

**COMMUNITY'S PERCEPTIONS ON THE ADEQUACY OF HEALTH AND
SAFETY PRECAUTIONS TAKEN WHEN USING DDT FOR INDOOR RESIDUAL
SPRAYING (IRS) FOR MALARIA CONTROL: A CASE STUDY OF VICTORIA
FALLS TOWN**



BY

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APPROVAL FORM

The undersigned clearly attest that they have read and recommended to the Midlands State University for acceptance a dissertation entitled: **Community's perceptions on the adequacy of health and safety precautions taken when using DDT for Indoor Residual Spraying (IRS) for malaria control: A case study of Victoria Falls town.**

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Submitted in partial fulfilment of the requirements of a BSc Honours Degree in Geography and Environmental Studies.

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Declaration

I declare that this is my own work and material used from other sources to compile this dissertation has been fully acknowledged.

Dedication

This dissertation is dedicated to my mother, brothers and sister whose sacrificial love throughout my studies have made my dream a reality. May the Almighty God continue shower them with blessings.

Acknowledgements

First and foremost my earnest gratitude goes to my research project Supervisor Dr. T Marambanyika for guiding me throughout the entire project. His professional expertise and commitment was excellent. My greatest appreciation goes to all family members for the never ending support throughout my studies and guidance in writing this research project. It would not be just not to thank the Lord for the gift life, love and kindness in the study of Geography and Environmental Studies.

Abstract.

The study sought to assess community's perceptions on the adequacy of health and safety precautions taken when using DDT for indoor residual spraying. Mixed methods were engaged in which collection of both qualitative and quantitative data collection techniques were used. Data was collected through the use of questionnaires and interviews. Questionnaires were randomly administered to a target population of ninety eight housing units. Interviews were also conducted with the key informants that are Victoria Falls Municipality Environmental Health Officer and Environmental Health Technician. Questionnaires were used to gather information on Chinotimba suburb residents' knowledge of health and safety risks associated with exposure to DDT, Safety and health precautions taken at household level as well as challenges associated with DDT for Indoor Residual Spraying. The study revealed that Chinotimba residents are not aware of the health and safety risks associated with exposure. Findings of the research revealed that majority of the respondents in Chinotimba suburb alluded that there are not taught on health and safety risks associated with DDT for Indoor Residual Spraying. Research showed that chinotimba suburb residents take inadequate health and safety precautions during indoor residual spraying, research findings shows that education on health and safety precautions is done rarely usually on an annual basis and during the spraying season. The research also highlighted some of the major challenges associated with DDT for indoor residual spraying. These challenges vary from housing units to local authority. Most housing unit's challenges are that mosquitoes are now resistant to DDT and that DDT soils the interior of their walls. The local authority face the challenge that people are less willing to attend education on DDT and there are less willing to have their houses sprayed. Generally Chinotimba suburb residents are not aware of health and safety risks associated with exposure to DDT hence they take inadequate health and safety precautions during Indoor Residual Spraying. In this regard the local authority should teach residents on risks associated with DDT in addition to intensifying education on health and safety precautions to observe during spraying.

Acronyms

CDCP	Centres for Disease Control and Prevention
DDT	Dichloro Diphenyl Trichloroethane
EHO	Environmental health Officer
EHT	Environmental Health Technician
EMA	Environmental Management Agency
EPA	Environmental Protection Agency
IACR	International Agency for Research on Cancer
IRS	Indoor Residual Spraying
MOHCC	Ministry of Health and Child Care
MOHCW	Ministry of Health and Child Welfare
SPSS	Statistical Packages for Social Sciences
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
USEPA	United States Environmental Protection Agency
VFM	Victoria Falls Municipality
WHO	World Health Organisation
ZIMSTAT	Zimbabwe National Statistics Agency

List of Tables

Table 4.1 Gender of Household	24
Table 4.2 Age of respondents	24
Table 4.3 Respondent's level of education	25
Table 4.4 Period Stayed in Chinotimba Suburb	26
Table 4.5 Education on Health and Safety risks associated with exposure to DDT	27
Table 4.6 Frequency of Education on Health and safety risks associated with DDT	28
Table 4.7 Necessity of education on health and safety risks	29
Table 4.8 Household's Observance of safety and health precautions during IRS	30
Table 4.9 Are you taught on safety and health precautions	31
Table 4.10 Frequency of education on safety precautions.	31
Table 4.11 Necessity of education on safety and health precautions	32
Table 4.12 Chi-Square Test for association.	33

List of Figures

Fig 1.1 Victoria Falls town map	6
Fig 4.1 Health and safety risks associated with exposure to DDT	27
Fig 4.2 Necessity of education on health and safety precautions	29
Fig 4.3 Reasons why education on DDT is necessary	33
Fig 4.4 Challenges associated with the use of DDT for IRS.	34

Contents	
APPROVAL FORM	i
Declaration	ii
Dedication	iii
Acknowledgements	iv
Abstract	v
Acronyms	vi
List of Tables	vii
List of Figures	viii
CHAPTER 1: INTRODUCTION	1
1.1 Background of Study	1
1.2 Statement of the Problem	3
1.3 Objectives	4
1.3.1 General Objective	4
1.3.2 Specific Objectives	4
1.4 Justification of study	4
1.6 Study Area	5
CHAPTER TWO: LITERATURE REVIEW	7
2.1 What is dichlorodiphenyltrichloroethane (DDT)?	7
2.1.1 DDT Use in Vector Control Programmes	8
2.2 DDT and Human Health	9
2.2.1 DDT as a carcinogen.....	10
2.3 DDT and the Environment.....	11
2.3 What are health and safety precautions when using DDT?	12
2.3.1 General safety precautions during spraying of the chemical.	12
2.3.2 Precautions during Storage	14
2.3.3 Precautions during Transportation	14
2.3.4 Precautions during disposal of DDT remains	15
2.4 Challenges associated with DDT.	15
2.5 Knowledge gap	17
CHAPTER 3: RESEARCH METHODOLOGY	18
3.1 Research Design.....	18
3.2 Target population.....	19
3.3 Sampling	19
3.4 Research Instruments	20
3.4.1 The questionnaire.....	20

3.4.2 Interviews.....	21
3.5: Research Ethics.....	22
3.6 Data analysis and presentation.....	23
CHAPTER FOUR: RESULTS AND DISCUSSIONS	24
4.1 Demographic characteristics of respondents.....	24
4.2 Resident’s knowledge of health and safety risks associated with exposure to DDT.	26
4.3 Safety and health precautions taken at household level.....	30
4.4 Challenges associated with the use of DDT for Indoor Residual Spraying	34
4.4.1 Mitigating measures on challenges associated with DDT	35
CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS	37
5.1 Conclusion	37
REFERENCE LIST	39

CHAPTER 1: INTRODUCTION

1.1 Background of Study

According to Bate (2007) the scientific name of DDT is dichloro diphenyl trichloroethane. It was noted that the chemical was initially produced in 1874 by an Austrian chemist Othmar Zeidler. DDT was recognised as an effective insecticide in 1939 and was greatly used during the course of the Second World War to control lice borne typhus. In the years following the war, DDT turned out to be the prime insect repellent in agriculture, homes as well as in malaria control programmes (Zubrin, 2012).

Zubrin (2012) acknowledges that United States of America was one of the pioneering countries to use DDT for disease vector control. It is alleged that soon after World War two, between one and six million Americans in the southern countryside contracted malaria. In 1946 the US public health service introduced an anti-malaria spraying campaign with DDT. The chemical was applied to the interior walls of vulnerable homes. The United States successfully eradicated malaria in 1952 although million cases had been recorded a few years earlier, insignificant cases were recorded in the year 1952 (Zelson, 2014)

However, the safety of DDT for human wellbeing and the environment was challenged in 1962 after the release of Rachel Carson famous book *Silent Spring*. The book highlighted that DDT bio accumulates in the food chain and raised alarm that the pesticide may have long-term effects on wildlife and possibly on humans. Consequently the use of DDT in most Western countries was controlled and eventually banned due to its long persistence and its negative impacts on animals and the environment (Sadasivaiah et al., 2007). According to Eskanazi et al. (2009) DDT is a carcinogen and is capable of causing cancer in humans.

By 1972 all non-public health uses of DDT were banned in the United States of America. Regulations by some other nations occurred more gradually. While many accept that DDT was banned after 1972, in point of fact it was not. DDT continued being used for malaria control in both areas of high and moderate transmission. In addition to that DDT is believed to be economically available. This is the reason why the chemical is still being used especially in Sub-Saharan Africa (Bate, 2007). Successful effective use of DDT has been sustained in several Asian and African countries and Zimbabwe is no exception to that (Stockholm Convention on Persistent Organic Pollutants 2008)

In the year 2001, about 100 nations signed an agreement known as the Stockholm Convention on Persistent Organic Pollutants (POPs), obliging to reduce the application of twelve identified chemicals of paramount concern to human health and the environment. DDT is one of the twelve chemicals identified POPs by the convention (WHO, 2011). However, realising the continued need for DDT, the convention permits the use of DDT for malaria vector control, on condition that there is no non-toxic, operative, and economic substitutes accessible. In this regard, it is requirement of the convention that each nation intending to use DDT for IRS should report to the secretariat of the convention. This is done to ensure that nations conforms to safe use of DDT hence reducing human exposure and environmental pollution (WHO, 2011). Sadasivaiah et al. (2007) postulates that the World Health Organisation together with the U.S. Agency for International Development (USAID) permitted the application of DDT for indoor residual spraying in malaria prevalent and endemic regions because it is affordable.

In Africa, DDT has been and is still being used for malaria vector control activities because of its low cost (Khosa et al., 2013). Zimbabwe is one of the African countries that bank on DDT for indoor residual spraying. This therefore means that there are possible adverse human health and environmental effects associated with exposure to DDT, meaning to say, possible health and safety precautions should be taken into account when using DDT for indoor residual spraying.

DDT has an established record in malaria control as it has been responsible for saving millions of lives from malaria and other vector borne diseases when used in Public Health vector control programmes (Bate et al. 2004). However, some scholars acknowledge that there are possible adverse health effects that results from exposure to DDT. For example Birkholtz et al. (2012) found evidence that contact and exposure to DDT and its breakdown product dichlorodiphenyldichloroethylene (DDE) has adverse health effects. Negative health effects from exposure include breast cancer, decreased semen quality, diabetes and spontaneous abortion (Eskanazi et al. 2009). In light of this, Bouwman et al. (2011) contend that the undesirable health effects of DDT must not be disregarded, even though malaria morbidity and mortality decline offsets the harmful health consequences. On the other hand Biscoe et al. (2005) in conjunction with Roberts and Tren (2011) argue in favour of DDT for indoor residual spraying, they contend that saving lives from mortality due to malaria has to be regarded as an option to bank on.

