmental working conditions, that might influence contractors' and workers' exposure to herbicides.

Working conditions

The working conditions, such as terrain, weather and WfW programme organisation, were found to be major factors influencing workers' and contractors' exposure to herbicides. Study workers mostly worked on steep terrains and were exposed to the various environmental conditions that characterise the Table Mountain National Park (see *Study population*). The access to the areas that were studied usually required workers and contractors to walk long distances carrying vegetation removal gear (e.g. chain saw, cutting tools, herbicides sprayers), personal supplies (e.g. food, water, clothing) and PPE. The nature of the WfW programme requires teams to comply with tight deadlines and spray herbicides in different types of terrains some of which present physical challenges and risks (see Figure 8).

Figure 8. Workers spraying herbicides on a steep slope.

Short term environmental risks

Workers were highly concerned about the intrinsic dangers of working in a mountain environment and the possibility of being injured after falling or getting hit by a rock or tree branch. Workers and contractors focused most of their preventive behaviours on avoiding accidents related with falling, slipping and getting cut. Workers' low perceived risk of herbicide use made them prioritise preventing strategies towards short term environmental risk such as falling, even if these preventive strategies could increase their exposure to herbicides. For example, workers were observed using spraying bottles as walking canes, throwing them to free their hands, and holding them in between their legs to prevent them from rolling downhill, which are practices that may produce herbicide leakage and increase herbicide exposures. Moreover, in order to facilitate the walking and handling of the cutting tools, most workers hooked the hand held sprayers to their belts or pants pockets which positioned the bottles filled with herbicides near by the scrotum area (see Figure 7), where the skin has the highest level of absorption in the human body (60,61).

Another common practice amongst workers and contractors was to rest and have lunch close to the PPE and gear. In many cases there were very limited spaces where workers could gather and rest. Therefore, activities such as eating lunch and resting necessarily occurred in spaces in which it was impossible to avoid the proximity to working tools and PPE. It is noteworthy, however, than such

behaviour was also observed by some workers in terrain with convenient and safe spaces for resting. This means that the characteristics of the terrain influence their safety practices but do not completely explain them.

Weather

Weather also played an important role on PPE compliance. PPE supplied by contractors did not include a warm garment in case the temperature was low. When workers perceived the weather as cold they used their personal warm tops while spraying. This is concerning, given that residual herbicide can be transported home (62) and it is possible that workers do not handle this clothing with the precautions many self-reported for PPE in the questionnaire. In addition, PPE compliance is affected in hot days, when the temperature can rise above 25°C which makes the use of PPE extremely uncomfortable. For example, workers were observed rolling up their shirt sleeves or using short sleeved shirts, which exposed their forearm skin to herbicides. In fact, dye in workers and contractors forearms was documented. Moreover, the use of masks and goggles was never observed, and contractors noted that workers complain about using these PPE as it makes them sweat and struggle to breath. Discomfort with PPE has been reported in the literature as a reason of low PPE compliance (50) and was also found to be relevant for the WfW case. Weather influences on PPE cannot only be addressed by training strategies. This study showed that unsafe behaviours can persist even if workers' and contractors' knowledge of health benefits of using PPE is high. Interventions addressing the characteristics of the PPE sourced could improve their level of comfort and appropriateness to the local weather. Given that contactors are in charge of sourcing the PPE they have many limitations (e.g financial constraints) to provide quality PPE and with characteristics suitable to the local conditions. As some contractors suggested, a better strategy could be that WfW sourced the PPE and provided it to workers and contractors. However, further research needs to be conducted to analyse the feasibility and benefits of this option.

Programme organisation

Coupled with the terrain and weather conditions, there are factors associated with the organisation of the WfW programme that might influence workers' and contractors' PPE compliance. The data collected showed that workers and contractors were concerned about the payment amount and the long wait from work to payment. There are several references in the data to discussions related to payment dates, issues arising from the perceived low wages, and risky practices necessary in order to comply with WfW contract standards. When workers were asked in the questionnaires 'What

would you say is currently your biggest worry in your life?' and 'What would you say is your biggest worry with your current job?', 'payment process', 'economical support' and 'little pay' were frequent answers and far more prevalent than answers mentioning working with herbicides.

Contractors reported at the focus group that workers' low wages represent a challenge for them to keep workers motivated and maintain them for long periods as part of the teams. These factors may influence workers' morale, which could be important in order to conduct effective exposure reduction interventions aiming to impact individuals' behaviours (e.g. PPE compliance). In addition, the high turnover rate of workers, currently a problem with many of WfW's teams, represents major challenges for productivity and for maintaining health and safety standards and team morale. The high turnover rate must be taken into account when designing interventions based on education tools, as it could make them costly, not sustainable and have a limited impact on the long term exposure reduction. It is possible that increasing workers' payment could improve their morale and motivation in the programme as well as reduce the high turnover rate of workers. This could have a positive impact on the effectiveness and sustainability of intervention and therefore play a role on improving workers safety behaviours. However, paying wages below the market average is a strategy of WfW to target the most in need (21) and it would be necessary to analyse how effective this strategy is and what the effects of increasing wages would be.

Contractors reported having difficulty meeting WfW deadlines under the programme standards. In order to get paid and assigned a new site, the sites must be checked by a supervisor. Contractors and workers complained that this process is slow which delays the payment process. The data collected showed that some risky practices are related with meeting these deadlines. Forst et al. (50), a PPE study amongst Latino farm workers found that 'the economic structure that entails pay for production rather than pay per hour will always tend to work against taking safety precautions'. In the WfW case, workers have a daily wage, however, they only get paid once the site is finished. Therefore, workers and contractors have an incentive to work faster. Contractors and workers reported different strategies that they use in order to clear the alien vegetation before the deadline stipulated by WfW. This included using higher concentrations of herbicides than recommended and spraying on days with poor weather conditions (e.g. rain and wind) when, according to WfW safety policies, teams are not supposed to be spraying. The need to work fast in order to meet contract's deadlines, receive payment, and be assigned with a new site, might reduce contractors' and workers' focus on safety related behaviours (e.g PPE compliance). This is especially concerning regarding those behaviours perceived to have a lower risk (e.g. herbicide exposure) as they are

expected to be the first ones to be neglected. Low PPE compliance has been reported in the literature as a strategy to avoid slowing down the pace of work (5,50). For example, in this study a female worker was observed several times working with only one glove. She used her bare hand to operate the hand held sprayer and the one with the glove to pull out plants, operate cutting devices, and for support while walking in steep terrain. This pattern of gloves use allowed her to work fast, as it is easier to operate the hand held sprayer without gloves. However, at the same time she could prevent accidents from activities perceived as highly risky such as handling cutting tools while walking in a steep terrain. It is concerning that safety related behaviours could be undermined by workers' and contractors' need to avoid slowing down the pace. Preventing strategies associated to occupational hazards perceived as less risky (e.g. PPE use to avoid herbicide exposures) may be the most affected.

In addition to workers' and contractors' herbicide use risk perceptions and the socio-cultural variables analysed (i.e. gender dynamics and social status), the contextual factors in which the working activities are embedded affect PPE compliance in different ways. It is noteworthy that these aspects are unlikely to be modified by interventions targeting workers behaviours change. Strategies to address these contextual factors that might increase the exposure of contractors and workers to herbicides should be focused on administrative, engineering or substitution controls. Intervention such as changes in the structure payment, increasing the wages, and sourcing more appropriate PPE for the local weather conditions, should be considered and explored further.

