

**EVALUATION OF INDOOR RESIDUAL HOUSEHOLD SPRAYING:
CHALLENGES FACED BY NDOLA URBAN DISTRICT.**

BY

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BSc. Nursing, RN**

*Thesis
M.M.
2009
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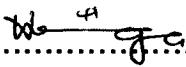
**A Dissertation submitted to the University of Zambia in the
partial fulfillment of the requirements for the Degree of Master
of Public Health.**

**UNIVERSITY OF ZAMBIA
LUSAKA**

2009

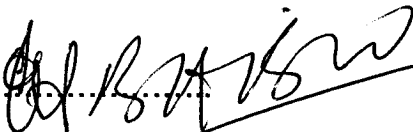
DECLARATION

I declare that this dissertation represents my own work and that all the sources I have quoted have been indicated and acknowledged by means of complete references. I further declare that this dissertation has not previously been submitted for a Degree, Diploma or other qualifications at this or another University. It has been prepared in accordance with the guidelines for Master of Public Health Dissertations of the University of Zambia.

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ABSTRACT

The study aimed at determining challenges associated with implementation of IRHS in Ndola urban district, Zambia. A cross sectional study was conducted at Ndola city council and public health offices along Broadway. All the 122 service providers were purposively selected into the study. This included 8 program officers and 114 spray operators. Data was collected using two separate semi-structured interview schedules and a checklist for program officers. The study sought to answer research questions on; policy challenges, operational challenges, institutional challenges and how these challenges can be addressed. The study was analyzed using SPSS version 11.5, Epi-info version 6 and content analysis, then Univariate and bivariate analysis. Chi-square was used to determine the association of the qualitative variables and the outcome (IRS challenges). The qualitative variables include adherence to policy guidelines, availability of IRS logistics and acceptability of IRS.

Policy challenges; the study revealed varied levels of compliance across different components of policy guidelines on DDT. The highest level of compliance $n=7$ was with storage and disposal guidelines, while $n=4$ did not comply with use and environmental safeguards. Program officers said that Spray operators used to spill DDT on the ground.

Operational challenges; the most significant factors found to be associated with implementation of IRS were availability of logistics, level of training, and acceptability of IRS. A significant association was found between availability of respirators and experienced problem, majority 81.3% of the respondents who said respirators were available experienced no problems while spraying compared to those who said they were not available. 71.4% experienced itching or rash, steezing and difficulties in breathing, p value 0.005. Training was associated with operational problems. 66% of Spray operators who had good training acquired more skill and had less problems in implementing IRS than 12 who had poor training and acquired less skills, p value 0.017. Acceptability of IRS in the community was between average and low because of refusals mainly due to bad smell, itching effect and dirtying walls, 75.2%, while 24.7%, said lack of Information, not effective and does not kill insects p value 0.036. Majority 73.7% of the respondents said acceptability of IRS in the community was average. The study found that out of 8 program officers interviewed, $n=7$ said that residents in the townships refused IRS. About 28.1% of the Spray operators revealed that Repainting of walls was

very much an operational problem. Concerning service delivery, 44.7% of the respondents said that spraying was not done at the same time every year, and majority 68.4% said reasons for variation were due to late arrival of funds and logistics. 57% of the Spray operators experienced itching with regard to use of IRS chemicals. About 64% of the spray operators revealed that household members were less likely to be found in their homes for IRS in the rain season.

Institutional challenges; 43.9% of the respondents said that shower and wash bay facilities were inadequate. Also more than half n=5 of the program officers said that storage facilities were inadequate and said it affected their operations much n=4. Verification using a checklist revealed Serious inadequacies evident in poor transport, disposal bay, preparation bay, wash bay, and change rooms , while shower clog were not sufficient, leading to some of the policy, operational and institutional problems experienced by service providers.

Poor institutional structure, poor IEC on IRS, non availability and insufficient logistics greatly impinged on daily operations of service providers in IRS and highly contributed to non adherence to some of the policy guidelines on DDT. Therefore refurbishment of storage facilities, regular supply of IRS commodities, community involvement, adequate community sensitization and proper planning and timing are cardinal to success of IRS not only in Ndola urban district but in all IRS districts.

DEDICATION

To God almighty, for his divine wisdom and guidance throughout my dissertation.

To my husband Victor, and Choolwe my son who endured my absence from home, encouraged and supported me throughout my study.

To my daughter Chipecto Nachooka Hatontola who has been a source of inspiration to work hard as she endured all the hardship with me while in school.

To my mother, father, brothers and sister for their support and prayers.