“Although the indoor spraying programme has been sustained for over 40 years as the mainstay of malaria control in Zimbabwe, a significant proportion of the target communities continue to have a poor understanding of why their homes should be sprayed” (Vundule and Mharakurwa 1996, p.58). This makes it imperative to know if residents in Victoria Falls are also aware of potential health effects of DDT and if they are aware of the precautions that should be taken into account to counter its adverse effects in this area highly prone to malaria infections. This study therefore seeks to assess community perceptions on the adequacy of existing health and safety precautions when using DDT for Indoor Residual spraying in Victoria Falls town.

1.2 Statement of the Problem

The use of Dichloro Diphenyl Trichloroethane (DDT) for Indoor Residual Spraying (IRS) has become a major public health and safety concern in as far as malaria control is concerned in many malaria endemic communities. DDT has been shown to be an effective, affordable residual insecticide for malaria vector control (WHO, 2011). It is considered to be a relatively safe insecticide to use in public health vector control activities. Nonetheless, its long persistence in the environment and its high bioaccumulation in fatty tissues have led to a great concern on community’s knowledge of health and safety precautions to be considered when using DDT for IRS. Commonly, all insecticides are poisonous. Just like other insecticides, DDT can be harmful if improperly used. Users and the general public should be fully aware of the hazards DDT pose to the environment and human health. Taking special safety precautions minimizes the risk of poisoning that insecticides not only pose to people, but to other non-target organisms, and the environment including drinking water, food, and soil. Victoria Falls town annually uses DDT for malaria vector control because of high prevalence of malaria causing mosquitoes due to prevailing environmental conditions. However, the extent to which households are affected by DDT as well as the adequacy of precautions to safeguard their health is not known. Therefore, there is need to assess people’s perceptions on the adequacy of health and safety precautions which should be considered when using DDT for IRS in order to minimize human health related problems.

1.3 Objectives

1.3.1 General Objective

To assess Victoria Falls town residents' perceptions on the adequacy of health and safety precautions taken into consideration when using DDT for Indoor Residual Spraying in light of known potential health effects of this chemical

1.3.2 Specific Objectives.

- To establish the residents' knowledge of health and safety risks associated with exposure to DDT at household level.
- To establish safety and health precautions taken at household level
- To assess the residents' perceptions on usefulness of health and safety precautions taken when using DDT at household level.
- To assess the challenges associated with the use of DDT for Indoor Residual spraying.

1.4 Justification of study

Globally, attention is increasingly focusing on adequacy of health and safety precautions taken into consideration when using insecticides. DDT is one commonly used insecticide for malaria vector control as indoor residual spraying. DDT use for Indoor Residual Spraying has become a major public health and environmental concern in many malaria endemic communities. Although DDT has an established record in malaria vector control, it is equally important to take note of the health and safety precautions to be taken into consideration when using DDT for indoor residual spraying at both household and community levels because of its known negative effects. To date most research is focused on human effects of insecticides in agricultural activities than households, a situation which therefore exposes people to household insecticides-related hazards.

Current evidence on DDT exposure to human populations and on its probable health effects support the Stockholm Convention on Persistent Organic Pollutants, which give emphasis that DDT should be cautiously used when needed, and when no other safe and effective alternatives are available (Eskanazi et al. 2009). It is an operation for this research to come up with recommendations on how to use DDT as indoor residual spraying at household level.

This research seeks to bring to light of the community perceptions on the adequacy of health and safety precautions when using DDT for malaria vector control as indoor residual spraying. In addition it is imperative of this research to establish the Victoria Falls town

resident's knowledge on the health and safety risks associated with exposure to DDT at household level. Knowing the residents knowledge on the environment and health risks associated with exposure to DDT will aid in educating the community on the possible health and safety risks associated with DDT. This ultimately aids in reducing household exposure to DDT.

Furthermore this research will try to bring out the importance of community and or household awareness on the health and safety precautions that should be taken when using DDT for indoor residual spraying. It is also a function of this research to provide the authorities responsible for malaria control programme with strategies that provide adequate information on the effectiveness and safety of DDT in malaria control in Victoria Falls town. The intention of this research is to come up with solutions and recommendations for Safety and Health Regulators, Victoria Falls Municipality and the residents of Victoria Falls town on how DDT can be best used for indoor residual spraying in order to reduce human exposure and discharge on the environment.

1.6 Study Area

Victoria Falls town is situated in the North West corner of Hwange district which is found on the west of Matabeleland North province as shown in figure 1.1. The town is located a few hundred meters from the southern bank of the mighty Zambezi River, facing the Victoria Falls, on the Zimbabwe-Zambia boarder. The town has 11 wards distributed over 4 residential suburbs. High density residential suburbs include Mkhosana and Chinotimba situated to the south of the town. Low and medium density suburbs to the south have no distinctive names but are locally known as Emayadini and Aerodrome respectively. The town has got the lowest poverty prevalence within Matabeleland North Province. Within the town, ward 4 in Chinotimba suburb has the highest poverty prevalence of 50.1% (ZIMSTATS, 2015). In light of this, this study will focus on Chinotimba suburb.

The town has a total population of 33710 people making up 9109 households, with an average household size of 3.7 people per household (ZIMSTAT, 2012). The town was given a municipal status in January 1990, with it being acknowledged to afford jobs to countless of the local residents through tourism (ZTA, 2009). Other economic activities that are done by the residents of Victoria Falls are crafting and selling of curios to tourists.

The town is found in natural region five characterized by low precipitation and high temperatures reaching 38°C. The dominant vegetation type is the teak woodland composed of

Baikiaea plurijuga growing in association with Pterocarpus angolensis and Guibortia coleosperma which are best adapted to the well-drained Kalahari sands. The town is susceptible to erosion hence the formation of gullies.

The town is vulnerable to malaria because it lies in the Zambezi valley where temperatures are very high; hence female anopheles mosquitoes can thrive and breed. In addition it also lies adjacent to malaria endemic regions of the neighbouring Zambia. In order to curb the risk of malaria the Municipality of Victoria Falls in conjunction with the Ministry of Health and Child Care embark on a malaria control programme annually where DDT will be used as indoor residual spraying.

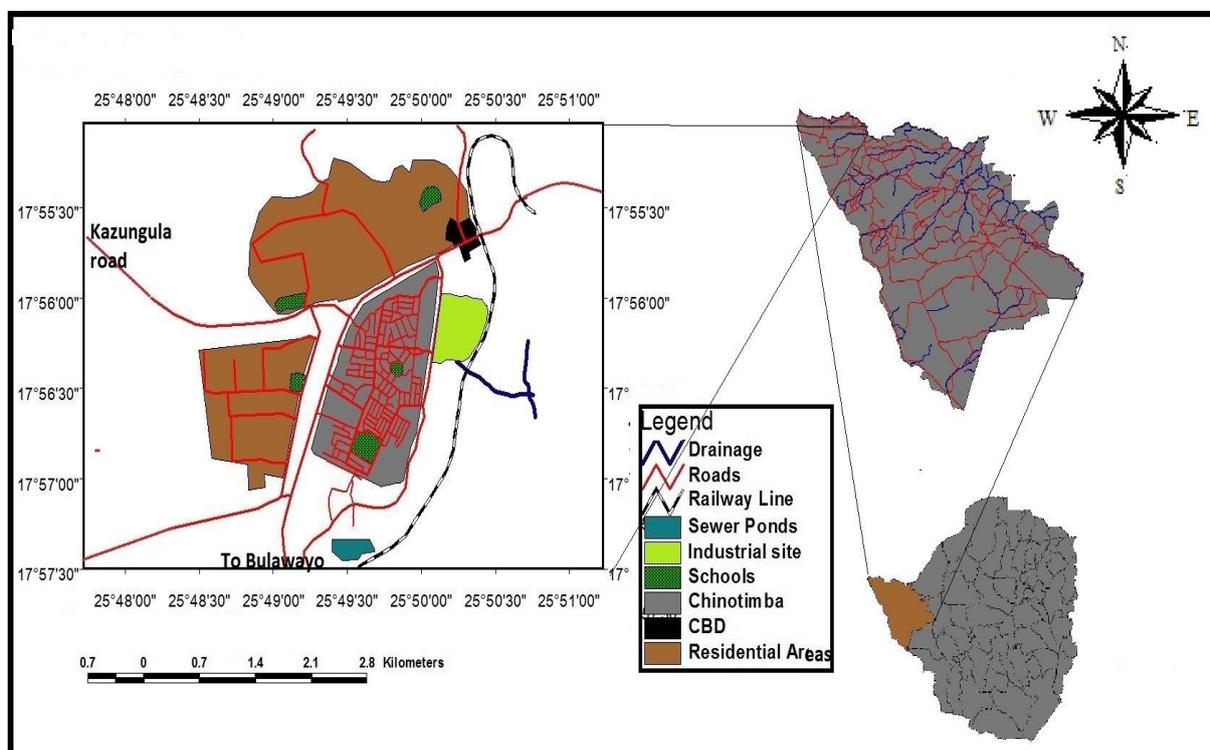


Fig 1.1Map showing the location of Chinotimba Suburb in Victoria Falls town in Hwange District

CHAPTER TWO: LITERATURE REVIEW

2.1 What is dichlorodiphenyltrichloroethane (DDT)?

According to Bate (2007) Dichlorodiphenyltrichloroethane DDT is a chemical compound used as an insecticide. Hedberg and Jernnas (2014) acknowledges that the chemical formula of DDT is $C_{14}H_9Cl_5$. The chemical is lethal to several living organism, most severely to marine animals, but also to mammals (Bouwman et al, 2011). DDT as an insecticide has been successfully and effectively used for many years in agriculture and public health vector control activities including malaria control programmes around the world (WHO 2011).

In Zimbabwe, the insecticide was effectively used to control tsetse fly in the 1960s and late 1970s. Although DDT was widely used in Zimbabwe for vector control activities. The use of DDT became highly controversial in the years following the liberation struggle mainly because of its effects on non-target wildlife and partly because of its persistence in temperate climates where it had already been banned earlier (Flint and Harrison 1998).

The safety of DDT for human wellbeing and the environment was challenged in 1962 after the release of Rachel Carson famous book *Silent Spring*. The book highlighted that DDT bio accumulates in the food chain and raised alarm that the pesticide may have long-term effects on wildlife and possibly on humans (Sadasivaiah et al., 2007). The book classified the environmental effects of extensive DDT spraying in the United States of America. Rachel Carson furthered on to question the rationality of discharging large amounts of potentially hazardous DDT without understanding its human and environmental effects (Eskenazi et al, 2009). In addition to that the book claimed pesticides including DDT had been revealed to be carcinogenic and that their use in agricultural activities is a threat to wildlife especially birds and marine species. The publication of *Silent Spring* was an influential event for environmental movement. Consequently as a result of that a large public outcry eventually led to the ban of DDT use in agriculture in the United States of America (USA) in 1972 (Bate, 2007). As if that is not enough the Stockholm Convention on Persistent Organic Pollutants POPs of 2001 targeted DDT as one of the twelve POPs to be eventually phased out because of their effects of bio accumulating in trophic level (UNEP, 2008).