Conclusions and recommendations

In this study it was found that the WfW PPE compliance strategies are not successfully protecting workers and contractors and WfW workforce is potentially being expose to herbicides. Although some PPE items were observed being worn, is possible that this behaviour was influenced by the presence of the researchers and workers' awareness of being part of the study. Therefore, the PPE compliance observed may be actually higher than under normal working circumstances (i.e. without the presence of researchers). This effect makes difficult to evaluate the effectiveness of the WfW compliance strategies. Furthermore, workers' and contractors' awareness of herbicides hazards, knowledge regarding herbicides health effects, and level of training did not necessarily translate into self-preventive practices such as PPE compliance. It was also found that PPE compliance is influenced by a range of factors which include herbicide use risk perception, socio-cultural context and working conditions. In addition to suggesting a low risk perception of herbicides use, this study shows that workers were willing to engage in prevention practices when their perceived risk of a

particular danger was high (e.g. snakes bites, falling). Gender dynamics and social status aspirations were found to be major socio-cultural variables that influence risk perception and PPE compliance. Workers' and contractors' tendency to conform to social constructions of masculinity and their aspirations to improve social status explain in part the low PPE compliance observed. However, this study reported other contextual factors (i.e. characteristics of the terrain, weather, and programme organisation,) that influence PPE compliance and risk perception, which are unlikely to be modified by interventions targeting workers' and contractors' behaviours change.

The complexity of modelling PPE compliance in countries with several economic and social constraints highlights the importance of not relying solely on PPE use as an exposure reduction strategy. This situation is especially important when large scale alien removal projects and other programmes using pesticides are being implemented. In middle- and low-income countries with limited working options and vulnerable populations, the occupational exposure of workers to pesticides could offset the benefits of poverty relief programmes such as WfW. Interventions aiming to improve PPE compliance should only be considered as one part of the exposure control. Moreover, in order to be effective, they must take into account particular characteristics of the socio-cultural context, local perceived risk of perception use, and other broad contextual factors. In terms of the methodology, this study showed that self-reported and observed behaviours may not agree for the case of risk perception and safety and health knowledge of herbicide use. Therefore, this showed the benefits of exploring in depth research tools (e.g. ethnography, interviews) to understand workers safety practices on site.

Although this study presents relevant insights in order to understand PPE compliance amongst WfW workforce, further research is needed to address some of its limitations. It is recommended that in-depth interviews are conducted to better understand the link between the social construction of masculinity and femininity, and safety practices. In addition this data could also provide relevant information to understand how workers and contractors associate social status with the low PPE compliance reported in this study. Moreover, the authors identified some other variables that could influence social status which need to be assessed in future research (e.g. local construction of race, family affiliation). Furthermore, teams selected to participate in future studies should work in a greater variety of terrains and also explore how workers and contractors handle PPE at home. Female contractors are also important players to be studied in future research. This would allow comparing the findings of this study in different working conditions and under different leadership. Moreover, in order to design sustainable interventions to reduce herbicides exposure, it is necessary

to understand the herbicide use risk perception of project managers and other WfW employees who influence health and safety policies and herbicide-related decisions of the programme.

Despite these limitations, this study highlights the importance of understanding workers' knowledge and beliefs as well as their working conditions when developing strategies to prevent occupational hazards. Exposure reduction interventions tent to be designed without an understanding of the socio-cultural context which reduces their likelihood of changing workers' safety behaviours, such as PPE compliance. This study provides insights in how in-depth research can be used in understanding occupational risks and workers' compliance to safety procedures. In addition, this study underscores the need for a complex and broad approach to exposure control strategies, which not only focuses on the promotion of PPE use, but uses it as only one of the several strategies to reduce exposure and protect vulnerable workers from occupational hazards.

Acknowledgments

The authors would like to thank the workers and contractors of WfW who supported and participated in this study. We also want to thank the fieldworkers who participated in the data collection. This study was funded by the WfW programme

References

1. Jeyaratnam J, Chia KS. Occupational Health in National Development. Singapore: World Scientific Publishing; 1994.
2. Williamson S, Ball A, Pretty J. Trends in pesticide use and drivers for safer pest management in four African countries. Crop Prot. 2008;27(10):1327–34.
3. Matthews GA. Attitudes and behaviours regarding use of crop protection products—A survey of more than 8500 smallholders in 26 countries. Crop Prot. 2008;27(3):834–46.
4. Ngowi AVF, Mbise TJ, Ijani ASM, London L, Ajayi OC. Smallholder vegetable farmers in Northern Tanzania: Pesticides use practices, perceptions, cost and health effects. Crop Prot. 2007;26(11):1617–24.
5. Naidoo S, London L, Rother HA, Burdorf A, Naidoo RN, Kromhout H. Pesticide safety training and practices in women working in small-scale agriculture in South Africa. Occup Environ Med. 2010;67(12):823–828.
6. Rother HA. South African farm workers' interpretation of risk assessment data expressed as pictograms on pesticide labels. Environ Res. 2008;108(3):419–27.
7. Nweke OC, Sanders WH. 3rd. Modern environmental health hazards: a public health issue of increasing significance in Africa. Environ Health Perspect. 2009;117(6):863–70.

8. Holtan N, Warwick M, Bomier B. What physicians can do to reduce occupational and incidental pesticide exposure: a guide to best practices. Minn Med. 2008;91(9):31–5.

9. Dich J, Zahm SH, Hanberg A, Adami HO. Pesticides and Cancer. Cancer Cause Control. 1997;8(3):420–43.

10. Samanic CM, De Roos AJ, Stewart PA, Rajaraman P, Waters MA, Inskip PD. Occupational Exposure to Pesticides and Risk of Adult Brain Tumors. Am J Epidemiol. 2008;167(8):976 –985.

11. Boers D, Zeegers MPA, Swaen GM, Kant I, van den Brandt PA. The influence of occupational exposure to pesticides, polycyclic aromatic hydrocarbons, diesel exhaust, metal dust, metal fumes, and mineral oil on prostate cancer: a prospective cohort study. Occup Environ Med. 2005;62(8):531 –537.

12. Costello S, Cockburn M, Bronstein J, Zhang X, Ritz B. Parkinson's Disease and Residential Exposure to Maneb and Paraquat From Agricultural Applications in the Central Valley of California. Am J Epidemiol. 2009;169(8):919–26.

13. Lim S, Ahn SY, Song IC, Chung MH, Jang HC, Park KS, et al. Chronic Exposure to the Herbicide, Atrazine, Causes Mitochondrial Dysfunction and Insulin Resistance. PLoS ONE. 2009;4(4):e5186.

14. Phillips KP, Tanphaichitr N. Human Exposure to Endocrine Disrupters and Semen Quality. J Toxicol Env Health, Part B. 2008;11(3-4):188–220.

15. Ochoa-Acuña H, Frankenberger J, Hahn L, Carbajo C. Drinking-Water Herbicide Exposure in Indiana and Prevalence of Small-for-Gestational-Age and Preterm Delivery. Environ Health Perspect. 2009;117(10):1619–24.

16. Waller SA, Paul K, Peterson SE, Hitti JE. Agricultural-related chemical exposures, season of conception, and risk of gastroschisis in Washington State. Am J Obstet Gynecol. 2010;202(3):241.e1–e6.