ACKNOWLEDGEMENTS

My sincere and utmost gratitude to the following for their contribution and support towards this Dissertation:

- My supervisor Professor K.S Baboo who critiqued the study, read numerous revisions, helped me make some sense of the confusion and for his untiring guidance, corrections and contributions.
- Mr. Bowa my co-supervisor for his guidance and support.
- Professor S. Siziya who provided statistical guidance and other Faculty members in the Department of Community Medicine for their contributions.
- Mr. Mwanza lecturer dept of social sciences UNZA for guidance and statistical analysis of data.
- Ministry of science and technology for awarding me the financial support for this project.
- Ministry of Health for enabling me to undertake the studies for Master of public health at the University of Zambia.
- My family who endured this long process with me, always offering support and love.
- Ndola district health management team, Ndola district council and the IRS team who supported me to carry out this study.

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LIST OF ABBREVIATIONS

SPSS	- Social science statistical package
NMCC	- National malaria control centre
MOH	- Ministry of health
CSO	- Central statistical office
DHMT	- District Health Management Team
RBM	- Roll Back Malaria
WHO	- World Health Organization
IRS	- Indoor Residual spraying
IRHS	- Indoor residual household spraying
HMIS	- Health Management Information System
UNICEF	- United Nations Children's Fund
GDP	- Gross domestic product
DDT	- Dichlorodiphenyltrichloroethane
PTS	- Pesticide toxic substance
SI	- Statutory Instrument
ECZ	- Environmental council of Zambia
POPs	- Persistent Organic Pollutants
PCBs	- Polychlorinated biphenyls
CBOH	- Central board of health

CHAPTER ONE: INTRODUCTION

1.1 BACKGROUND INFORMATION

The burden of malaria is unacceptably high globally. Today malaria remains a major cause of poverty and underdevelopment, and it is estimated that 3.2 billion people live at continuous risk of this disease. Each year, there are more than 350 million cases of malaria and more than a million deaths from the disease. More than two-thirds of malaria cases occur in Africa, as well as approximately 90% of deaths, which are mainly in children under five years of age (WHO 2006) and part of the answer rests with IRHS.

Its importance as a public health problem is reflected by the staggering toll malaria extracts in illness and suffering. In general, malaria epidemiology has the characteristics of a stable, endemic infectious disease. Consequently, at a macro-epidemiologic level, malaria is not as much an emerging disease as it is an established, intractable public health plague for fully one-third of the earth's population (Olliaro, 1996; WHO, 1994).

WHO defines IRHS as the application of liquid insecticide with long-lasting residue properties which dries to form a crystalline deposit on the sprayed surface; the mosquitoes that come into contact with the surfaces absorb a lethal dose of the insecticide. Reducing the lifespan / longevity of the adult anopheles mosquito and reducing the density of adult anopheles mosquitoes (NMCC 2005) IRS can kill a mosquito any time it enters a house for a blood meal, which it typically does every 2-3 days, so that few will survive the approximately 12 days that are required for malaria parasites to complete part of their life cycle in the vector mosquito, if all the houses they visit are properly sprayed.

The efforts of the Malaria Eradication Programme (1955–1969) were based on IRS against the vector mosquitoes, as endorsed by the WHO Kampala Conference of 1950. These efforts, combined with other measures, led to

malaria eradication from Europe, the former USSR, and several countries in Asia and the Caribbean. About 700 million people, or more than half of the previously exposed populations, were no longer at risk (Bruce-chatt 1985). Indoor residual spraying (IRS) is a major means of malaria vector control to reduce and eliminate malaria transmission including, where indicated, the use of DDT. IRS is a method for community protection, and given its mode of action, the highest possible level of coverage is required to achieve the maximum impact on malaria transmission. Achieving this level of coverage and timing spraying correctly (in a short period of time before the onset of the transmission season) are crucial to realize the full potential of IRS (WHO 2006). The basic premise that appropriate IRS management will result in demonstrable gains in community survival depends critically upon whether spraying is done and effectively.

In the last 20 years Africa has witnessed a shift in strategic emphasis away from the unattainable eradication of malaria towards the reduction and effective management of disease outcome (Dobson 1999). Roll back malaria (RBM) was launched in 1998 and was built on the technical elements of the global strategy for malaria control (WHO 2000). Central to renewed efforts to Roll-Back Malaria (RBM) is the reduction of mortality through use of Indoor residual spraying (WHO 2000a). Scientific evidence of IRS efficacy in reducing or interrupting malaria transmission in different epidemiological settings has been available since the 1940s and 1950s (De Mellion 1936; Russell 1955). The first house spraying campaigns, just after World War II showed the capacity of this intervention to produce profound reduction in malaria transmission due to reduction in malaria vector longevity (Hanson K et al 2004). Numerous studies have shown that IRS has substantially reduced infant and child mortality. This evidence formed the rationale for introduction of IRS as a primary intervention for malaria control and eradication. Despite its initial widespread use and contribution to the success of malaria eradication and control efforts, in recent years, the use of IRS has declined. This is due in part to lack of government

commitment and financing to sustain these efforts over the long term and to concerns about insecticide resistance and community acceptance (WHO 2006). However, another important factor has been general disapproval of DDT use, due to fears of its harmful effects on the environment and on human health, fears which are unjustified when DDT is used appropriately for IRS (Govere 2004).