However DDT is on the list of the World Health Organisation recommended insecticides for Indoor Residual Spraying. Nonetheless, WHO recommended the use of DDT for Indoor Residual Spraying in regions of unceasing and intense transmission only. In 2009 the world

health organisation declared to reduce the global use of DDT by 30% in 2014 and eventually do away with the production and use of DDT in 2020 (WHO, 2008).

2.1.1 DDT Use in Vector Control Programmes

The use of DDT in Vector Control Activities started during World War Two to control lice borne typhus. This was accomplished through dusting members of the public and soldiers with DDT powder. DDT powder was very effective killing the lice which transmitted typhus (Zubrin, 2012). During the years following the war DDT turned-out to be the prime insect repellent of choice for malaria control activities. Southern European nations were the first to implement the IRS programmes using DDT. Within a few years of using DDT for malaria control Europe eradicated malaria. In 1946 the United State of America introduced an antimalarial spraying campaign using DDT. As a result of the use of DDT in Indoor Residual Spraying USA successfully eradicated Malaria in 1952 (Zelson, 2014). USA and on a positive note the use of DDT. In addition to that it is acknowledged that Latin America and several Caribbean states eradicated malaria in the early 1950s. Again Bate et al (2004) acknowledges that in 1951 India launched the malaria control programme with DDT and achieved to lessen malaria cases from an estimated 75 million/annum to an insignificant 50 000/annum.

When DDT is used for IRS sprayers usually spray small amounts about 2 grams of active ingredient per m². The solution is usually sprayed on the inside walls of houses and maybe under the eaves of houses. Because of its long lasting properties the DDT has been effective in malaria control. DDT as an insecticide works in three ways. Firstly the chemical is toxic to the anopheles mosquitoes and hence effective at killing them, secondly the chemical acts as a repellent so that mosquitoes may not enter the house at the first place and lastly DDT irritates mosquitoes which may cause the mosquitoes to exit the house without biting (Bate et al, 2004)

African nations have implemented effective IRS programs with DDT. South Africa maintained the indoor residual spraying programme with DDT from 1946 to 1996. In the year 2000, South Africa reintroduced DDT for IRS in Kwazulu Natal Province, the province with the highest malaria prevalence in the country (Bate et al 2004). According to Flint and Harrison (1998) Zimbabwe effectively used DDT to control tsetse fly in the 1960s however by the 1980s the use of DDT had become controversial in Zimbabwe. This was because of its

persistence on the environment and its effects on non-target flora and fauna (Flint and Harrison 1998).

According to the Ministry of Health and Child Welfare MOHCW (2013) DDT was used up until 1991 when it was replaced with other insecticides like Icon and Bug stop. Nonetheless, the substitution of DDT saw an increased malaria cases in Zimbabwe in the years following the year 1991. In light of this the MOHCW was prompted to reintroduce the application of DDT in the year 2004, Zimbabwe conforms to the Stockholm Convention requirements or recommendations pertaining the use of DDT. DDT turns to be the insecticide of choice because of it is affordable as well as residual effect of up to 12 months on sprayed walls. The application of DDT in Zimbabwe conforms to other SADC member states who have also implemented the use of DDT for malaria control.

Today Zimbabwe uses DDT for indoor residual spraying annually. WHO recommends the use of DDT for IRS in malaria endemic regions given that no other safe alternatives are available. The 2001 Stockholm Convention on Persistent Organic Pollutants gives conditions on the use of DDT. The convention requires nations to inform the secretariat of the convention of their intention to use DDT for IRS and to prevent human exposure and discharge into the environment (WHO, 2011)

2.2 DDT and Human Health

Humans are exposed to DDT in various ways, these include ingestion, inhalation as well as skin absorption. People are most likely to be exposed to DDT from foods they take, these foods include fish, meat and dairy products (EPA, 2009). DDT can be absorbed by eating, breathing, or touching products contaminated with DDT. When DDT is absorbed by the human body it is converted into breakdown products which are known as metabolites including dichlorodiphenyldichloroethene (DDE). Both DDT and DDE are stored in the fatty tissues. In pregnant mothers, the unborn is exposed to both DDE and DDT. In addition to that nursing infants are exposed to DDT because the chemical is found in breast milk (Centre for Disease Control and Prevention, 2009)

The topic of DDT and its effects on human health has been a highly debated issue since the 1950s. There are two school of thoughts pertaining the issue of DDT and human health. Those that argue against the use of DDT for Indoor Residual Spraying claim that DDT is toxic and that the chemical is known to be carcinogenic (Bate et al, 2004). On the other hand those who support the use of DDT for malaria control claim that the need to save lives from

malaria outweighs unproven claims that DDT is a carcinogen. In addition to that, Smith (2015) postulates that innumerable people have been exposed to huge amounts of DDT in the 1940s where civilians and troops could deliberately dust their cloths with DDT powder without any ill effect. Again Smith (2015) claims that since the discovery of DDT, countless tonnes have been produced and dispersed world over and countless people have been directly exposed to DDT. At first the use of DDT was only authorised to militants during the Second World War and then to everyone in years following the war. In this regard Smith (2015) postulates that if the substantial volumes of DDT used are scrutinised, the safety of DDT for human health is exceptionally well. When DDT was extensively used in the post-World War Two period it gave birth to a plethora of studies with regard to DDT safety on human beings and its effects on the environment (Eskenazi et al, 2009).

2.2.1 DDT as a carcinogen.

The International Agency for Research on Cancer (IARC) rated DDT Group 2B as a probable carcinogen to people (IARC, 1991). This evaluation was based on animal studies that reported significant increases in hepatomas neoplastic liver cell tumours in several species of male and female rodents orally exposed to DDT and DDE (IARC, 1991). Bate et al (2004) contends that most studies done on human beings did not show any positive correlation between human health and exposure to DDT for Indoor Residual Spraying. In addition to that Lancet (2005) postulates that in 2002 the Centres for Disease Control and Prevention (CDCP) informed that regardless of some insignificant positive associations for cancers within certain people, there is insignificant evidence to support the claim that exposure to DDT and DDE causes cancer in people. Bate (2007) suggests that most studies on humans by the International Agency for Research on Cancer did not reveal any association between the risk of cancer and exposure to DDT for Indoor Residual Spraying. However Eskenazi et al (2009) assumes that some studies submit that exposure to DDT may be associated with certain cancers such as lymphomas and lung cancer. According to Bate (2004) research on cancer and exposure to DDT and DDE have continued to yield indefinite results. In light of this, Eskenazi et al (2009) contends that there is need to review research paying particular attention exposure to DDT and the risk of liver cancer, breast cancer as well as pancreatic cancer.

2.3 DDT and the Environment

The use of DDT in agriculture resulted in the discharge of huge amounts of DDT in the environment. DDT got its way in the environment through indiscriminate spraying of fields and consequently it caused certain negative ecological effects (Eskenazi et al, 2009). As a result of the stability of DDT, the insecticide persist in the upper strata of soil and lower deposits of watercourses for a significant period. However most research on the Persistence of DDT and its breakdown product DDE have been conducted in temperate climates of the northern hemisphere where the chemical was initially used (Zelson, 2014). Nonetheless, Bate (2004) suggests that in warmer tropical climates of the southern hemisphere DDT and DDE do not endure for a long time in the environment as compared to the cooler climates.

In light of this, Bate (2004) contends that the ecological effects of DDT should be seen in the context of Indoor Residual Spraying since the chemical is only recommended for IRS in regions of intense malaria transmission. According to Bate (2004) Indoor Residual Spraying requires insignificant amounts of DDT roughly 450 grams is sufficient for the application of a very big house of which the chemical is applied on the inside walls of the house. Having this in mind, it is logical to ascertain that little or no DDT is discharged into the environment when the insecticide is used for malaria control. In addition to that even though DDT for IRS leaks into the environment, the amounts are insignificant to do any substantial damage to the environment (Bate, 2004). In this regard a research by Bouwman et al (1990) postulates that there is no noticeable variation in the intensity of DDT in the environment before and after Indoor Residual Spraying. In addition to that WHO (2008) claims that guidelines and recommendations for the use of DDT for Indoor Residual Spraying show a much diminished environmental threat if there is any.

While it is appreciated that DDT persists in the environment, environmental concerns pertaining the use of DDT for IRS are unreliable arguments against the use of DDT for malaria vector control (Attaran et al, 2000). As a result of that issues pertaining to safe use of DDT for Indoor Residual Spraying have become topical over the past three decades (Attaran et al, 2000). In addition to that many scholars contend that DDT as a Persistent Organic Pollutant is readily absorbed in soil and the environment which act as sinks as well as long-term sources of exposure affecting flora and fauna species (Eskenazi et al 2009). As a result of DDT's hydrophobic characteristic, in riverine ecosystems both DDT and DDE are absorbed by aquatic flora and fauna species, again DDT and its breakdown product are

absorbed by suspended particles in marine ecosystems leaving little DDT and DDE dissolved in water. According to the Agency for Toxic Substances and Disease Registry (ATSDR) both DDT and DDE persist in the environment and are transported from regions of warmer climates to regions of cooler climates where they mount up in the region's food web. This is achieved through a process known as global distillation.

Because of its enduring characteristic, DDT and its breakdown products bio-accumulates especially in beds of prey (Connell et al, 1999). According to Eskenazi et al (2009) DDT, DDE and DDD magnify through trophic levels with secondary and tertiary consumers such as birds of prey concentrating more chemicals than other animals in the same environment. DDT, DDE and DDD are stored mainly in the body's fatty tissues.

2.3 What are health and safety precautions when using DDT?

Exposure to DDT may occur during spraying, handling, mixing, transportation as well as storage and disposal of the insecticide. In order to avoid human exposure and possible discharge into the environment there are certain healthy safety precautions which are supposed to be observant for safe and effective use of the chemical.

2.3.1 General safety precautions during spraying of the chemical.

Prior to spraying, Spray operators should caution the householders of their intention to spray their houses with DDT for malaria control. They should inform them on the spraying programme. Again spray cautioners should inform and train householders on what they are required to do before spraying so as to enhance safety. In this way, householders will get to know about the safety risks of DDT hence they will facilitate safe application of the chemical through preparation prior spraying. This is done to ensure that householders have enough time to prepare for spraying hence minimise exposure (WHO, 2015). During spraying, it is essential for spray operators to emphasize to householders on the safety precautions to be observed during spraying. In addition to that spray operators should outline the benefits of spraying as well as the probable after spraying side effects (WHO, 2015).

It is a requirement for householders to know the duration of the efficacy of DDT on the interior walls of their houses usually 6 to 12 months in the case of DDT. In light of this, spray operators as well as spray cautioners should emphasize the importance of not washing their walls during the period. In addition that, in order to reduce exposure to householders they should be continually educated on health and safety precautions to observe during indoor

residual spraying. The need for staying outside during and up until two hours elapses after spraying when the chemical has dried out in the air.