17. Holzmueller EJ, Jose S. Invasive plant conundrum: What makes the aliens so successful? J Trop Agr. 2009;47(1/2):18–29.

18. Norgaard KM. The Politics of Invasive Weed Management: Gender, Race, and Risk Perception in Rural California. Rural Sociol. 2007;72(3):450–77.

19. Simberloff D. We can eliminate invasions or live with them. Successful management projects. Biol Invasions. 2009;11(1):149–57.

20. Coulston GJ. Control of invasive plants on the Poor Knights Islands, New Zealand. Turning the Tide: The Eradication of Invasive Species : Proceedings of the International Conference on Eradication of Island Invasives. IUCN; 2002.

21. Buch A, Dixon AB. South Africa's working for water programme: searching for win–win outcomes for people and the environment. Sustain Dev. 2009;17(3):129–41.

22. Joshi RC. Invasive alien species (IAS): Concerns and status in the Philippines. International workshop on the development of database (APASD) for biological invasion [Internet]. 2006 [cited 2013 Jan 17]. page 11–23. Available from: http://www.fftc.agnet.org/htmlarea_file/activities/20110826121346/paper-729213301.pdf

23. Wagner RG, Newton M, Cole EC, Miller JH, Shiver BD. The role of herbicides for enhancing forest productivity and conserving land for biodiversity in North America. Wildlife Soc B. 2004;32(4):1028–41.

24. Little KM, Willoughby I, Wagner RG, Adams P, Frochot H, Gava J, et al. Towards reduced herbicide use in forest vegetation management. South Afr Forest J. 2006;207(1):63–79.

25. Thompson DG, Pitt D. Frequently Asked Questions (FAQs) On the Use of Herbicides in Canadian Forest. Canadian Forest Service; 2011.

26. Hansen E, Donohoe M. Health Issues of Migrant and Seasonal Farmworkers. J Health Care Poor U. 2003;14(2):153–64.

27. McDaniel J, Casanova V. Pines in lines: Tree planting, H2B guest workers, and rural poverty in Alabama. South Rural Sociol. 2003;19(1):73–96.

28. Richardson DM, Van Wilgen BW. Invasive alien plants in South Africa: how well do we understand the ecological impacts? S Afr J Sci. 2004;100(1-2):45–52.

29. Woodworth P. Working for Water in South Africa: Saving the World on a Single Budget? World Policy J. 2006;23(2):31–43.

30. Hope RA. Water, Workfare and Poverty: The Impact of the Working for Water Programme on Rural Poverty Reduction. Environ Dev Sus. 2006;8(1):139–56..

31. Rother HA, De Souza MA, Patten G. Working for Water Project: Assessing Working for Water Community Workers Herbicide Exposures and Prevention Strategies. Recommendation list. Centre for Occupational and Environmental Health Research (COEHR) School of Public Health and Family Medicine. University of Cape Town of Cape Town; 2010 Dec.

32. Keifer M, Gasperini F, Robson M. Pesticides and Other Chemicals: Minimizing Worker Exposures. J Agromed. 2010;15(3):264–74.

33. Lunt JA, Sheffield D, Bell N, Bennett V, Morris LA. Review of preventative behavioural interventions for dermal and respiratory hazards. Occup Med. 2011;61(5):311–20.

34. Wirth O, Sigurdsson SO. When workplace safety depends on behavior change: Topics for behavioral safety research. J Safety Res. 2008;39(6):589–98.

35. Ellenbecker MJ. Engineering controls as an intervention to reduce worker exposure. Am J Ind Med. 1996;29(4):303–7.

36. Tuah NA, Amiel C, Qureshi S, Car J, Kaur B, Majeed A. Transtheoretical model for dietary and physical exercise modification in weight loss management for overweight and obese adults. Cochrane Database Syst Rev.2011;(10): CD008066.

37. Lippke S, Ziegelmann JP. Theory-Based Health Behavior Change: Developing, Testing, and Applying Theories for Evidence-Based Interventions. Appl Psychol. 2008;57(4):698–716.

38. Austin LC, Fischhoff B. Injury prevention and risk communication: a mental models approach. Inj Prev. 2012;18(2):124-129

39. Brewer NT, Chapman GB, Gibbons FX, Gerrard M, McCaul KD, Weinstein ND. Meta-analysis of the relationship between risk perception and health behavior: The example of vaccination. Health Psychol. 2007;26(2):136–45.

40. Rother HA. Risk perception, risk communication, and the effectiveness of pesticide labels in communicating hazards to South African farm workers [Internet] [Ph.D.]. [United States -- Michigan]: Michigan State University; 2005 [cited 2012 Oct 11]. Available from: http://search.proquest.com.ezproxy.uct.ac.za/docview/305429979/abstract?accountid=14500

41. Peres F. Percepción de Riesgo de los Agricultores con Respecto al Uso de Pesticidas en un Área Agrícola del Estado de Rio de Janeiro, Brasil. Cienc Trab. 2007;26:164–71.

42. Feola G, Binder CR. Why don't pesticide applicators protect themselves? Exploring the use of personal protective equipment among Colombian smallholders. Int J Occup Environ Health. 2010;16(1):11–23.

43. Bull S, Fletcher K, Boobis AR, Battershill JM. Evidence for genotoxicity of pesticides in pesticide applicators: a review. Mutagenesis. 2006;21(2):93–103.

44. Protano C, Guidotti M, Vitali M. Performance of Different Work Clothing Types for Reducing Skin Exposure to Pesticides During Open Field Treatment. B Environ Contam Tox. 2009;83(1):115–9.

45. Varona M, Henao G, Lancheros A, Murcia Á, Díaz S, Morato R, Morales L. Revelo D, de Segurado P. Factores de exposición a plaguicidas organofosforados y carbamatos en el departamento del Putumayo, 2006. Biomédica. 2007;27(3):400–9.

46. Palis FG, Flor RJ, Warburton H, Hossain M. Our farmers at risk: behaviour and belief system in pesticide safety. J Public Health. 2006;28(1):43–8.

47. Hunt LM, Tinoco-Ojaguren R, Schwartz N, Halperin D. Balancing Risks and Resources: Applying Pesticides without Using Protective Equipment in Southern Mexico. In: Hahn RA. editor. Anthropology in Public Health. Bridging differences in culture and society. New York: Oxford University Press; 1999.

48. Feola G, Schoell R, Binder CR. Identifying barriers and opportunities for transitions towards more sustainable agriculture through system analysis. The case of Vereda La Hoya, Colombia. Proceedings of the IFSA 2010 Symposium [Internet]. 2010 [cited 2012 Aug 25]. Available from: http://ageconsearch.umn.edu/bitstream/117781/2/feola_2010.pdf

49. Barraza D, Jansen K, Van Wendel de Joode B, Wesseling C. Pesticide use in banana and plantain production and risk perception among local actors in Talamanca, Costa Rica. Environ Res. 2011;111(5):708–17.

50. Forst L, Noth IM, Lacey S, Bauer S, Skinner S, Petrea R, et al. Barriers and Benefits of Protective Eyewear Use by Latino Farm Workers. J Agromed. 2006;11(2):11–7.

51. WfW. Contractor's Manual. Working for Waters, Department of Water Affairs and Forestry; 2003.

52. Cabrera-Orozco F. Walking to the Sedentarization: Anthropological Study About the Politic Change in a Nomadic Group from the Amazonic Region of Colombia. [Netherlands]: vrije Universiteit; 2009.