While this seems to be an apparently simple strategy, the majority of the African continent has a number of distinguishing features which make this approach complex. Hence the need to explore the problems associated with IRS.

Historical background of malaria in Zambia echoes back way beyond 1970 during the Rhodesian era when integrated vector control and Indoor residual spraying with DDT was carried out on regular basis along with law enforcement (1944 the mosquito extermination Act). All hospitals, health centre and institutions diagnosed all fever cases confirmed with microscopy and all positive cases were successfully treated on regular basis with chloroquine. Malaria currently accounts for nearly four million clinically diagnosed cases per year, 36% of hospitalisations and outpatient department visits, and about 20% of maternal mortality (NMCC strategic plan 2006- 2011). To address the disease burden of malaria, indoor residual household spraying (IRHS) is one of the primary malaria prevention strategies in Zambia and is carried out in 15 districts targeting urban and peri-urban areas in 2007. These include Kazungula, Livingstone and Mazabuka in southern province; Solwezi in north western province; Chongwe, Kafue and Lusaka in Lusaka province; Chingola, Kalulushi, Chililabombwe, Kitwe, Luanshya, Mufulira, and Ndola in copperbelt province; Kabwe in central province. It has expanded from two districts in 2000, to five districts in 2003, then to fifteen (15) districts in 2006/2007 and now to thirty-six districts in 2008/2009. The main objective of IRS work area for 2007 was to increase coverage among eligible populations from 75% to 85% by 2008 (approximately 700,000 households in 15 districts) and to be maintained to 100% by 2011. Planned activities among others included prioritizing adherence

to environmental monitoring and safeguards, strengthening logistics and availability of transport, storage facilities to conform to environmental council of Zambia (ECZ), MOH and WHO standards. Conduct impact studies and developing resistance management strategies, reinforcement of community participation and awareness through IEC/BCC/advocacy group incorporation (MOH 2007 action plan). The rapid scale-up of IRS coverage from 75% to 85% in 2008 and to be maintained to 100% in 2011 can only prove successful if communities accept IRS. Therefore communication is an integral part in ensuring that communities understand the benefits of IRS intervention so that the desired impact can be achieved. The IRS coverage can be greatly achieved through increased IEC on IRS in the community to win their co-operation during spray programs so that percentage of refusals goes down. In practice, the effectiveness of IRS depends on adherence to application procedure, efficacy of the insecticide, public acceptance of spraying, and availability of well-maintained equipment, adequately trained spraying personnel, efficient supervision and strong financial support. The size of the operational area depends on local circumstances and is influenced by the distribution of malaria and malaria vectors, the distance from important breeding sites, the flight range of the vectors and demographic features (WHO 2006). However there are challenges that are inhibiting the country from meeting this target.

1.2 STATEMENT OF THE PROBLEM

In Zambia malaria is still the number one cause of morbidity and mortality among the top 10 killer diseases, with an incidence of 412/ 1000 (MOH, HMIS 2006). It accounts for 45% of all out patient attendances and 50% of admission cases among children under-five years of age (MOH, HMIS 2004). It also contributes to about 20% of maternal mortality and 40% of infant and under-five child mortality (NMCC 2005). To reduce the disease burden integrated vector management has been introduced, of which IRHS is one of the interventions. Studies have shown that IRHS with DDT reduced annual malaria prevalence from 74% to less than 1% in 1979 over a 2year period in Konkola copper mine in

Zambia (Tren & Bate 2004). In copperbelt province 180 villages were sprayed with insecticide in 1979 and parasite rate ranged from 2.4% to 6.2% mainly due to good control measures which were being practiced by the mining health authorities (NMCC 1999). IRS was restricted in early 1980s due to allegations of adverse effects of DDT on the environment and human health and later introduced by Konkola copper mines in 2000.

In 2000 -2002 the incidence of malaria in Ndola ranged between 354 in 2000 and 484/ 1000 in 2002. Ndola has shown some reduction in the malaria incidence since IRS was re-introduced in 2003 as shown below. The incidence was 482/ 1000 in 2003 and has further reduced to 434/ 1000 in 2006 and now 381/ 1000 in 2007 (Ndola DHMT, HMIS 2008). This is still high as it is above the national incidence of 358/ 1000. WHO estimates IRHS with insecticide coverage at 42% which is extremely low despite its effectiveness (Park 2007). The IRS objective in 2008 was to ensure that at least 85% of the targeted households in the 36 districts are protected by the end of 2008 in Zambia. Statistics shows that the national coverage of IRS have improved from 87% in 2006 to 93% in 2007 (MOH 2008 national malaria action plan), of which Ndola had 89% IRS coverage in 2006 and 90% in 2007 (Ndola RBM report 2007). Despite the high coverage there are problems that IRS is not functioning properly as the incidence of malaria is still high, hence the need to identify implementation challenges associated with IRHS in Ndola urban district. If effectively done IRS is supposed to reduce malaria incidence by 75%, reason being that it reduces vector longevity, vector density and human contact in sprayed dwellings.