Exposure to DDT may take place during handling and application DDT. Absorption of DDT occurs mainly through ingestion, inhalation as well as skin absorption (EPA, 2009). Exposure to DDT may occur during opening of the package, mixing, spraying as well as disposal of DDT solution and containers (WHO 2015). In light of this, this therefore means that observing health and safety precautions is a prime necessity during indoor residual spraying. The World Health Organisations recommends the following as general precautions during the indoor residual spraying.

- Spray operators should always wear adequate protective clothing consisting of protective hats to shield the head from spray droplets, goggles to protect the eyes against spray droplets, face mask to protect the nose and mouth from air borne particles as well as long sleeved overalls. Rubber gloves and boots are also on the list of required protective clothing for indoor residual spraying
- Before spraying, the spray operator is required to inspect the whole house to be sprayed. This is done to ascertain that all items that are capable of being contaminated are moved out of the house, these items include food, children toys as well as garments
- During spraying, only the spray operator is required to be in the house. The inhabitants of the house are required not to enter the house up until two hours have elapsed. This is done to avoid absorption through inhalation since the insecticide (DDT) particles would be in Brownian motion in the air within the house.
- Spray operators are not allowed to drink, eat or smoke while on duty. This is done to avoid ingestion and inhalation of the chemical.
- Before eating drinking or smoking, spray operators are required to wash their face and hands with detergent and running water.
- It is a prime necessity of each and every spray operator to take a shower soon after completing each day's duty.
- It is a requirement that at the end of each day's duty, each spray operator should cleanse his/her protective clothing in detergent and running water.
- If DDT touches the skin during spraying, it is a necessity to rinse it off instantly with detergent and running water.
- If protective clothing is soiled with DDT one is required to change the clothes right away.

2.3.2 Precautions during Storage

There are also necessary precautions to observe during storage of the chemical. This is done to prevent any release into the environment which may result as result of poor storage and location of the chemical. Firstly it should be noted that the DDT storerooms are required to be situated far from both human and animal habitant. Avoid discharge into water sources again DDT storerooms must be located away from lakes, rivers, canals, wells as well as other sources of water (WHO, 2015).

In addition the storehouses should be strategically positioned on high ground and fenced where only authorised individual have got access to. There must be easy of access for DDT delivery as well emergency vehicles in case of emergency. In the storehouse it is a necessity that DDT must not be exposed to moisture or sunlight which could adversely affect its stability. In addition to that, DDT containers, boxes and sachets should be well arranged within the storehouse to evade the likelihood of leakage. When issuing for the chemical the first expiry principle must be adhered to.

Furthermore Stock registers must be updated when issuing out DDT it is necessary to use first in first out FIFO principle to avoid expiring of insecticide. It is a requirement that the storehouse should have clearly labelled caution marks so that users of the storehouse may know that there are poisonous substances in the storehouse. Again DDT containers should be arranged in such a manner that reduces handling reducing the possibility of mechanical damage which can result in leakages. DDT packages must be stacked safely on pallets and the stakes should not be low enough to ensure stability.

2.3.3 Precautions during Transportation

When transporting DDT it is requirement that DDT should be packaged in labelled and well-sealed vessels. It is logical to note that to avoid contamination of other goods DDT should not be transported in the same truck with other goods such as agricultural produce, clothes to mention a few. This is so because other goods like foodstuffs can easily become lethal if contaminated with insecticides. In addition to that, the way in which DDT packages are loaded and arranged in the vehicle should minimise the possibility mechanical damages that may occur during transportation. DDT packages must be staked in a way that labels and safety precautions may not be rubbed off during transportation. In addition to that vehicles transporting DDT mast display a warning communication that hazardous substances are on board.

Furthermore the DDT cargo must be checked constantly during the course transportation to check for leakages. If leaks or any other form of pollution is recognised the vehicle should stop and pollution must be cleaned up instantly in line of recognised standard measures. Upon arrival it is a requirement that an expert inspects the cargo to ascertain that the chemical has been received safely and in the intended condition.

2.3.4 Precautions during disposal of DDT remains

The World Health Organisation recommends at the end of each days duty spray operators are required to wash the inside of their spray pumps as well as the lance and nozzle of the spraying gun. This is achieved by rinsing the spray pump three times. The water used to wash the spray pumps is not supposed to be discharged, instead the water must be collected in tightly sealed and well labelled drums for the dilution of the following day's work. In some cases the dilute water is disposed properly in line with the recommendations with the World Health Organisation. It is emphasized that DDT should not be disposed of in water sources as this will lead to contamination of the environment.

According to USAID (2009) there is need to decontaminate containers. Highlighted above this can be achieved by rinsing the spray pumps three times. In addition that the spray pumps should be hanged upside-down in the storeroom with valves open so that they can dry out. When DDT expires it should not be disposed of indiscriminately. Instead there is need to engage the manufacturer and or experts in disposing of expired DDT. Again it should be noted that before disposing of DDT the efficacy of the chemical should be tested to see if the chemical can still be used for IRS or it has become unusable. This is done to reduce environmental pollution (USAID, 2009).

2.4 Challenges associated with DDT.

There are several challenges are said to be associated with the application of DDT for IRS. Firstly the chemical is an organophosphate and is known to persist in the environment for a long period of time up to 10 years. In addition, the 2001 Stockholm Convention on POPs identified DDT as one of the twelve chemicals that persist in the environment and its intention to reduce their use and production until it achieves a total phase out in 2020 (Pilula, 2010). Even though, DDT use over the past years may have assisted to avert countless Malaria cases. However based on current studies, (Eskanz et al, 2009) claim that through IRS humans are at risk of being exposed to both DDT and DDE. Both DDE and DDT can endure in the environment for a very long time usually 6 to 10years. Both chemicals bio

accumulate right through trophic levels (Longnecker 2005). When absorbed by the human body both DDT and DDE are stored in the fatty tissues of the body and the chemical is said to be a carcinogen.(Longnecker 2005). However insignificant studies have been done to measure body burdens to DDE and DDT (Wolff et al. 2000). Furthermore it is alleged that there is scarcity of research focusing on effects of DDT exposure at household level through IRS. However some contend that exposure to DDT and cause cancer (Pilula, 2010).

In addition to the above mentioned is the issue of insect resistance to DDT. It has been generally observed that mosquitoes are becoming more resistant to the chemical as it is no longer effective as it was used during World War Two. Pilula (2010) acknowledges that the goal of using DDT for malaria control is to eliminate the burden caused by the disease. However Pilula (2010) claims that the primary goal of using DDT has been seen to be failing as it has been the case in Sub Saharan African, Asian as well as some South American nations who are still burdened by malaria up to date. Again it is alleged that soon after DDT spraying both mosquito and malaria prevalence escalates noticeably (Attaran et al. 2000). In Peru and Colombia the issue of DDT vector resistance was in the early 1990s where by malaria cases doubled soon after spraying was complete. In this regard it has also been noted that malaria has reappeared in regions where it had already been eradicated before. These regions include the Amazon area, Korea as well as Sri Lanka (Roberts, Manguin, and Mouchet 2000). Attaran et al (2000) acknowledges that when Sri Lanka eradicated malaria in 1961 when DDT application was done, 500 000 cases were recorded in the year 1968 just eight years after the disease was eradicated in the country.

As programs using DDT for IRS are increasing, so is the issue DDT vector resistance growing. From the time of DDT introduction for malaria control resistance has been noted of over 50 species of the female anopheles mosquitoes including other disease vectors as well(Hemingway and Ranson, 2000).WHO (1970) acknowledges that in southern Greece in 1952 an increase was noted in the resistance of the main vector anopheles this was just six years after the initial use of DDT for malaria control. Consequently DDT resistance was noted in numerous anopheles species, predominantly in Southern Europe, Africa and Southeast Asia (Roberts et al, 2000).

On a more positive note the use of DDT eradicated malaria in Central Europe and nearly eliminated malaria in Asia and South America. In Africa DDT was effectively used until resistance was first reported in West Africa (Zahar, 1984) DDT resistance advanced fairly

swiftly in the Sub-Saharan Region. According to UNEP (2008) DDT use in agricultural activities was the main reason why mosquitoes become resistant to the insecticide, according to UNEP this is so because mosquitoes breed in farming environments. According to the UNEP (2008) Brown in 1965 acknowledged that resistance of anopheles species to insecticides like DDT is more common in humid highly agricultural areas.

Consequently governments especially those in the developing are concerned the burden caused by malaria. These nations tend to bank on DDT for malaria control because the chemical is known to be cost effective and has a residual effect of up to 12 months. However environmental movement groups are worried more about the enduring characteristic of DDT in the environment. International institutions like WHO and UNEP are also worried about probable health effects associated with DDT for IRS. However recognising continued need to save life from malaria especially with the knowledge that an estimated 880 000 succumb to malaria annually on a global scale. There is need for international policy makers to think about the use of DDT for Indoor Residual Spraying. In this regard, the use of DDT for IRS has given birth to the DDT controversy.

2.5 Knowledge gap

Literature shows that innumerable research has been done in regard to the use of DDT. The use of DDT is a controversial one, which has seen different parties having different views pertaining to the use of DDT for indoor residual spraying and other public health vector control activities. This has given birth to a plethora of studies/research with regard to DDT safety to human health and the environment. Although research has been conducted with regard to DDT safety to the environment including human health, there is a paucity of information regarding peoples/communities perceptions on the adequacy of health and safety taken when using DDT for indoor residual spraying. For researches done so far it is clear that DDT is a Persistent Organic Pollutant hence it has the capability of passing through trophic levels. The question now is, how are existing health and safety precautions are taken when using DDT for Indoor Residual Spraying communities perceived by people/communities?

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Research Design

Research design can be defined as a comprehensive outline of techniques applied to a study or research. It deliberates on how data was collected, what instruments were engaged, how the instruments were used to gather data as well as the anticipated methods of analysing and interpreting collected data (Creswell, 2013)

Mixed methods were engaged in this research. Mixed methods research is an approach which allows collection of both quantitative and qualitative data. The supposition of this approach is that the combination of qualitative and quantitative techniques provides a more comprehensive understanding of a research problem than either approach alone (Creswell, 2013). Qualitative approach was employed because it helped the researcher to gain a clear understanding of resident's views and knowledge on health and safety risks associated with exposure to DDT. Again qualitative techniques assisted the researcher to assess resident's perceptions on usefulness of health and safety precautions taken when using DDT at household level. Qualitative approach allowed the respondents to openly and fully express their views pertaining the issue under study. Qualitative Research allows the researcher to step beyond the known and enter into the world of the participants/respondents. (Corbin and Strauss, 2008). Qualitative data was captured using open-ended questions on questionnaires containing a mixture of both closed and open-ended questions. Qualitative data was also captured as notes during interviews with Victoria Falls Municipality VFM Environmental Health Officer (EHO) and Environmental Health Technician (EHT).