53. Bean J. Beyond Walking With Video: Co-Creating Representation. EPIC. 2008;(1):104–15.

54. Didkowsky N, Ungar M, Liebenberg L. Using Visual Methods to Capture Embedded Processes of Resilience for Youth across Cultures and Contexts. J Can Acad Child Adolesc Psychiatry. 2010;19(1):12–8.

55. Ray JL, Smith AD. Using Photographs to Research Organizations: Evidence, Considerations, and Application in a Field Study. Organ Res Methods. 2012;15(2):288-315.

56. Couch D, Liamputtong P, Pitts M. What are the real and perceived risks and dangers of online dating? Perspectives from online daters. Health Risk Soc. 2012;14(7-8):697–714.

57. Reed DB, Browning SR, Westneat SC, Kidd PS. Personal Protective Equipment Use and Safety Behaviors Among Farm Adolescents: Gender Differences and Predictors of Work Practices. J Rural Health. 2006;22(4):314–20.

58. Cabrera NL, Leckie JO. Pesticide Risk Communication, Risk Perception, and Self-Protective Behaviors Among Farmworkers in California's Salinas Valley. Hispanic J Behav Sci. 2009;31(2):258–72.

59. Courtenay WH. Constructions of masculinity and their influence on men's well-being: a theory of gender and health. Soc Sci Med. 2000;50(10):1385–401.

60. Karan A, Alikhan A, Maibach HI. Toxicologic implications of cutaneous barriers: a molecular, cellular, and anatomical overview. J Appl Toxicol. 2009;29(7):551–9.

61. Ngo MA, O'Malley M, Maibach HI. Percutaneous absorption and exposure assessment of pesticides. J Appl Toxicol. 2010;30(2):91–114.

62. García AM. Occupational exposure to pesticides and congenital malformations: A review of mechanisms, methods, and results. Am J Ind Med. 1998;33(3):232–40.

PART D: APPENDICES

Contents

APPENDIX A: Observation Guide

WFW Exposure Observation Guide for Fieldworkers

Instructions

This is a guide when you are in the field observing Working for Water (WFW) workers and contractors when using and applying herbicides.

This is a guide to remind you what to look for and NOT a questionnaire for you to ask. This means that you are expected to write down everything you observe rather than just what is in this guide. At the end of each observation session, fill in the information on to the form below. Give as much information and detail as you can. More is better! Draw pictures to explain some of your points. Use the blank page on the next to this page to give more information and detail. If you need to explain a question listed below in more detail, and then put the section number and letter of the question (e.g., 1a)

Put your name on your journal. In your journal, document your observations.

Most of the observations information you write below will be for the workers. If you observe and activity that was done by the contractor please indicate next to your text (**done by contractor**).

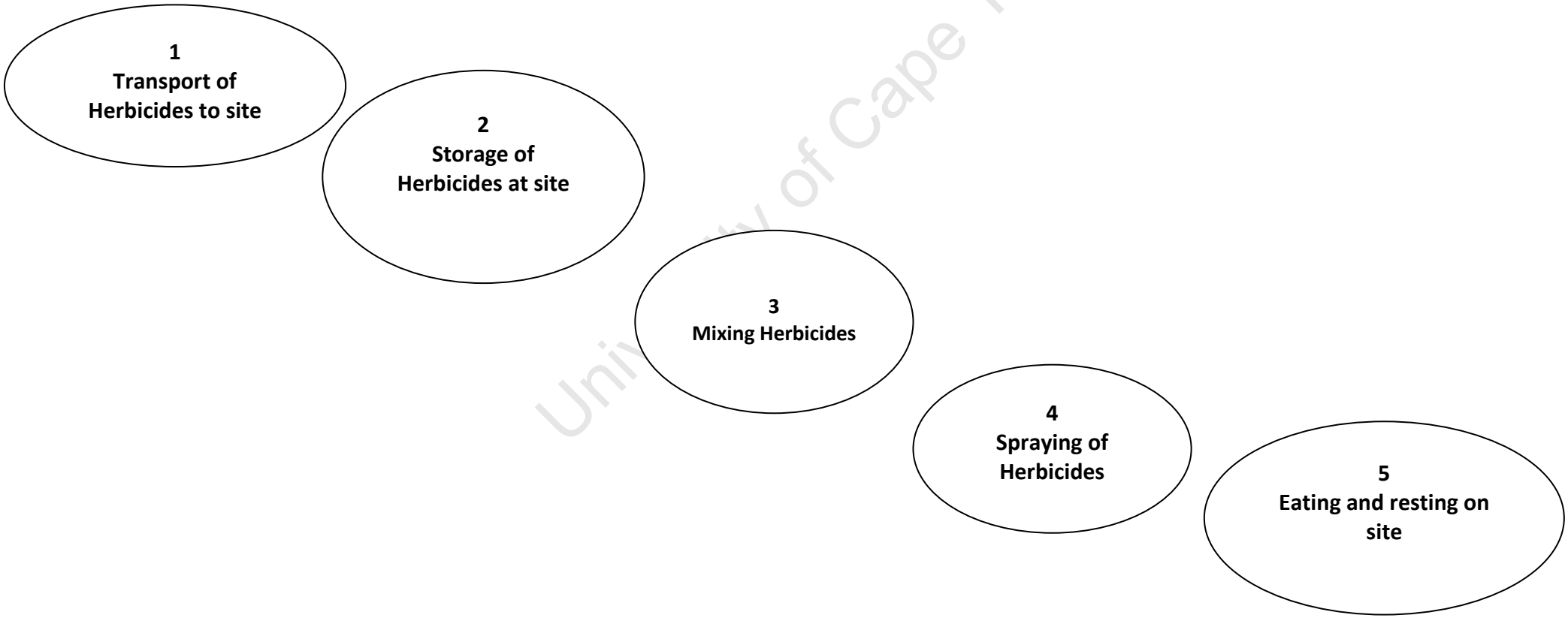
In all the sections, please note the personnel protective equipment (PPE) that they use and especially if things are not worn properly or if they are taken off and why.

Remember we are looking at ways in which workers and the contractor might be exposed to the herbicides (come into contact with them). If you are not sure whether something a worker did will lead to an exposure or not, write it down!

Thanks and enjoy the skill of observing.

This diagram gives you an idea of some of the key herbicide use activities you will be observing and you need to be familiar as to what to look for.

Remember to write down more than just these activities as what might seem unimportant to



6

Cleaning up after spraying and using herbicides

7

Any accidents with Herbicides?

8

Other things to look out for that may be important

WFW Exposure Observation Guide for Fieldworkers

Fill in the information below for each day you conduct an observation:

Date of observation _____

Time observation started _____

Time observation ended _____

Give the name of the location/area where the observation took place _____

Describe the area (grassy, trees, hilly, what vegetation is being removed)

_____

Name of the Contractor _____ (Male ____ or Female _____)

How many women working in team (not including contractor) _____?

How many men working in team (not including contractor) _____?

Are any of the workers new (this is their first day)? Yes____ No____ How many? _____ How many are males _____ and how many are females _____

Describe the weather when you first start observing. If the weather changes during the observation explain how it changed and put down the time when it changed. You may have to do this several times. Please also draw pictures to help us see the wind direction in relation to the direction of the spraying.