According to IRS guidelines spray rounds should be done regularly at the same interval, however In Zambia, Ndola inclusive IRS programme is only done once a year in contrast to the duration of effective action of the chemicals used of up to 6 months for pyrethroids and up to 12 months for DDT. In view of this scenario there is need to explore implementation problems associated with this intervention. The other benefit of IRS is to contribute to the reduction of all

causes of mortality by 20% in children under-five; High coverage of IRHS activities could reverse malaria trend and provide better economic growth as was evidenced in the past and currently in the Konkola copper mines (Sipilanyambe and Nalishebo (2005). Also malaria control will improve the main health indicators and provide economic benefit at household and national level. However there are reported problems unsupported by empirical data that are inhibiting the country from meeting the set target of reducing malaria incidence by 75% and reducing deaths due to malaria by the end of 2010. This study has been undertaken solely to find out the claims made by the NMCC and district councils that IRHS if successfully implemented will relatively reduce the prevalence of malaria in all the districts where this campaign is being carried out, with an estimated coverage of 90 - 100% by 2011. If this is not true, then what are the challenges of IRHS campaign, what could be impeding this program?

1.2.1 RESEARCH QUESTIONS

1. What policy problems exist in the execution of IRHS?
2. What institutional problems are associated with implementation of IRHS?
3. What operational problems are associated with implementation of IRHS?
4. How can the problems be addressed?

1.3 JUSTIFICATION

IRHS has been chosen by the researcher among the other malaria intervention package (which include intermittent presumptive treatment (IPT), insecticide treated nets (ITN), prompt and effective case management) as it reduces vector longevity, vector density, and contact between the vector and human beings in sprayed dwellings thereby reducing morbidity and mortality associated with this disease burden. The investigator wishes to find out factors contributing to high incidence of malaria in Ndola despite high coverage of IRS. The investigation of implementation problems associated with IRHS from a public health evaluation perspective has great potential for improving service delivery and reducing morbidity and mortality rates for malaria. The study finding will be able to highlight program needs, provide strategic direction for future programs by

ensuring that best approaches are explored and used to refine the implementation process. Also the findings may be incorporated into policy process to ensure that interventions that are effective are implemented. At the same time this study will generate first hand data based on lived local experiences and this will strengthen planning and implementation of IRS. It is envisaged that from this project, policy makers like NMCC, service providers and the community at large will understand some of these problems, which must be explored, and solutions put in place to ensure that IRHS interventions are a success if malaria is to be reduced in Zambia.

1.4 LITERATURE REVIEW

1.4.1 INTRODUCTION

This chapter reviews the literature related to malaria and IRS. The literature review provides the reader with an overview of major academic works done by other scholars. This is not a comprehensive review of the available literature, and it is not a meta-analysis (a synthesis of research results using various statistical methods to retrieve, select, and combine results from previous studies). An electronic search on keywords published only in peer reviewed articles in data bases where the University of Zambia subscribes was performed to compile the main body of literature that has been reviewed. Major sources of data were from journal articles, and Particular note was taken of references that were frequently cited in bibliographies and appeared to be classics. Other sources included consultation from IRS programme experts and officers. In general, the literature review on malaria and IRS has been arranged according to themes like operational challenges. This thematisation serve as a convenient way of organizing the work in building answers to the research questions.

Since the author is trained in public health, the emphasis of this literature review takes an infection prevention orientation rooted in medicine. Nevertheless, examples outside these areas are provided to show that the analytic framework

offered can easily be applied to studies of malaria from a wide range of disciplines.

Literature review provides the researcher with the opportunity to determine how much pertinent material is available concerning the potential study and helps to put the problem in the context of what has already been done (Dempsey and Dempsey 2000).

1.4.2 DEFINITION OF KEY CONCEPTS

In academic writings, it is just prudent from the outset that key words, which form the building blocks of a subject matter, are identified and defined. There are benefits for doing this from the outset and in the literature section. Essentially it makes the reader appreciate concepts when they reappear later in the text. It makes things flow linearly so that intra textual definitions do not obstruct the reader. Further than this, it gives room for the writer to give a synthesis and if possible provide a unitary position on what could be the best meaning from a sea of definitions if at all they are there. Therefore, below are definitions of key concepts that have been used in this study.