Quantitative methods emphasized objective measurements and the statistical analyses of data collected through research instruments. Quantitative research focused on gathering numerical data and analysing it to explain a certain phenomenon (Babbie, 2010). The goal of conducting a quantitative research study is to determine the affiliation between an independent variable and a dependent or outcome variable within residents (Muijs, 2010). In this research, quantitative techniques were engaged in comparing and generalizing information obtained from Chinotimba residents. Quantitative techniques allowed the researcher to test the relationship between the level of education and residents' perceptions on usefulness of health and safety precautions taken when using DDT at household level. Quantitative approach allowed the researcher to analyse and assess data obtained through closed-ended questions on the questionnaire.

3.2 Target population

It is a particular portion of the population that has one or more characteristics that are identified to be relevant to the researcher (Bryman, 2008). The target population for this research include Chinotimba suburb residents and VFM Environmental Health Officer EHO as well as Environmental Health Technician EHT.

Chinotimba suburb residents are the prime target for this research. Chinotimba suburb has been targeted because the suburb has the highest poverty prevalence within the town. In addition Chinotimba suburb residents have their houses sprayed annually for malaria control, hence they helped the researcher with information regarding to their experience with the IRS Programme. Chinotimba residents also helped the researcher with information on safety and health precautions they observe when their houses are being sprayed with DDT as Indoor Residual Spraying.

The reason for targeting the Environmental Health Officer is because he is the one in charge of the Public Health Section. The section is responsible for administering the Malaria Control Programme in Victoria Falls town. Hence the Public Health Officer has general knowledge on resident's perceptions and attitude towards the IRS programme. More so, the Environmental Health Technician also helped the researcher with information on resident's awareness on health and safety precautions taken when using DDT for IRS. He also provided information on the number of housing Units in Chinotimba suburb.

3.3 Sampling

Sampling is defined as the selection of a particular group of individuals from a population to approximate the attributes of the whole population (Bryman, 2008). The aim of sampling is to get a balanced characteristic sample of the target population (Jensen, 2005). A sample size can be defined as a limited number taken from the target population for examining and analysis and can be used as a representative of the entire target population (Bryman, 2008). The researcher carried out his fieldwork in Chinotimba suburb. According to Victoria Falls Municipality Survey Report 2015, Chinotimba suburb had 2551 housing units.

To come up with the sample size the researcher used the Yamane Formula.

$$n * = \frac{N}{1 + N(e)^2}$$

Where: n^* is the sample size, N is the population size and e is the precision level which is set at 0.1 (Israel, 2013). In this case calculations for the sample size for this research were as follows,

$$n^* = \frac{2551}{1 + 2551(0.1)^2}$$

$$n^* = \frac{2551}{2552(0.01)}$$

$$n^* = \frac{2551}{25.52}$$

$$n^* = \frac{2551}{26} = 98.1$$

This therefore means that 98 housing units were targeted as a sample in Chinotimba Suburb.

Chinotimba suburb is made up of 2551 housing units (VFM, 2015). In order to carry out the research effectively and avoid any bias in sampling, the sampling frame or sample size was then exposed to simple random sampling. A simple random sample is a subset of population in which each and every member of the subset has an equal chance of being chosen (Jensen, 2005). Simple random sampling technique was engaged because it is considered to be a fair way of selecting a sample from a larger population, since each member of the population has an equal chance of getting selected. Therefore, the researcher opted to use simple random sampling in distribution of questionnaires to avoid bias as housing units were selected using Microsoft excel.

Purposive sampling was also used in selecting participants for interviews. Purposive sampling is done on limited people who have knowledge and expertise on the matter being researched upon (Yin, 2003). For instance the EHO and EHT where purposively chosen as they had specific expertise that was needed in this research.

3.4 Research Instruments

3.4.1 The questionnaire

A questionnaire is a form prepared and distributed to secure responses to certain questions and also secures answers to questions using a form by which respondents fill by themselves (Creswell, 2012). The questionnaire in this research is used to find information on community's perceptions on the adequacy of health and safety precautions taken when using

DDT for IRS. The researcher opted to use questionnaires because they are a time-efficient method of collecting data from many people since they can be distributed over a short space of time. The questionnaire was used to gather both quantitative and qualitative data. A combination of both open and closed-ended questions were used to solicit household information. Open ended questions permit respondents to express their own views and were used to solicit information on residents' perceptions on usefulness of health and safety precautions taken when using DDT at household level. Closed ended questions were used to gather more factual information like age, marital status, gender as well as respondent's level of education. Closed questions were time efficient as they were easy to fill in, they also lessened discrimination against the less literate as they were self-administered.

The questionnaire was divided into four sections.

A – Demographic information / General information of the respondent

B – Residents' knowledge of health and safety risks associated with exposure to DDT at household level.

C – Safety and health precautions taken at household level

D – Challenges associated with the use of DDT for Indoor Residual spraying.

The questionnaires were distributed during the weekend basing on the assumption that most of the people in the resort town are employed, thus there will be at their homes and a bit free to attend to the questionnaires. The questionnaires were self-administered so as to discriminate against the less literate as the researcher had to clarify some questions in their native languages because the questionnaire was written in English.

3.4.2 Interviews

Interviews were also conducted with VFM Environmental Health Officer and Environmental Health Technician. The EHO and EHT were selected for interviews because of their expertise in the area under study as illustrated in Table 3.1. This was done to acquire some information that could have been omitted in the questionnaires and also to get information on Victoria Falls town resident's attitude towards the Malaria Control Programme.

Semi-structured interviews were conducted to allow interviewees to express themselves without restrictions, expand answers and also provide information they think is essential. The interviews were conducted face to face with the interviewees at VFM Public Health Section Offices. During the interviews, notes were taken. An interview guide was prepared to guide

the dialogue. An appointment was made in advance of the interview so that the EHO and EHT were not caught unprepared and also to avoid an unfruitful effort in the case of absence.

Table 3.1. Interviewees and justification

Interviewee	Justification
EHO	<p>He is the head of the VFM Public health Section.</p> <p>He has knowledge on innumerable public health issues including the malaria control programme.</p> <p>He knows the resident’s attitude towards the malaria control programme.</p>
EHT	<p>Responsible for sensitising the community about the IRS programme.</p> <p>He is responsible for training spray operators.</p> <p>He has the expertise of implementing Environmental Health Programmes including the IRS programme.</p>

3.5: Research Ethics

Ethics are norms for conduct that make a distinction between acceptable and unacceptable behaviour (David and Resnik, 2015). They can be understood as a set of moral principles and rules of conduct (Powel et al, 2013). In order to carry out the study effectively and efficiently the researcher had to respect the morals of the targeted population. Bearing in mind that Victoria Falls town is multicultural in nature, the academic had to observe the social norms of the respondents so as to avoid upsetting them in any way thus compromising the effectiveness of the study. The researcher sought permission from Chinotimba suburb ward councillors to carry out the research in Chinotimba suburb. This was done so as to ensure that no boundaries would be crossed to ensure that the research was strictly for academic purposes and not for political motives.

Data collection techniques developed must deliberate on whether research procedures are likely to cause any emotional or physical harm (Chaleunving, 2009). The researcher therefore sought informed consent before the interviews began. Harm may be caused by violating informant’s right to confidentiality and failing to observe certain social ethics valued by informants.

Therefore, in this context, the researcher observed all the ethical elements of the research. The researcher made it clear that the findings of the research are for academic purposes only

and assured on the confidentiality of the information that the respondents were going to give. This was done to ensure respondents to present detailed responses without fear of being exposed.

3.6 Data analysis and presentation

After data collection through questionnaires and interviews, its analysis and presentation is crucial so as to produce meaningful information and come up with a clear picture and conclusion of what is actually transpiring in the real world. Generally, data analysis and presentation involves manipulation of data using different tools and software to come up with a more meaningful information from which one can deduce conclusions. The researcher coded and organised all data obtained from the questionnaires and interviews. This was done through the collection of relevant information from the research instruments used. Questionnaire answers were organised and analysed using Statistical Package for Social Scientist software (SPSS) to acquire information on community's perceptions on the adequacy of health and safety precautions taken when using DDT for Indoor Residual Spraying (IRS).

Again the researcher used Chi-Square test to examine the relationship between the independent variable and dependent variable, in this case relationship between the level of education and residents' perceptions on usefulness of health and safety precautions taken when using DDT at household level. Further analysis was made on the challenges associated with the use of DDT for Indoor Residual spraying and the ways that can be engaged to reduce them at community level.

Qualitative data collected to assess resident's views and knowledge on health and safety risks associated with exposure to DDT was exposed to qualitative content analyses and presented in terms of graphs, tables and pie charts coupled with detailed descriptions where clarification is needed. Direct quotations were noted considering the fact that the information was qualitative in nature. Microsoft excel was used to generate percentages and frequencies of responds gained from data collected.

CHAPTER FOUR: RESULTS AND DISCUSSIONS

4.1 Demographic characteristics of respondents

Of the 98 questionnaires administered in Chinotimba suburb only 89 were answered constituting a response rate of about 91% of the sample size population. The response rate is fairly acceptable considering the fact that most of the inhabitants of the town will be at work hence without enough time to attend to the questionnaires. Of the 89 questionnaires answered, 51.7% of the respondents were female while 48.3% were male as shown on Table 4.1. This therefore means that the sex ratio of respondents is 93%. This somehow tally with national statistics whereby the sex ratio of the nation was estimated at 87% (ZIMSTAT, 2012)

Table 4.1 Gender of Household

	Frequency	Percent	Valid Percent	Cumulative Percent
Male	43	48.3	48.3	48.3
Valid Female	46	51.7	51.7	100.0
Total	89	100.0	100.0	

In terms of age, the dominant age group was 31-40 which constituted 44.9% of the respondents. The proceeding age range was 21-30 years constituting 21.3% of the respondents as illustrated on Table 4.2. This therefore means that the household respondents were economically active people. This probably means that the town attracts economically active people from the surrounding rural areas with the hope of finding jobs in the resort town hence the domination of the economically active age group.

Table 4.2 Age of respondents

	Frequency	Percent	Valid Percent	Cumulative Percent
20 and less	12	13.5	13.5	13.5
21-30	19	21.3	21.3	34.8
31-40	40	44.9	44.9	79.8
Valid 41-50	11	12.4	12.4	92.1
51-60	5	5.6	5.6	97.8
60+	2	2.2	2.2	100.0
Total	89	100.0	100.0	

In light of Table 4.2 findings of the research will not be compromised since the majority of the respondents are most likely to be aware of what is happening in their vicinity by virtue of their age. Results also show that those aged 60 and above accounted for an insignificant 2.2% of the respondents (Table 4.2). This probably means that the study area has short life expectancy as indicated by the findings of the fieldwork.

Most of the respondents who were randomly sampled in Chinotimba suburb showed that they had at some point have had access to school which made the research a bit easier because most of the respondents were able to read and write and even understand most of the questions. Table 4.3 shows that 97.8% of the 89 respondents went to school. Table 4.3 also shows that a significant 69.7% of the respondents had reached secondary level.