_____
_____
_____
_____
_____
_____

1. Storage of Herbicides

There are two types of storage you need to write down information about:

A) Off site storage: If you are only joining the team on site you might have to ask questions to get this information. It would be useful though to try to visit the depot where the herbicides are stored.

a. Where are the herbicides stored before and after they are used?	
b. Are the herbicides stored on site overnight if workers are returning the next day?	
c. What kind of containers are they stored in?	
d. Is a record kept of what is in storage and how much?	
e. Are other chemicals stored with the herbicides? What are they?	
f. Any other issues you observed or heard	

B) On site storage:

a. Where were the herbicides kept while they were working?	
b. Did a worker or workers get exposed to herbicide while creating the storage site? How many incidents? How many workers got exposed?	
c. was the storage site marked differently in any way (tape around area?)	
d. what other activities took place near and around this storage area?	
e. was the drinking water in this area?	
f. Any other issues you observed or heard	

2. <u>Transport of Herbicides</u> (If you are only joining the team on site you might have to get this information by asking questions. Ideally, you should travel from the depot to the site so you can observe the transportation of herbicides)

a. How are herbicides transported to the site?	
b. In what kind of containers?	
c. How are the containers secured during transport? Were any damaged during transport?	
d. Are the containers sealed?	
e. Do workers sit next to the herbicides during transportation? ? If so, what activities they conduct while being transport (e.g. eating, sleeping)	

f. Was there any spillage? Describe how it happens.	
g. Did a worker or workers get exposed to herbicide during this activity? How many incidents? How many workers got exposed?	
h. Any other Comments:	

3. Mixing of Herbicides (This may have happened before the team arrived on site, please try get to observe the teams mixing by arranging to be where ever they mix their herbicides)

a. Are the herbicides mixed and prepared on site?	
b. Who does the mixing and preparation?	
c. Are there mixing instructions and are these followed?	
d. Where is the mixing done? Was this area some how marked?	
e. Describe the area where the mixing is done, how is the environment protected? Any covers put on the ground?	
f. Who did the mixing? What protective clothing does the person mixing wear? Do they keep PPE on the whole time?	
g. Where are the other workers when the mixing is done?	
h. What does the worker doing the mixing do immediately after completing the mixing?	

i. Was there any spillage during mixing? Describe how it happens. Was any leftover chemical/mixed put/stored elsewhere?	
j. Did a worker or workers get exposed to herbicide during this activity? How many incidents? How many workers got exposed?	
k. Describe how often the mixing is done, is it done once a day or more?	
l. Any other Comments:	

4. Spraying Herbicides

Please give as much information as possible about the different spraying methods. If you write more text on the spare page, be clear if the activity was using back pack sprayers or hand held sprayers.

	Back pack sprayer	**Hand Held sprayer**
a. How many team members sprayed with the following?	_____Males _____ Females	_____Males _____ Females
b. Did the contractor spray?		
c. Who fills the sprayer for each sprayer? How is the sprayer filled? Is there any spillage?		
d. How full is it when filled?		
e. Who filled the sprayers and where? Draw picture on blank page		
f. Do workers wear PPE while filling back pack sprayer? Do they have gloves on while they hold the sprayer for filling?		
g. Is there any leakage or spillage once full and sealed?		
h. What are the weather conditions when the spraying is happening?		

i. How close are workers to each other when they are spraying? Do they walk into each other's spray or are sprayed accidentally? Explain		
j. Can you see the spray drifting in the air? Are other workers in that spray drift? Can you smell the chemical? Describe the smell.		
k. What protective clothing are the workers wearing? Those doing the spraying or close to the spraying? See [5] for how to do this		
l. Did a worker or workers get exposed to herbicide during this activity? How many incidents? How many workers got exposed? Explain how they were exposed.		
m. Did workers take off gloves to unblock equipment? Explain what they did and how they unblocked the equipment.		
n. Any other Comments:		

[5] Give each worker a number, on the spare paper list what each worker was wearing from head to toe. How does it fit? When do they take it off or put it back on. Give lots of detail

5. Eating and resting on site

For each of the questions below, it is unlikely that all workers will be doing the same thing. Describe the different things that you see and how many workers are doing what.	
a. How close do workers sit to the herbicide containers, mixing area and spray equipment when they have their break?	
b. Are workers sitting upwind or downwind from the herbicide containers? Draw a picture to explain.	
c. Where is food and drink stored while workers are mixing herbicide, filling sprayers and doing their spraying work?	
d. Do workers have access to water to wash before they eat, smoke or have a break?	
e. Do workers wash their hands before eating? Describe the different things that you see and how many workers are doing what.	
f. Do workers wash their hands before smoking? Describe the different things that you see and how many workers are doing what.	
g. What else do the workers do during the rest time?	
h. Did a worker or workers get exposed to herbicide during this activity? How many incidents? How many workers got exposed?	
i. Where do workers go to the toilet during working with herbicides? What do they do with their spray equipment? Do they wash their hands before going?	
j. Any other Comments:	

6. **<u>Cleaning up after Spraying and using Herbicides</u> (This** is important to document every time they may wash up or clean up.)

a. Is water and soap available for workers to wash after spraying, mixing or handling herbicides?	
b. Where do workers wash? How close to herbicide containers?	
c. What pattern do you see of washing when workers have finished spraying, mixing or handling herbicides?	
d. Do workers change their clothes after they have finished working with herbicides?	
e. If workers change, what do they do with their clothes? Where to they wash them? Give details	
f. Do workers change their shoes after they have finished working with herbicides? If yes what do they do with the shoes?	
g. Where do workers change? How close to herbicide containers?	
h. What is done with empty herbicide containers?	
i. Is there any herbicide runoff? Is it washed away or covered?	
j. Did a worker or workers get exposed to herbicide during this activity? How many incidents? How many workers got exposed?	
k. Any other Comments:	

7. Accidents with Herbicides

An accident with a herbicide is when a worker comes accidently into contact with the herbicide. It may be minor or major. The person might not see it as an accident or the contractor, but we want to know about it.

a. Do you observe any accidents with herbicides including: • Spilling herbicides on the ground • Spilling herbicides on clothes • Spilling herbicides on bare skin • Workers getting sprayed directly • Herbicide getting into workers' eyes, mouth nose. • Touching face with unclean/herbicide contaminated hands	
b. Describe what happened for any such incident	
c. How did workers respond to any of these incidents? How do they organize themselves in these incidents?	
d. Is there a WFW procedure that should be followed for any of these incidents? Was it followed? Are workers familiar with it?	
e. Did a worker or workers get exposed to herbicide during this activity? How many incidents? How many workers got exposed?	
f. Any other Comments:	

8. <u>Other Information to look out for</u>

Do workers raise any issues related to herbicide spraying that was not captured under the other sections?

Were any workers obviously pregnant? Explain

Were any workers sick? Explain (coughing, etc)

Did workers complain about anything? Explain

Were workers worried or scared about any activity? Not just herbicides

Please note if you see any worker with dye staining on their hands or clothes.

What was the biggest danger you observed for workers that day?

APPENDIX B: Consent Form

Appendix A: INFORMED CONSENT FORM - Workers

ASSESSING WORKING FOR WATER COMMUNITY WORKERS PESTICIDE EXPOSURES AND PREVENTION STRATEGIES CONSENT

Read to participant

Hello, my name is …… I am from the University of Cape Town. I am involved in a project that is studying the use of herbicides used by workers employed by the Working for Water programme.