1.4.2.1 Implementation is simply putting IRS strategies into action.

1.4.2.2 Challenges are simply difficulties or problems.

1.4.2.3 Indoor takes place inside the building.

1.4.2.4 Residual is small amount of insecticide that remains on the wall after spraying.

1.4.2.5 Household is a dwelling place.

1.4.2.6 Spraying consists of many drops of liquid insecticide applied on the wall.

1.4.2.8 Indoor residual household spraying is the procedure of applying liquid drops of insecticide which remain on the walls of the inside of the dwelling place for some time.

1.5 THE MAGNITUDE OF THE PROBLEM

Malaria continues to be a major cause of preventable death. The annual burden includes 350 to 500 million clinical cases, more than 1 million deaths, and

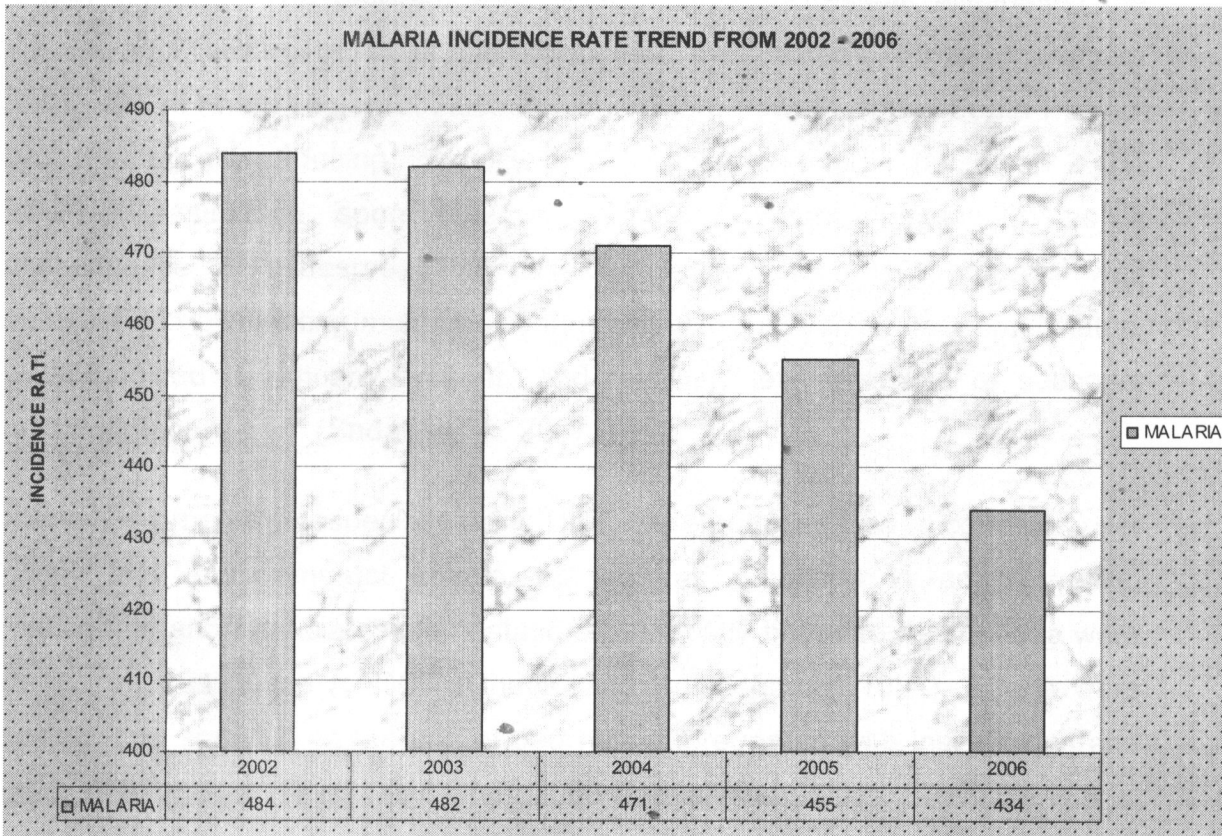
reduced economic growth (WHO & UNICEF 2005). Malaria is one of the biggest healthcare problems on the African continent. Sub-Saharan Africa accounted for 89% of the world total malaria deaths in 2005. An estimated 25 to 35% of all outpatient consultations and 20 to 45% of hospitalizations in this region are due to malaria (WHO & UNICEF 2005 in Marianela et al 2008). Malaria is not only a major health problem, but also has a significant economic impact on the socio-economic development of nations (Gallup & Sachs 2001; Sachs & Malaney 2002). More than 125 million people living in 26 African countries with unstable transmission are estimated to live in areas at risk of malaria epidemics (Worrall *et al.* 2004). Unstable malaria affects children and people in the productive age groups, resulting in substantial economic loss because of the compromised capacity and efficiency of the labour force. This contrasts with stable malaria, which has a lesser effect on the productive age group because of the development of adequate protective immunity (Kiszewski & Teklehaimanot 2004; Worrall *et al.* 2004).