Table 4.3 Respondent's level of education

	Frequency	Percent	Valid Percent	Cumulative Percent
Primary	19	21.3	21.3	21.3
Secondary	43	48.3	48.3	69.7
Valid Tertiary	25	28.1	28.1	97.8
None	2	2.2	2.2	100.0
Total	89	100.0	100.0	

The respondent's level of education was advantageous to the researcher as it helped to obtain useful information as it was provided by people who were understanding of the trends happening within their locality. Respondents could easily ask for questions where they needed clarity and some of them could even write other issues related to the issue under study.

This

was made possible because the questionnaire contained both closed and open ended questions which permitted collection of both qualitative and quantitative data from the respondents.

Focusing on the respondent's residence in chinotimba suburb it can be noted that of the 89 respondents who participated in the field survey, 94.4% had stayed in Chinotimba Suburb for more than five years (Table 4.4). With this in mind it is logical to assume that majority of the respondents have an understanding of the study area and are quite familiar with the Indoor Residual Spraying Programme as it is done on an annual basis. In light of this it becomes logical to ascertain that the respondents gave adequate information pertaining their experience with DDT for indoor residual spraying

Table 4.4 Period Stayed in Chinotimba Suburb

	Frequency	Percent	Valid Percent	Cumulative Percent
less than 5	5	5.6	5.6	5.6
6-10	19	21.3	21.3	27.0
11-15	31	34.8	34.8	61.8
Valid 16-20	21	23.6	23.6	85.4
21+	13	14.6	14.6	100.0
Total	89	100.0	100.0	

4.2 Resident's knowledge of health and safety risks associated with exposure to DDT.

Research findings shows that a substantial portion of the respondents are not aware of health and safety risk associated with exposure to DDT. Fieldwork findings revealed 61% of the respondents are not aware of the health and safety risks associated with exposure to DDT. Of the 39% percent who acknowledged that there are aware of the health and safety risks associated with exposure to DDT. Figure 4.1 shows the health and safety risks perceived by Chinotimba residents. Figure 4.1 also shows that 91% of the proportion of respondents who are aware of safety hazards associated with exposure to DDT acknowledged that DDT irritates their skin, 29% noted that their eyes itchy after DDT spraying, 60% established that the chemical affects their respiratory system as they have troubles in breathing after spraying, 43% noted that contamination of food is an effect of DDT and 11% acknowledged that DDT kills non target organisms including pets. In light of this Chinotimba suburb residents take inadequate health and safety precautions during spraying as indicated by the established health and safety risks associated with exposure to DDT (Figure 4.1). In this regard the local authority should consider teaching residents on potential post spraying side effect. WHO (2009) emphasises the need for educating householders on the potential post spraying side effects so that people take adequate safety precautions during IRS. Having noted all this there is need for interested organisations together with the local authority to setup educating teams within chinotimba suburb for IRS monitoring.

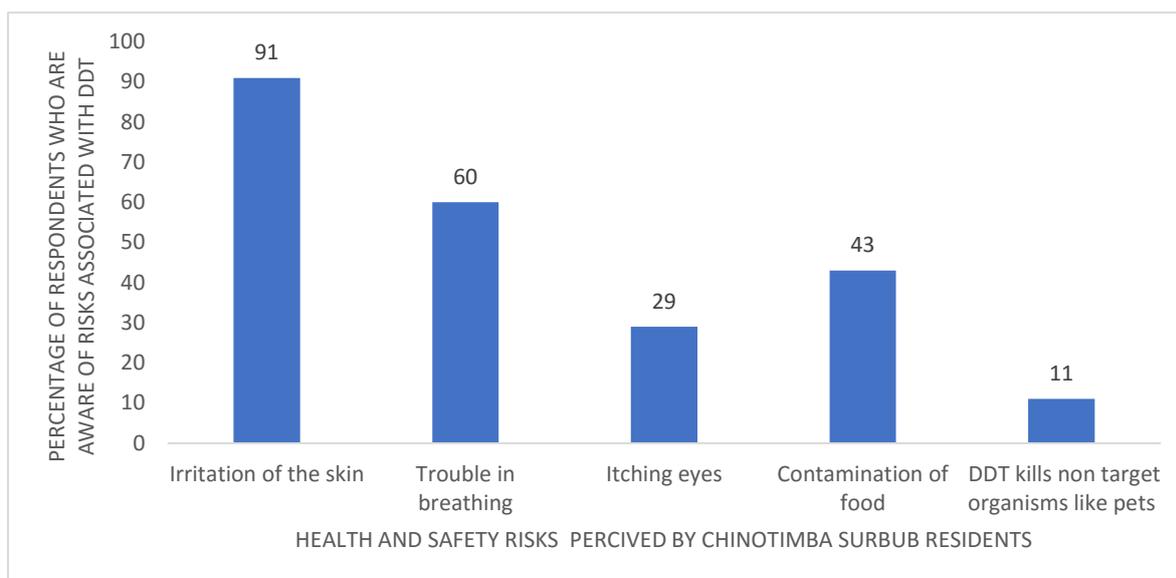


Figure 4.1 Health and safety risks associated with exposure to DDT

The major reason why Chinotimba suburb residents may take inadequate health and safety precautions when using DDT for Indoor Residual Spraying (IRS) for malaria control could be because lack of education on the health and safety risks associated with exposure to DDT. Out of the 89 housing units which constituted this study, findings reveal that 61.8% are not educated on health and safety risks associated with exposure to DDT. Therefore, lack of education had been a major blow on the safety of DDT for Indoor Residual Spraying. This is so because it has been generally noted that people take inadequate health and safety precautions because they lack knowledge of what will happen and who will be at risk. Table 4.5 illustrates responses that were obtain from Chinotimba suburb respondents on whether there are taught on health and safety risks associated with exposure to DDT or not.

Table 4.5 Education on Health and Safety risks associated with exposure to DDT

	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	34	38.2	38.2	38.2
Valid No	55	61.8	61.8	100.0
Total	89	100.0	100.0	

Findings of the fieldwork revealed that 61.8% of the targeted housing units claimed that there are not taught on health and safety risks associated with exposure with DDT for Indoor Residual Spraying (Table 4.5). Of the 38.2% who alluded that there are taught on health and safety risks associated with exposure to DDT. 44.1% acknowledged that the education was

done on a seldom basis whilst 50% of the respondents acknowledged that the education was done on an annual basis (table 4.6). Those who alluded that education was done on an annual basis acknowledged that the education was imparted to them during the malaria spraying season. Victoria Falls Municipality VFM, Evangelical Lutheran Church in Zimbabwe ELCZ as well as the Ministry of Health and Child Care MOHCC are the organisations which were alleged to impart education to Chinotimba residents. It was also alleged that Victoria Falls Municipality is the main educator amongst the three organisations because the area under study is under the jurisdiction of VFM. In light of this it can be noted that Chinotimba residents are only educated in times of emergency. This ultimately defeats the purpose of education as some people might miss the education as it is done during the spraying season only

Interviews conducted at VFM Public Health Offices yielded contradicting information as that obtained from Chinotimba Suburb residents questionnaires. In an interview with the EHO the researcher noted the following; the schedule of the Public Health Section accommodates Health Education and Training in each quarter of the year. Again it was noted that the education on health and safety precautions and risks associated with DDT is imparted to Victoria Falls town residents annually through awareness campaigns, newsletters as well as during indoor residual spraying. In addition to that, the researcher also noted that VFM Public Health Section embarks on malaria education and training before, during and after spraying of DDT. However, having noted all these positive efforts by the local authority to teach the locals about DDT, on a more negative note the EHO alluded attendance of Chinotimba residents to awareness campaigns is dismally poor. This possibly explains why 61.8% of the housing units targeted alluded that there are not taught on health and safety risks associated with exposure to DDT (Table 4.5).

Table 4.6 Frequency of Education on Health and safety risks associated with DDT

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Biannual	2	2.2	5.9	5.9
Annual	17	19.1	50.0	55.9
Rarely	15	16.9	44.1	100.0
Total	34	38.2	100.0	
Missing System	55	61.8		
Total	89	100.0		

In light of this one may easily agree with 89.9% of the respondents who alluded that education on health and safety risks associated with exposure to DDT is necessary. As shown on Table 4.7, 89.9% of the respondents acknowledged that education on health and safety risks associated with exposure to DDT is a necessity while 10.1% alleged that it was not necessary to be taught on health and safety risks associated with exposure to the insecticide. They claim that even if there are taught on health and safety risks associated with the use of DDT for IRS, they cannot adequately shield themselves from exposure to DDT as they will be exposed to DDT residues on interior walls of their dwellings.

Table 4.7 Necessity of education on health and safety risks associated with exposure to DDT

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Yes	80	89.9	89.9	89.9
No	9	10.1	10.1	100.0
Total	89	100.0	100.0	

Out of those 89.9% who alluded that it was necessary to be taught on health and safety risks associated with exposure to DDT (Table 4.7), 60% acknowledged that it's necessary so as to take sufficient health and safety precautions during IRS. 50% acknowledged that so as to know the implications of the IRS programme. 65% alluded that so as to prevent exposure and 45% suggested that it's a necessity to be taught on health and safety risks associated with DDT so as to know the possible side effects of the chemical (Figure 4.2).

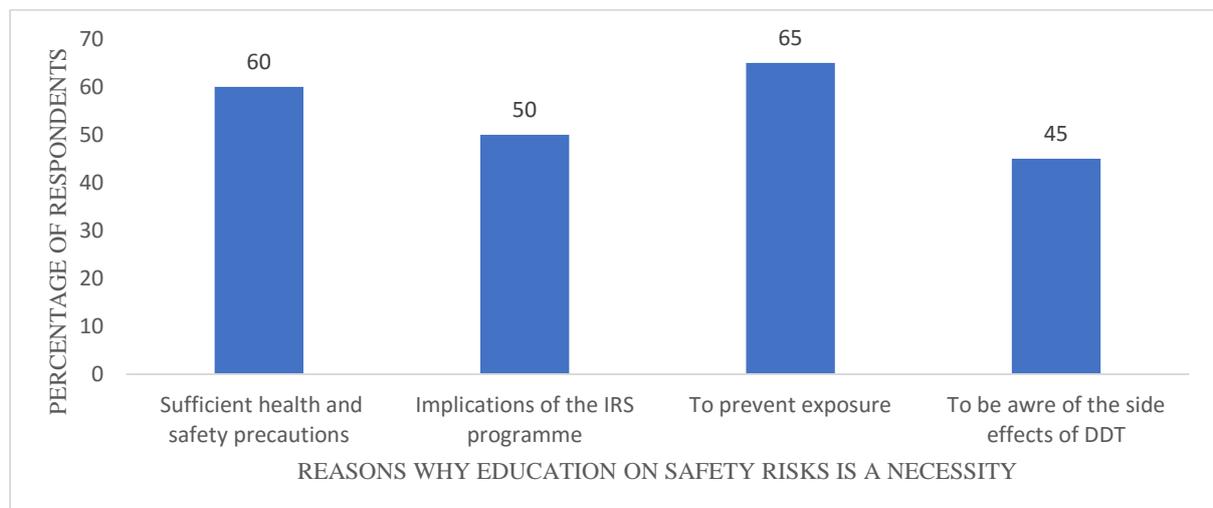


Fig 4.2 Necessity of education on health and safety precautions to observe during IRS

4.3 Safety and health precautions taken at household level

In an interview with the Environmental Health Officer (EHO), it was noted that Chinotimba suburb residents take inadequate health and safety precautions during indoor residual spraying. The EHO highlighted that Chinotimba suburb residents are less willing to take their belongings out of the house during spraying. However, this information contradicts information obtained questionnaires. Chinotimba suburb residents claim that they take clothes, toys and food out of the house during Indoor Residual Spraying. Of the 89 targeted housing units 94.4% claimed that there are observant of health and safety precautions (Table 4.8). This figure somehow tallies with 79% who alluded that there are taught on health and safety precautions to note during Indoor Residual Spraying with DDT (Table 4.9).