Our research will be done during working hours at your place of work and you will still be paid your normal salary during this time. You will not be paid extra to participate but will receive something to eat. There is no risk to your continued employment with WFW if you participate in this study. We will also be providing training on safety while working with herbicides (see attached letter from WFW regarding continued employment).

I would like to ask your permission to watch you while you work and to interview you for a research study that is running from October 2011 to December 2012. The purpose of watching and the interview is to find out about the use of herbicides to clear alien vegetation and your understanding of health & safety issues related to these chemicals. I will also ask you some questions about other work which you may have done with herbicides as well as use of herbicides at home.

Your participation in this study is very important to us as a worker in the WFW programme and will assist us in understanding better about the use of herbicides by community workers. Your answers will help us to improve your own health and safety. This interview is confidential. Your name will not be linked to your responses as you will be identified only by a study number.

This is not a test and there are no right and wrong answers. Please try to answer these questions as truthfully as possible for us to better understand the use of herbicides. If you do not understand a question, please ask me to repeat it or explain it. The interview should take 30-45 minutes. We would like to tape record the interview if you comfortable with this. May we tape record the interview? **Yes..... No.....**

We will also have a group session called a focus group. Your participation is voluntary, which means that you can refuse to participate and you can stop the interview at any time. However we cannot control what members of the focus group say outside of the group so we cannot guarantee that what you say remains confidential. The focus group will be held during your work time and will take between 45 – 60 minutes. We would like to tape record the discussion if you comfortable with this. May we tape record our discussion? **Yes..... No.....**

We may also like to take photographs or video to show work practices. Is it ok if we take photographs or video while you work? **Yes..... No.....**

This study will not involve any harm or discomfort to you. May I watch you while you work and interview you? **Yes..... No.....** (**If yes, please sign below.)**

If you have any questions or want further information about the study, please contact:

Study Principal Investigator:

Dr. Andrea Rother
School of Public Health and Family Medicine
University of Cape Town, Anzio Rd., Observatory 7925 South Africa
T: (021) 4066721; F: (021) 4066459; e-mail: Andrea.Rother@uct.ac.za

Or
Professor M Blockman, Chairperson, Health Sciences Faculty
Human Research Ethics Committee, University of Cape Town
T: (021) 4066338; F: (021) 4066411, email: shuretta.thomas@uct.ac.za

Name of participant (print)	**signature**	**Date**
Interviewer's name (print)	**signature**	**Date**
Witness's name (print)	**signature**	**Date**

APPENDIX C: Workers Questionnaire

WFW Occupational Exposure Questionnaire for WORKERS 2012

Study Subject No: _____ **Date of Interview: _____**

Name of Interviewer: _____

Place of interview: _____

Read consent form first to participant and only continue if the person has signed the consent form. Tick box when consent form has been read and signed. ☐

DEMOGRAPHIC DETAILS:

1. Gender: ____Female _____ Male (tick)
2. Age:_____ (put year of birth if age is not known)
3. What is your nationality? _____
4. What is your mother tongue? _____
5. What other languages can you speak? _____
6. What other languages can you read? _____
7. Current Job in Working for Water (tick – can tick more than one)

   ☐ General worker

   ☐ Peer educator

   ☐ First aider

   ☐ Health and safety rep

   ☐ Driver

   ☐ Other: _____

8. What are the main tasks you do currently for WFW?

   _____

9. Total Number of months or years employed with WFW: _____years _____months _____days

   9.1 Year first started working for WFW: _____

10. Highest std/grade at school passed: _____

11. Where do you currently live (name of area)? _____

12. Do you have running water in the house? _____ If not how far away from the house is the nearest running water? _____

13. How many people live on your property? _____

14. How many people live in the same home as you? _____

    14.1. How many are children under 4_____; 4-12 years old _____; 12-18 years old _____

15. Do you have a cell phone that you use on a daily basis? ____ yes ___no

16. Can your cell phone..... (tick all relevant)

- ☐ **Receive sms (text messages)**
- ☐ **Receive emails**
- ☐ **Watch videos on it**

PREVIOUS EMPLOYMENT:

17. **What was your last job before WFW?**

[Fill in the table for the person's last job]

Job description of most recent job before WFW	Duties	In which year did you start this job?	In which year did this job end?	Did this job involve any handling or spraying of herbicides or other chemicals: **Y=1 N=0** **If yes,** explain what kind of chemicals and exposures

18. Have you ever had to use or work with chemicals / pesticides / herbicides in any of your past jobs? ____ yes ____ No _____ Don't know

If yes, give details of the work and how you worked with the chemicals.

_____
_____
_____

GENERAL RISK PERCEPTIONS

19. What would you say is currently your biggest worry in your life?

_____
_____
_____
_____

20. What would you say is your biggest worry with your current job?

_____
_____
_____

21. In your current job, what would you say is the most dangerous thing you do and why?

_____
_____
_____
_____

22. What are the biggest dangers for you personally at work?

_____
_____
_____
_____

23. What is the most dangerous part of your work? (list starting with most dangerous if more than one)

_____
_____
_____

24. What do you do to protect yourself from the dangers you listed above?

_____

_____

_____

25. Why do you wear gloves when you work?

_____

26. Why do you wear boots when you work?

_____

27. Why do you wear a knap jacket when you work?

_____

28. Why do you wear a helmet?

_____

29. Why do you wear pants?

_____

HEALTH EFFECTS PERCEPTIONS

30. **Do you think chemicals used to kill pests in your home (e.g., ants, bed bugs, flies, rats/mice, cockroaches, fleas, etc) can** .....: (tick answer for each question)

	Yes	**No**	**Don't Know**
30.1 .....make you sick?			
30.2 .....make your children sick?			
30.3 .....cause health effects to unborn children?			
30.4 .....prevent you from having children?			
30.5 .....harm those you work with from Working For Water?			

31. Do you think that the herbicides used by Working For Water can:

	Yes	No	Don't Know
31.1 make you sick?			
31.2 make your children sick?			
31.3 cause health effects to unborn children?			
31.4 prevent you from having children?			
31.5 harm those you work with from Working For Water?			

32. Do you think that.....:

	Yes	No	Don't Know
32.1 using your cell phone while working with herbicides can make you sick?			
32.2 walking through plants that are wet from herbicides is dangerous?			
32.3 herbicides on the bottom of your shoes can be taken home and make others sick?			
32.4 breathing in herbicide spray from others can make you sick 10 years from now?			
32.5 Do you think that eating or smoking near to herbicides can make you sick?			