Malaria is seasonal and unstable in Ethiopia (Tulu 1993; Abeku *et al.* 2003; Deressa *et al.* 2004; Adhanom *et al.* 2006 in Wakigari 2007)), causing frequent epidemics. Infections with *Plasmodium falciparum* (>60%) and *Plasmodium vivax* (about 40%) have been consistently reported in many parts of the country (Adhanom *et al.* 2006). In 2004 - 2005, malaria was reported to be the first cause of outpatient consultations (16.6%), admissions (15%) and deaths (29%) in Ethiopia (Ministry of Health 2004 - 2005 in Wakigari 2007). The peak transmission of malaria in the country coincides with the season of major agricultural activities from September to December, leading to substantial economic loss to the family as well as to the nation due to a significant withdrawal of labour force from farm work. The costs of malaria in terms of prevention, treatment and loss of productivity can comprise a significant portion of the annual income of poor agricultural; Malaney 2003).

In Zambia malaria is responsible for nearly 4.3 million clinical cases and an estimated 50,000 deaths per year, including up to 20% of maternal mortality.

Malaria’s economic impact in Zambia has not yet been quantified, but is likely substantial, with regional estimates suggesting a deficit of 1.5% GDP growth annually (NMCC strategic plan 2006 - 2011).

Malaria incidence rates in Zambia tripled over the last three decades, from 121/1000 in 1976 to 428/1000 in 2003, 412/ 1000 in 2006 and a remarkable reduction was achieved in 2007 and now is at 358/ 1000 (MOH HMIS 2007). Many factors have led to this increase, including the spread of drug resistance, reduced vector control, decreased access to health care, HIV, and poverty (NMCC strategic plan 2006- 2011). How ever the trend in the incidence of malaria in Ndola has shown some reduction since IRS was re-introduced in 2003 as shown below. The incidence was 482/ 1000 in 2003 and has further reduced to 434/ 1000 in 2006 and now 381/ 1000 in 2007. This is still high as it is above the national target of 358/ 1000.



Having looked at the magnitude of malaria, it is imperative that we should look at the history of IRS as an intervention in malaria control.

1.6 HISTORY OF IRHS

The first trial testing of residual spraying application of insecticides for malaria control in southern Africa was carried out in 1931 in Kwazulu Natal South Africa. By 1932 a wide spread residual house spraying programme using pyrethrum was undertaken (Musawenkosi et al 2004). DDT's insecticidal properties were discovered in 1939 by the Swiss scientist Paul Hermann Müller, (Nobel Prize.org 1948). DDT was used in the 1940s and 1950s especially during World War II by Allied troops in Europe and the Pacific as well as certain civilian populations to control the insect vectors for typhus and malaria. In 1955, the World Health Organization commenced a program to eradicate malaria worldwide, relying largely on DDT. The program was initially highly successful, eliminating the disease in "Taiwan, much of the Caribbean, the Balkans, parts of northern Africa, the northern region of Australia, and a large swath of the South Pacific" and dramatically reducing mortality in Sri Lanka and India (Gladwell 2001). However resistance soon emerged in many insect populations as a consequence of widespread agricultural use of DDT. The program was successful in eliminating malaria only in areas with "high socio-economic status, well-organized healthcare systems, and relatively less intensive or seasonal malaria transmission" (Sadasivaiah, 2007).

Spraying programs (especially using DDT) were curtailed due to concerns over safety and environmental effects, as well as problems in administrative, managerial and financial implementation, but mostly because mosquitoes were developing resistance to DDT (Chapin and Wasserstrom 1981). Efforts were shifted from spraying to the use of bed nets impregnated with insecticides and other interventions (Rogan and Chen 2005 Sadasivaiah 2007).

The Stockholm Convention, ratified in 2001 and effective as of 17 May 2004, outlawed several persistent organic pollutants, and restricted the use of DDT to vector control. The Convention was signed by 98 countries and was endorsed by most environmental groups. Recognizing that a total elimination of DDT use in many malaria-prone countries is currently unfeasible because there are few affordable or effective alternatives for controlling malaria, the public health use of DDT was exempted from the ban until such alternatives are developed (Wikipedia 2008).