Table 4.8 Household's Observance of safety and health precautions during IRS

	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	84	94.4	94.4	94.4
Valid No	5	5.6	5.6	100.0
Total	89	100.0	100.0	

To enhance information obtained from an interview with EHO. Information obtained in an interview with Victoria Falls Municipality EHT again contradicts information obtained from Chinotimba suburb residents. In an interview with the Environmental Health Technician (EHT) it was noted that Chinotimba suburb residents take inadequate health and safety precautions during Indoor Residual Spraying. The EHT highlighted that Chinotimba suburb residents do not prepare in advance of Indoor Residual Spraying regardless of warning campaigns done by the local authority. Interestingly the Environmental Health Technician alluded that Chinotimba suburb residents are taught on IRS health and safety precautions each and every spraying season. This somehow agrees with information obtained from Chinotimba residents as shown on table 4.9 whereby 88.8 % of the respondents alluded that they are taught on health and safety precautions to observe during Indoor Residual Spraying. It was noted that the education is imparted to Chinotimba suburb residents through ward health workers, awareness campaigns as well as by spray operators during indoor residual spraying. The EHT added that the community is educated each and every spraying season.

Table 4.9 Are you taught on safety and health precautions

	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	79	88.8	88.8	88.8
Valid No	10	11.2	11.2	100.0
Total	89	100.0	100.0	

As shown on Table 4.10, of the 88.8% respondents who alluded that they are educated on health and safety precautions to observe during the indoor residual spraying, 65.2% claim that the education is imparted to them on an annual basis. This is in consensus with information obtained from Victoria Falls Municipality EHO and EHT who both highlighted that the education is done on during the spraying season hence on an annual basis. One of the reasons which could be driving Chinotimba resident to take inadequate health and safety precautions during indoor residual spraying could be lack of adequate education on health and safety precautions to observe during indoor residual spraying with DDT. This is evidenced by findings of the research which are illustrated on Table 4.10 where by 73.4% of alluded that education on health and safety precautions is done on annual basis. In light of this there is need to intensify education on health and safety precautions when using DDT for IRS. Frequency of education on health and safety precautions means that people will always aware of what they are expected to do hence minimising exposure. Again there is need for the local authority to engage relevant community based groups in educating the community on IRS health and safety precautions.

Table 4.10 Frequency of education on safety precautions.

	Frequency	Percent	Valid Percent	Cumulative Percent
Biannual	7	7.9	8.9	8.9
Annual	58	65.2	73.4	82.3
Valid Rarely	14	15.7	17.7	100.0
Total	79	88.8	100.0	
Missing System	10	11.2		
Total	89	100.0		

Again a significant 15.7% alluded that there are educated on a rare basis. There is need to intensify education on health and safety precautions to be observe during indoor residual spraying if ever the message is to be driven home.

Pertaining to usefulness of education on safety and health precautions to observe during spraying with DDT, Findings of this research revealed that majority of the respondents agreed that it was necessary to be taught on health and safety precautions to observe during indoor residual spraying. As shown on table 4.11, of the 89 respondents who participated in the research 94.4% alluded that education on safety and health precautions is a necessity. Furthermore respondents went on to give reasons why education on health and safety precautions is necessary during indoor residual spraying. In light of this, one may easily ascertain that to ensure safe use of DDT for Indoor Residual Spraying there is need to intensify education on IRS health and safety precautions.

Table 4.11 Necessity of education on safety and health precautions

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Yes	84	94.4	94.4	94.4
No	5	5.6	5.6	100.0
Total	89	100.0	100.0	

This is in accord with information obtained from interviews with Victoria Falls Municipality EHT and EHO, they both highlighted education on health and safety precautions when using DDT for IRS is a necessity. They contend that education on safety precautions is a tool used against human exposure to DDT, environmental pollution as well as to enhance the safety of DDT for Indoor Residual Spraying. For easy of analyses and presentation the researcher categorised reasons why Chinotimba Residents agreed that education on health and safety precautions is a necessity. This was done because the responses were obtained from open ended questions.

Reasons to support the necessity of education on health and safety precautions to observe during indoor residual spraying were categorised as follows, to minimise exposure, minimise environmental pollution, avoid contamination of food as well as enhance safety (Figure 4.3).

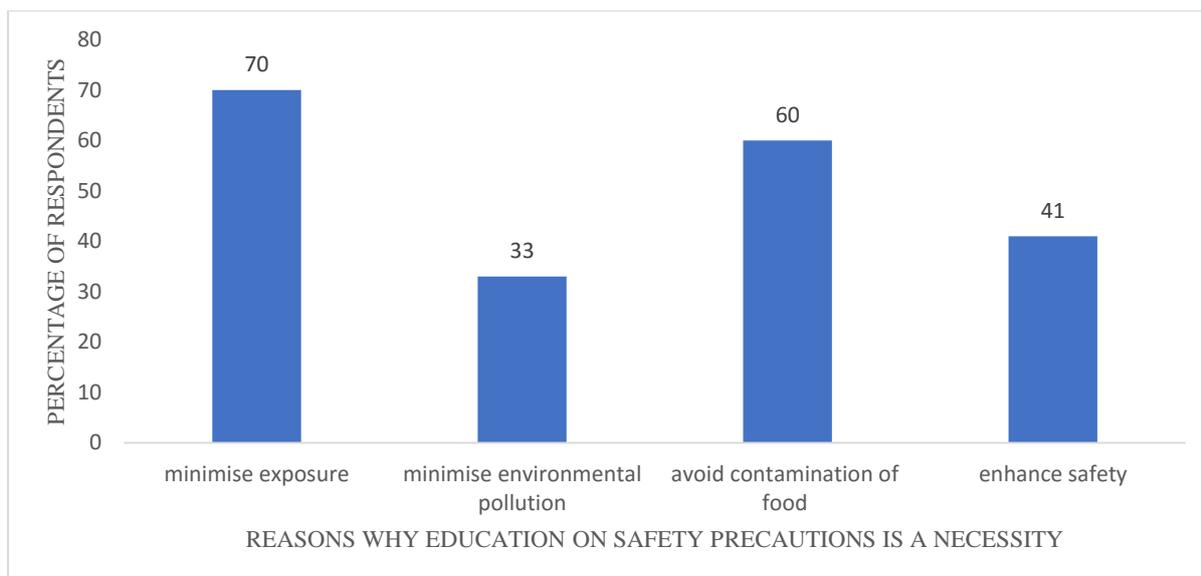


Fig 4.3 Reasons why education on DDT is necessary.

Table 4.12 Chi-Square Test for association between resident’s level of education and usefulness of education on health and safety precautions.

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.667 ^a	3	.644
Likelihood Ratio	2.806	3	.423
Linear-by-Linear Association	.758	1	.384
N of Valid Cases	89		

5 cells (62.5%) have expected count less than 5. The minimum expected count is .11.

However, Chi-Square results show that there is no association between the resident’s level of education and usefulness of health and safety precautions to observe during IRS as shown on Table 4.12 (P = 0.644) Chi-square value. This therefore means that when the local authority is targeting people for awareness campaigns it should not base on the level of education of the audience that they perceive health and safety precautions as useful. In this regard, the local Authority must target each and every resident of Victoria Falls town when educating about safety precautions when using DDT for IRS. This is so because policy makers and local authorities usually target the less educated with the assumption that the educated ones are aware of what is happening around them.

4.4 Challenges associated with the use of DDT for Indoor Residual Spraying

Several challenges were identified to be associated with the use of DDT for Indoor Residual Spraying. Majority of questionnaire respondents 85.4% complained that the chemical (DDT) does not kill the mosquitoes any more (Figure 4.3). Instead they contend that mosquitoes increase after spraying. Information obtained from the interviews pertaining to challenges associated with the use of DDT for indoor residual spraying tally with information obtained from questionnaires. In an interview with the Environment Health Officer, he noted that vector resistance was a major challenge as the Public Health Section could receive complains about mosquito prevalence even after spraying.

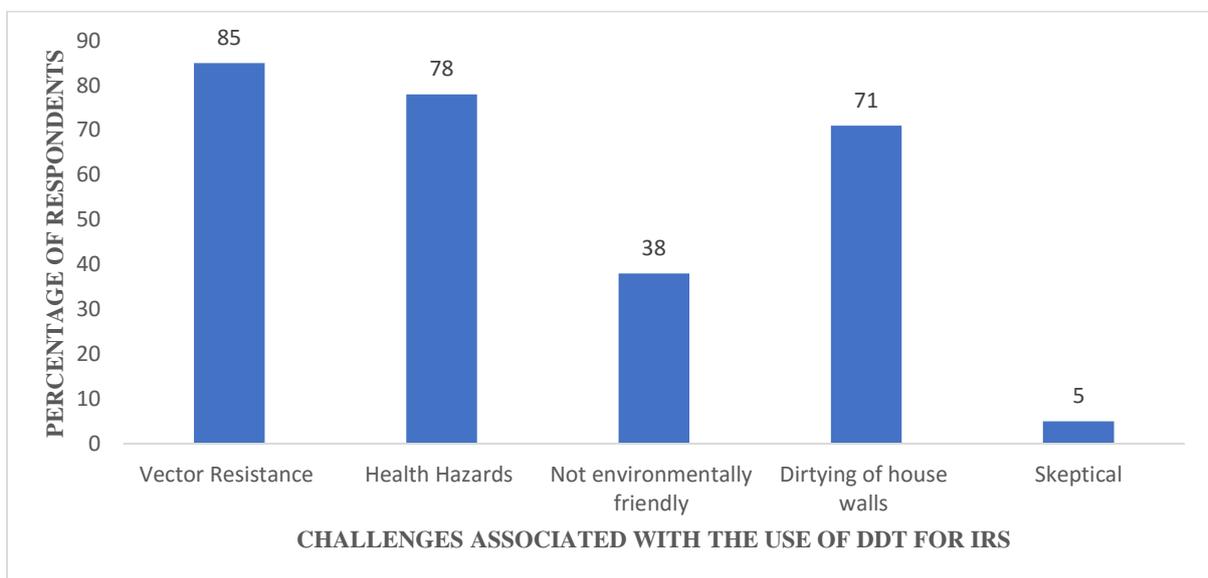


Fig 4.4 *Chinotimba Residents views on Challenges associated with the use of DDT for Indoor Residual Spraying.*

It can also be noted that a significant number of respondents complained that DDT leaves dirty residues on the walls of their houses. 71% respondents claimed that DDT soils their walls (Table 4.3). They revealed that DDT residues on the walls can be a potential long-term source of DDT exposure hence in light of this they questioned the safety of DDT for IRS. 38% of the targeted housing units alluded that DDT is not environmentally friendly (Figure 4.4). In this regard they claim that DDT kills non target organisms including pets and fish. Again, Figure 4.4 shows that an insignificant 5% of the targeted housing units are sceptical of the safety of DDT for IRS. Thus they refuse to get their house sprayed because the chemical is known to have been banned over the past. The Environment Health Officer also

highlighted that there are a lot of complains from householder that the chemical soils their beautiful walls. 78% of the respondents alluded that DDT was associated with health hazards (Figure 4.4). These include itching of skin, eye irritation as well as difficulties in breathing

The issue of mosquitoes being resistant to DDT has been a topical challenge associated with the application of DDT for IRS. Literature also agrees with the position that vector resistance has become a public health concern in as far as malaria control is concerned. Roberts et al (2000) claims that the reason why DDT did not manage to eradicate malaria is that the mosquitoes had developed resistance to the traits.