33. Which is more harmful to your health the dye in the herbicide or the herbicide?

____ dye

____ herbicide

____ neither are dangerous

_____ don't know

HERBICIDE PERCEPTIONS

34. What is a herbicide?

_____

_____

35. What is a pesticide?

_____

_____

36. Why does Working For Water use herbicides?

_____

_____

37. Do you worry about possible dangers when working with or near herbicides?

____ yes ____ No _____ Don't know

If yes, what are these dangers? Please list:

_____

_____

38. How much control do you believe you to avoid possible harmful health effects from herbicides?

☐ No control

☐ some level of Control

☐ I am able to prevent all harmful health effects

39. If yes to 37. List what you can do to prevent any dangers to your health from herbicides.

_____

_____

____

40. What suggestions do you have for safer herbicide use at work?

_____

_____

41. Which method of applying herbicides do you prefer and why?

Application Method	**Like**	**Don't Like**	**WHY**
Manual Pump Knapsack (Foliar spraying)			
Spray bottle (hand held sprayer)			

TRAINING AND PEER EDUCATION

42. Have you received any training on the following in the last five years? (tick)

Herbicide health effects	Yes	No
How to apply herbicides	Yes	No
How to read the label on a herbicide container	Yes	No
How to dispose of herbicide containers	Yes	No
How to store herbicides	Yes	No

43. What have you been taught about herbicides during the toolbox talks? (tick box)

☐ Never had a toolbox talk on herbicides

☐ I was taught: (please list)

_____

_____

_____

44. Approximately when was the last toolbox talk on herbicides?

_____

45. What are the main things you have been told you need to remember when working with herbicides? (please list; say "nothing" if never learned from that source)

From the Working for Water induction training	
From the team contractor	
From the health and safety rep	
From the peer educator	

46. What is a peer educator?

_____

_____

47. What does a peer educator do?

_____

_____

48. How many peer educators are a part of your team?

☐ 0

☐ 1

☐ 2

☐ Don't know

49. How many women are currently peer educators currently on your team? _____

50. How many men are currently peer educators on your team? _____

51. Who do you think should be teaching :

Describe person

You how to use herbicides?	
You how to handle herbicides safely?	
New team members about herbicides?	
You the dangers with herbicides?	

52. You are very busy when you get out onto site and start removing alien vegetation. But sometimes you need extra training or to be reminded about things. In what way would you like to regularly receive health and safety training?

(tick one for each methods)

Methods	**Best Way**	**Sometimes**	**Don't Use this way**
Messages to your cell phone			
Through toolbox talks			
From a peer educator			
From the health and safety rep			
From the contractor			
From one of the workers			
Messages on backs of workers shirts			
Pamphlets / material to read/ take home			
Posters on the insider of contractors trailers			
Stickers with messages on hand held & back pack sprayers			
Other (please list/suggest):			

HERBICIDE USE:

53. Do you do herbicide spraying? _____Yes _____No

54. Do you mix the herbicides before spraying? _____ Yes _____No

55. How many days this month did you:

Application Method	**Days this month**
Use a Manual Pump Knapsack (Foliar spraying)	
Use a spray bottle (hand held sprayer)	

56. What safety precautions do you take when you spray with herbicides with..... (list the main items you use because you are spraying):

A Backpack sprayer:

_____

A Handheld sprayer:

_____

57. When spraying/applying herbicides, how often do you use any of the following?

	Never	Sometimes	Always
Rubber Gloves			
Cloth Gloves			
Other types of gloves_____ (give name)			
Dust mask			
Respirator Mask			
Eye protection			
Boots			
Overalls			
Handkerchief /scarf			

to cover your face			
Hat			
Trousers			
Log sleeved shirt			
Warm top			

58. Do you wash your hands after spraying? ____Yes _____No

58.1 If yes, explain why you wash your hands after spraying (for what reason)?

_____

59. Where do you go to the toilet during spraying activities?

_____

60. How often do you clean your gloves?

_____

61. Do you wear special gloves when you work with herbicides? (tick)

☐ Yes

☐ No

☐ Don't know

If yes, why _____

62. I would like to ask you some questions about washing your equipment (*tick yes or no and then answer the when, how and where questions*)

Questions **DO YOU....**	**Yes**	**No**	**When**	**How**	**Where**
Wash you knap jacket?					
Wash your work pants?					
Wash your hand held sprayer					
Wash your backpack sprayer?					
Wash your mask?					
Wash your helmet?					

63. What do you do with the water that you use to wash any of your equipment?

_____

64. If there is herbicide left over after spraying what do you do with it?

_____

65. What do you do with the empty herbicide containers?

_____

66. Have you ever refused to spray? Yes_____ No_____

If yes, when and why: _____

67. Explain what you do when your sprayer is blocked.

_____

_____

68. How often do you use any of these gloves when working with herbicides?

	Always	**Never**	**Sometimes**
			
			
			
			

AFTER HERBICIDE USE:

69. What do you do with the clothes that you wear when spraying herbicides after work? Answer the following

I.....	**Always**	**Never**	**Sometimes**
Store them on site to be reused			
Take them home daily for storage			
Give them to the contractor			
Wash them daily on site			
Wash them once a week on site			
Wash them daily at home			
Wash them weekly at home			
Wash them with my families clothes			
Wash my work boots			

70. Where do you store the boots that you wear when spraying at the end of the day?

_____

71. How often do you wash the boots that you wear at work? _____

72. Do you wear your work boots home after spraying? _____ yes _____ no

If yes, why do you not change them? _____

HEALTH QUESTIONS:

73. Would you say your health in general is (tick one)

Excellent	
Good	
Poor	

74. In the past twelve months how many times have you been to any of the following after spraying herbicides?

	Explain what your symptoms were
a. Clinic	
b. Hospital	
c. Private Practitioner	
d. Traditional healer	
Other	

75. In the past twelve months how many times have you stayed overnight in hospital?

_____

76. Have you ever been told by a doctor that you had asthma Yes ___No___

77. If answered yes above do you still have it Yes___ No___

78. Have you ever been told by a doctor / nurse that you had TB Yes___ No___

79. Have you ever been treated for herbicide poisoning Yes___ No___

If answered yes to herbicide poisoning answer the following

80. How many times did you get sick after working with herbicides? _____

81. For each of the your herbicide poisoning episodes answer the following below

	Did you see a Doctor / nurse / none	Did you stay away from work Yes /No	If yes, for how many days were you away from work
Herbicide Poisoning 1			
Herbicide Poisoning 2			
Herbicide Poisoning 3			
Herbicide Poisoning 4			

82. Have you ever been treated by a doctor, clinic, pharmacist for any of the following after you started working with Working for Water?

	Yes	**No**
Skin Rashes/ pimples/ problems/ eczema		
Infertility		
Severe headaches		
Kidney problems		
Liver problems		

Seizures		
Allergies		
Any type of cancer (list .....)		
Lung Cancer		
Diarrhoea		
Lung problems		
Stroke		
Chronic Bronchitis		
Eye problems		
Nose problems		
Throat problems		
Shaking hands		
confusion		
Memory loss		
Numbness of hands and feet		

83. Are you currently pregnant? Yes_____ No_____ (women only)

84. Have you had any miscarriages before? Yes_____ No _____

How many?_____ When?_____(women only)

85. Is your wife trying to get pregnant? Yes____ No_____ Since when? _____ (men only)

86. Do you smoke Yes ____ No_____

87. If answered yes what do you smoke? _____

88. How many do you smoke in a day? _____

89. Do you drink alcohol? Yes_____ No_____

90. Do people/family say you drink too much alcohol? Yes_____ No_____

91. Which type of activity do you think is more likely to cause you health problems? (tick responses)

- ☐ Using a hand held sprayer
- ☐ Using a back pack sprayers
- ☐ Having dye on my skin
- ☐ Walking through we sprayed plants
- ☐ Breathing in the spray of other workers
- ☐ None of these will affect my health

92. To control pests in your house (such as ants, cockroaches, bed bugs, flies, fleas, rats/mice etc), how often do you:

	Daily	**Weekly**	**Monthly**	**Never**
Use herbicides to spray the house				
Use cans of pesticide to spray the house				
Use pesticides bought at informal markets, taxi ranks, on trains or from door to door sellers				
Use pesticides in your garden / yard				

Thank you for your time.