Use of DDT in public health to control mosquitoes is primarily done inside buildings and through inclusion in household products and selective spraying; this greatly reduces environmental damage compared to the earlier widespread use of DDT in agriculture. It also reduces the risk of resistance to DDT. (Malaria Foundation International, 2008). Scientific evidence of IRS efficacy in reducing or interrupting malaria transmission in different epidemiological settings has been available since the 1940s and 1950s (De Mellion 1936; Russell 1955; Mac Donald 1957). IRS has substantially reduced infant and child mortality. This evidence formed the rationale for introduction of IRS as a primary intervention for malaria control and eradication. Despite its initial widespread use and contribution to the success of malaria eradication and control efforts, in recent years, the use of IRS had declined. This is due in part to lack of government commitment and financing to sustain these efforts over the long term and to concerns about insecticide resistance and community acceptance.

In Zambia studies have shown that IRS with DDT reduced annual malaria prevalence from 74% to less than 1% in 1979 over a 2 year period in Konkola copper mine in Zambia (Tren & Bate 2004). The study revealed that in Copperbelt province 180 villages were sprayed with insecticide in 1979 and parasite rate ranged from 2.4% to 6.2% mainly due to good control measures which were being practiced by the mining health authorities (NMCC 1999). IRS was restricted in early 1980s due to adverse effects of DDT on the environment and human health and later introduced by Konkola copper mines in 2000. The

government of Zambia re-introduced IRS in 2003 in five pilot districts of which Ndola was one of them. Then it was increased to 15 districts in 2006/2007 spray season and now to 36 districts in the 2008/ 2009 spray season. The incidence of malaria by then was 482/1000 in 2003 and five years after implementation of IRS the incidence is still high 385/ 1000 despite a high coverage of IRS. The coverage of IRS ranged from 83% in 2003, 86% in 2004, 90% in 2005, 89% in 2006 and 90% in 2007 (Simpungwe 2007). Five years have passed and IRS has been going on in Ndola. This study attempts to find out how IRS has been going on and what problems do the Ndola urban council experience in the implementation of this intervention in malaria control.

1.7 GUIDELINES ON MALARIA VECTOR CONTROL BY RESIDUAL HOUSEHOLD SPRAYING

The purpose of this guideline is to help countries considering using IRS and those already using IRS to take into consideration operational, technical and logistical issues necessary for implementing an effective IRS program.

1.7.1 INDICATIONS FOR IRS

- To prevent epidemics in specific epidemic-prone areas;
- To prevent seasonal peaks of malaria transmission in areas of intense seasonal transmission
- To control transmission in high-risk situations, such as refugee camps, labour camps, army and police outposts etc;
- To control endemic malaria in areas of high population density such as peri-urban areas;
- To reduce malaria transmission in areas of high drug resistance
- To eliminate new foci of infection in malaria-free areas.

After deciding that IRS is the right measure in the circumstances the next important areas to consider about the insecticide to use, is effectiveness and acceptability to house owners.

In order to perform spraying systematically and effectively with a better coverage, geographical reconnaissance should be undertaken for the selected areas. To maintain effective coverage during the entire transmission season, spraying of the whole area to be protected should be completed before the beginning of that season. Spraying should be:

- Total – that is all the dwellings are sprayed
- Complete – that is all sprayable surfaces are covered
- Sufficient – that is uniform application of the required dose to all sprayable surfaces
- Regular – that is spraying should be at regular intervals so as to ensure that an effective residue is in place during the whole transmission season.

1.7.2 HOW TO APPLY IRS

To apply a uniform dose of insecticide to all sprayable surfaces, compression sprayers, which meet WHO specifications, are used. The spray pumps should be fitted with nozzle tips producing the required swath and discharge rate, and pressure gauges or control flow valves graduated to deliver the required rate of application. The use of protective devices and safe working practices are essential to avoid or reduce the contamination of spray operators with insecticide. Overalls, broad-brimmed hats, gloves and shoes or boots, light masks, goggles and visors are the protective devices for spray operators. Supervisors or squad leaders should enforce safe behaviour and the appropriate use of protective devices. Calculation of amount of insecticide (T=total amount) for IRS: N= #of houses; S=Av sprayable surface per house (m^2); Y=Target dosage of insecticide (g/m^2); C=Concentration (%). $T = (N \times S \times Y / C \times 100)$

1.8 GLOBAL PERSPECTIVE

A study done in Sheikhpura district, Punjab province in Pakistan to determine the efficacy of indoor residual spraying with alphacypermethrin ('Fendona', Cyanamid, NJ, USA), applied at $25 \text{ mg}/m^2$, to prevent falciparum and vivax

malaria, revealed that the incidence of falciparum malaria was 95% lower and that of vivax malaria 80% lower in Wettable powder sprayed than unsprayed sectors (Rowland et al 2000). Similar results were obtained for sectors sprayed with the Suspension concentrate formulation. Cross-sectional surveys gave estimates of efficacy comparable to those obtained by active case detection. Anopheles culicifacies was 80% less abundant and A.stephensi, the predominant anopheline, was up to 68% less abundant in sprayed areas over the 7-month period. Reductions in anopheline parous rates indicated that the single-spray treatment was effective for the entire transmission season. Sprayed surfaces lacked odour, which contributed to the popularity of the campaign. This meant that the intervention was highly acceptable by the community.