4.4.1 Mitigating measures on challenges associated with DDT.

4.4.1.1. At household level.

As highlighted on table 4.3 Chinotimba residents identified several challenges to be associated with the use of DDT for Indoor Residual Spraying. A significant 85% Of the respondents acknowledged that DDT does not Kill mosquitoes anymore. 78% of the respondents acknowledged that the chemical is associated with several health effects including etching of the eyes, difficulties in breathing to mention but a few. Majority 80% of the respondents are of the view that they should use alternative insecticides like target, doom, killem, bygone to mention a few. 76% of the targeted housing units noted that it is also necessary to use locally available resources as mosquito repellents. An insignificant 5% of the sample population alluded that burning elephant dung can help repel mosquitoes.

4.4.1.2. By the local authority.

Chinotimba residents are of the view that the local authority should discontinue its use of DDT for indoor residual spraying. This is in consensus with information obtained from a semi structured interview held the EHO. The EHO alluded that the use of DDT should be discontinued in light of the known and perceived challenges associated with the use of DDT for Indoor Residual Spraying. It was noted that the residual effect of DDT was the main reason why DDT is still being used in Victoria Falls town. DDT is the chemical approved by the Ministry of Health And Childcare for Indoor Residual Spraying. Again it was also noted that in order to mitigate the perceived impacts on human health and the environment. The Public Health Section engages ward health monitors in monitoring the IRS programme to ensure that safety is enhanced. In addition to that it was also noted that educational

campaigns are also done on the safety of DDT for IRS. These campaigns are done during the spraying season.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The safety of DDT for Indoor Residual Spraying and other public health vector control activities has remained a topical issue since the release of Rachel Carson book '*Silent Spring*' in 1962. The safety of DDT for vector control activities remains an issue of concern especially in malaria endemic regions in the developing world. Findings of this research revealed that majority of the respondents 61% are not aware of the health and safety risks associated with exposure to DDT. Again findings of the research revealed that 61.8% of the targeted population are not taught on health and safety risks associated with exposure to DDT while 38.2% agreed that there are taught on safety and health risks associated with DDT. Interviews held with VFM Environment Health Officer revealed that Chinotimba suburb residents are less willing to attend educational campaigns on the safety of DDT. In light of this majority of Chinotimba suburb residents do not perceive safety precautions as a necessity because there are not aware of the Hazards that DDT poses to them and their environment.

Chinotimba suburb residents claimed that there are observant of health and safety precautions during Indoor Residual Spraying. However information obtained from revealed that Chinotimba suburb residents take inadequate health and safety precautions during indoor residual spraying. This shows that there is lack of coordination between the local authority and chinotimba residents. This highlights the need to engage ward councillors in educating and monitoring the safe use of DDT. In addition to that education on health and safety risks and precautions to note during spraying is done on an annual basis during the spraying season. In light of this, it can be noted that intensity in educational campaigns on the safety of DDT of Indoor Residual Spraying may increase the coordination between the local authority and Chinotimba suburb householders. In addition to that the research also revealed that there are several challenges associated with the use of DDT for Indoor Residual Spraying. Challenges associated with DDT for indoor residual were identified to be vector resistance, health hazards, not environmentally friendly, dirtying of interior walls of houses and that other people question the safety of DDT for IRS hence sceptical about the safety of DDT because the chemical was once banned.

To sum up the account the researcher realised that there is need for the local authority together with local NGOs to intensify education on DDT for indoor residual spraying as

results reveal that this is only done during the spraying season. There is need for educational campaigns to be done on an annual basis.

5.2 Recommendations.

- The government of Zimbabwe should create a comprehensive policy pertaining to the use of DDT for indoor residual spraying in light of the known health and safety hazards associated with the insecticide.
- The local Authority together with local NGOs including Ward Health Workers should assist residents to establish more community health communities and monitoring team that will be involved in monitoring the use of DDT in their localities. This will be done to enhance the safety of DDT for Indoor Residual Spraying.
- There is need for Victoria Falls Municipality public health section to monitor the application of DDT for indoor residual spraying because most of the respondents complained that the chemical soils the interior of their house walls.
- VFM, MOHCC and other stakeholders should intensify education on the safety of DDT for Indoor Residual Spraying. This is so because respondents complained that education was only imparted to them on an annual basis and only during the spraying season.
- Chinotimba Suburb residents must attend awareness campaigns on the use of DDT for indoor residual spraying so that they get to know of the potential hazards as well as health and safety precautions to observe when using DDT.

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APPENDICES

Appendices 3.1 Questionnaire for Chinotimba suburb Residents.

Dear Respondent

My name is **MACHINO NGONIDZASHE**, a final year B.Sc. Geography and Environmental Studies Honours Degree student at Midlands State University. This questionnaire is part of the research that assesses “Community’s perceptions on the adequacy of health and safety precautions taken when using DDT for Indoor Residual Spraying (IRS) for malaria control”. Your response to this study will be kept confidential and your contribution will be used for academic purposes only. No name or any form of identification is required on this form.

(Please tick where applicable or write response in space provided)

Do you wish to participate in this research? Yes No

SECTION A: General Information

1. Gender

Male	Female

2. Marital Status

Single	Married	Divorced	Widowed

3. Age in years.

≤20	21-30	31-40	41-50	51-59	≥60

4. Level of education

primary	secondary	tertiary	None

5. Period/years stayed in Chinotimba

≤5	6-10	11-15	16-20	≥21

SECTION B: Residents’ knowledge of health and safety risks associated with exposure to DDT.

6. What do you think are health and safety risks associated with exposure to DDT?

.....
.....
.....

7. a) Are you taught on health and safety risks associated with exposure to DDT?

Yes No

b) If yes list the organisations that offer the education.

.....
.....

c) How often is the training done?

Fortnightly	Monthly	Quarterly	Biannual	Annual	Rarely

d) Is it necessary to be educated about health and safety risks associated with exposure to DDT?

Yes No

e) Explain your response in question 7. d).

.....
.....

SECTION C: Safety and health precautions taken at household level.

8. a) Do you observe safety and health precautions during the IRS programme?

Yes No

b) If yes list the precautions taken.

.....
.....

9. a) Are you taught on safety and health precautions to observe during the IRS programme?

Yes No

b) If yes list the organisations that offer the education.

.....
.....

c) How often is the training done?

Fortnightly	Monthly	Quarterly	Biannual	Annual	Rarely

10. Usefulness of safety and health precautions taken.

Is it necessary to be taught about safety and health precautions to observe during the IRS programme?

Yes No

b) Explain your response.

.....
.....

SECTION D: Challenges associated with the use of DDT for Indoor Residual spraying.

11. What do you think are the challenges associated with the use of DDT for indoor Residual spraying?

.....
.....
.....

12. What do you think should be done to mitigate these challenges?

a) At household level.

.....
.....

b) By the local authority.

.....
.....

Thank you for your cooperation!!!!!!!!!!!!

Appendices 3.2 Semi-Structured Interview guide for the Environmental Health Officer

Objective 1. Assessment of knowledge on health and safety risks associated with exposure to DDT.

1. How long have you been in this office?
2. Why do you use DDT for IRS?
3. Are you aware of the safety and health hazards associated with exposure to DDT?
4. Are Chinotimba residents aware of the safety and health hazards associated with exposure to DDT?
5. Does your schedule accommodate awareness campaigns on the effects of DDT for IRS?
6. If no why
7. If yes how often are they conducted?

Objective 2. To establish Safety and health precautions taken.

8. As a section, what safety and healthy precautions do you observe when undertaking the IRS programme.
9. Does your schedule accommodate awareness campaigns on Safety and health precautions to be observed during spraying?
10. How often do you conduct the awareness campaigns?
11. Are Chinotimba residents observant of safety and health precautions during spraying?

Objective 2 Challenges associated with the use of DDT for Indoor Residual spraying

What challenges are associated with the use of DDT for IRS?

What do you think should be done to mitigate these challenges?

Is there an act or Legislation on the use of DDT for IRS?

Appendices 3.2 Semi-Structured Interview guide for the Environmental Health Technician.

Objective 1. Assessment of knowledge on health and safety risks associated with exposure to DDT.

1. How long have you been in this office?
2. Why do you use DDT for IRS?
3. Are you aware of the safety and health hazards associated with exposure to DDT?
4. Do you teach residents on safety and health hazards associated with exposure to DDT?
5. How often are residents taught on safety and health hazards associated with exposure to DDT?
6. a) Are Chinotimba residents willing to attend awareness campaigns on safety and health hazards associated with exposure to DDT?
 - b) If no what could be done to ensure that they attend?
 - c) If yes are chinotimba residents observant of the risks associated with DDT

Objective 2. To establish Safety and health precautions taken.

7. a) As a Department what safety and health precautions do you observe when undertaking the IRS programme?
 - b) What safety and health precautions are taken by households?
8. Do spray operators inform residents Safety and health precautions to be observed during spraying?
9. Do you educate Chinotimba community on Safety and health precautions to be observed during spraying?
10. How often do you educate them?
11. Are Chinotimba residents observant of safety and health precautions during spraying?
12. Are the safety precautions measures assisting to reduce exposure?

Objective 2 Challenges associated with the use of DDT for Indoor Residual spraying

13. What do community/households say in terms of effects of IRS?
14. What challenges are associated with the use of DDT for IRS?
15. What do you think should be done to mitigate these challenges?
16. Is there an act or Legislation on the use of DDT for IRS?