Appendix D: Letter of Approval from Research Ethics Committee

UNIVERSITY OF CAPE TOWN

Health Sciences Faculty
Human Research Ethics Committee
Room E52-24 Groote Schuur Hospital Old Main Building
Observatory 7925
Telephone [021] 406 6338 • **Facsimile** [021] 406 6411
e-mail: shuretta.thomas@uct.ac.za

28 November 2011

HREC REF: 445/2011

Dr HA Rother
Public Health & Family Medicine

Dear Dr Rother

PROJECT TITLE: HERBICIDE EXPOSURE PREVENTION STUDY FOR WORKING FOR WATER-USING PEER EDUCATION TO PROMOTE HEALTH AND SAFETY AMONGST A HIGHLY MOBILE WORKFORCE.

Thank you for responding to the issues raised by the Faculty of Health Sciences Human Research Ethics Committee.

It is a pleasure to inform you that the HREC has **formally approved** the above-mentioned study.

Approval is granted for one year till the 15th December 2012.

Please submit a progress form, using the standardised Annual Report Form (FHS016), if the study continues beyond the approval period. Please submit a Standard Closure form (FHS010) if the study is completed within the approval period.

Minor Typos:
Protocol, page 9: Hawthorne (not Hawthrone) Effect
Appendix A: Principal (not principle) Investigator; Please add the contact details for the Faculty of Health Sciences Human Research Ethics Committee in case participants have any questions regarding their rights and welfare in the study.

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Please quote the HREC. REF in all your correspondence.

Yours sincerely
signature removed

PROFESSOR M BLOCKMAN
CHAIRPERSON, HSF HUMAN ETHICS
Federal Wide Assurance Number: FWA00001637.

s.thomas

APPENDIX E: Instructions for Authors (Health, Risk & Society)

General guidelines

● Papers are accepted only in English/in English etc. English spelling and punctuation is preferred. Please use single quotation marks, except where 'a quotation is "within" a quotation'.

• A typical article will not exceed 7000 words inclusive of tables/references/figure captions/footnotes/endnotes. Authors can make a case for additional words up to 10,000.

• Manuscripts should be compiled in the following order: title page; abstract; keywords; main text; acknowledgments; appendixes (as appropriate); references; table(s) with caption(s) (on individual pages); figure caption(s) (as a list).

• Abstracts of 250 words are required for all papers submitted.

• Each paper should have 5 to 6 keywords.

• Search engine optimization (SEO) is a means of making your article more visible to anyone who might be looking for it. Please consult our guidance here.

• All the authors of a paper should include their full names, affiliations, postal addresses, telephone numbers and email addresses on the cover page of the manuscript. One author should be identified as the corresponding author. The affiliations of all named co-authors should be the affiliation where the research was conducted. If any of the named co-authors moves affiliation during the peer review process, the new affiliation can be given as a footnote. Please note that no changes to affiliation can be made after the article is accepted.

• For all manuscripts non-discriminatory language is mandatory. Sexist or racist terms should not be used.

• Authors must adhere to SI units. Units are not italicised.

• When using a word which is or is asserted to be a proprietary term or trade mark, authors must use the symbol ® or TM.

(source:http://www.tandfonline.com/action/authorSubmission?journalCode=chrs20&page=instructions)

Taylor & Francis Style No. 1	
(single column, ranged left)	
Running heads	*(verso) J. Smith and P. Jones* or *J. Smith* et al. if 3 or more authors. If J.B. Smith then initials are closed up *(recto) Journal Title* position left and right of pages
Article type (when needed)	**RESEARCH ARTICLE** bold caps, ranged left
Title	**Bold, first word and proper nouns cap only** ranged left
Authors	An Author and Another Author (initials closed up if J.B. Smith) ranged left
Affiliation	[a]*Department, University, City, Country;* [b]*Department, University, City, Country* ranged left
Received dates	(*Received 20 July 2009; final version received 17 August 2010*) After affiliation, ranged left
Abstract	Text smaller, indented both sides ranged left
Keywords	**Keywords:** word; another word; lower case except names Position aligned with abstract, same size as abstract
Correspondence details	Given as footnote on page 1* *Corresponding author. Email: xxxxxxx ranged left, no indent. Postal address not included in footnote. If there is only one author, use *Email: xxxxxxx
Headings	A. **Bold initial cap only** B. ***Bold italic initial cap only*** C. *Italic initial cap only* D. *Italic initial cap only.* Text runs on All ranged left, numbers to be included if supplied, no indent below.
Paragraphs	Indented
Tables	(Table 1) in text. Table 1. Title initial cap only. (ranged left above table) Note: This is a note. (ranged left under table)
Figures	(Figure 1) in text. Figure 1. Caption initial cap only. (ranged left under figure) Note: This is a note. (ranged left under figure)
Displayed quotations	Indented left and right, smaller font (over 40 words, or when appropriate)
Lists	(1) for numbered lists Bullets if wanted
Equations	Equation (1) in text Centred
Acknowledgements	A heading. Goes before notes, bio notes and refs Text smaller
Notes	**Notes (A heading)** 1. This is a note. 2. This is another note. Text smaller
Notes on contributors Not all journals require this – please see the relevant instructions for authors page	**Notes on contributors (A heading)** First author details. Line space Second author details. Goes after Acknowledgements, before refs Text smaller

Appendix	**Appendix 1. Title if given (A heading)** Goes after References Text smaller
Spelling preferences	Please consult the instructions for authors page for the journal
Punctuation	Initials (e.g. US, NJ, BBC) do not have full points between them. For names of article authors and in references, no space between initials (J.P. Smith, Smith, J.P. or Smith JP depending on reference style). Please consult the instructions for authors page for the journal for further details
Dashes	Spaced en rules for parenthetical dashes Use en rule between spans of numbers (e.g. 20–40), including page numbers in references
Numbers and units	Numbers: spell out one to nine, then 10, 1000, 10,000 10% (except at start of sentence) Units: follow author
Dates	4 October 2005 in the twenty-first century in the 1970s
Editorial	**Editorial (as title)** If editorial has a title, use **EDITORIAL** (section heading) **Title of editorial** Editor Name *Affiliation if wanted*
Other article types	Follow style for main article
Book reviews	**BOOK REVIEWS (as section heading)** **Book title: all bold**, by Author and Author / edited by Editor, Cambridge, Harvard University Press, 2003, xliii + 584 pp., US$28.95 (paperback), ISBN 0-95-445440-6 **Book title**, edited by Editor, Manchester, Manchester University Press, 2010, xv + 340 pp., £24.99 (paperback), ISBN 978-0-719-08154-5 **Book title**, edited by Editor, Editor and Editor, Abingdon, Routledge, 2009, xvi + 360 pp., $170 (hardback), ISBN 978-0-415-56085-9 / $44.95 (paperback), ISBN 978-0-415-56086-6 / $35.96 (ebk), ISBN 978-0-415-46087-3 **Book title,** by Author, Lanham MD, Lexington Books, 2008, 542 pp., £59.95 (hardback), ISBN 978-0-739-11434-6 / £27.95 (paperback), ISBN 978-0-739-11435-3 Reviewer's Name *Affiliation* *Email* (c) year, Reviewer Name References go before reviewer details Next review follows after a space No copyright line on first page of reviews
Obituary	**OBITUARY (section heading)** **Name and dates if given (as title)** Author Name *Affiliation* *Email*