Nieto et al (1999) KAP study done in Columbia revealed that 56.8% of community members were knowledgeable of spraying of houses as a preventive measure against malaria control. However, despite their level of knowledge acceptability of the intervention is not obvious. A different study was done in Thailand on spray men's attitude. The study revealed that spray men were more likely to use high dosage of DDT powder in the morning than afternoon to lighten the weight of DDT powder that has to be carried from house to house. It was also given to villagers for agriculture use in return for food or as courtesy and about 1/3 of DDT carried by spray men was misused each day (Hanson K et al 2004). This shows that despite the level of knowledge these service providers have concerning the program they may be influenced by personal attitudes and practices posing great operational challenges on IRS.

During DDT symposium at TDRC in Ndola, Dr Govere and professor Baboo (2004) pointed out that after 50 years of study no replicated study on DDT showed any harm to humans. On the contrary, a study done in Poland revealed that very high concentration of DDT were detected in human adipose tissue with the maximum value as high as 52microgram g-1 lipid weight in skierniewice. However Dr Govere (2004) further argued that the benefits outweigh the risks,

DDT saved more than 100 million human lives, eliminated malaria in USA and Europe.

In India IRHS with DDT led to sharp decline in the incidence of malaria from 75million cases in 1953 to 2million cases in 1958 with estimated 80% reduction (Park 2007). This further qualifies why IRS program should be continued, though there is need to ensure that environmental safe guards are upheld.

A study in Malkangiri District in India revealed that, nearly 50% of households were found to have re-plastered their walls by day 60 and 100% by day 90. In Koraput District, the corresponding rates were 80% by day 30 and 100% by day 60. The results showed that the wall re-plastering was more frequent in Koraput District and this might be the reason for the relatively short residual effect of DDT spraying observed in this district. The study further revealed that in re-plastered walls anopheles fluviatilis mortality were once or twice reduced to 27% and 13% respectively. At week 16, the mortality was only 19% on walls which had not been re-plastered and, during this period, re-plastering twice brought down the mortality to 5% (Gunasekaran 2005). Such practices compromise the effectiveness of IRS programme. This study further showed that DDT indoor residual spraying with 74 to 86% household coverage brought down the abundance of Anopheles fluviatilis resting indoors by 93 to 95%. This was associated with a significant reduction of incidence of malaria fever as well as prevalence of malaria infection from November to February during which period transmission of malaria would have otherwise peaked. In view of these various studies done globally there is need to establish studies done in Africa.

1.9 REGIONAL

In Africa the first period of field research and pilot control projects was between 1950 and 1964. IRHS with DDT reduced malaria by over 80% in just one year, from 7000 cases to 9 cases in kwazulu natal, South Africa (Tren & Bate 2004). Also Musawenkosi (2004) documented that a study done by SAMC 2000 revealed that IRS is the main vector control strategy in south Africa, Namibia,

Swaziland, Botswana, Zimbabwe and Mozambique and over 13 million people were currently protected by IRS in the region.

Guyatt, H.L et al study in (2002) further revealed that IRS is both more effective and less expensive than insecticide-treated bed nets (ITN) for controlling malaria in the highlands of Kenya. The blood tests of the residents of homes where IRS and ITN were used after a malaria outbreak were done; it was found that IRS-treated homes had a lower percentage of residents with malaria parasites still in their blood than ITN-treated homes, and that the cost had also been significantly lower. Also Dr Govere (2004) revealed that IRS with DDT is cost effective as it is cheap, lasts twice as long as intermittent presumptive treatment (IPT) and Insecticide treated mosquito nets (ITN). Several studies in African countries showed that the use of IRS insecticides such as DDT may decrease, at times considerably, the amount of malaria transmission, but interruption of transmission could not be achieved, except in two relatively small projects in the forest areas of the Cameroon and Liberia (Bruce-Chatt 1984; Broadley 1991; Najara 2001). However, from 1965 to 1974, the difficulties of malaria eradication and control of malaria became more evident because of the development of resistance of *Anopheles gambiae* to DDT, and dieldrin; moreover administrative, logistic, and financial problems had emerged. It became clear that the prospects for malaria control were related to the availability of a network of basic health services (Bruce-Chatt 1984).

The British Medical Journal of March 11, 2000, reported that the use of DDT in Mozambique "was stopped several decades ago, because 80% of the country's health budget came from donor funds, and donors refused to allow the use of DDT," (Sidley P 2000) Many African nations have been dissuaded from using DDT in part because the European Union has said that their agricultural exports may not be accepted if spraying was "widespread," (US Department of State 2006).

Some challenges of IRS were highlighted by Newberry and Jansen (1986) who revealed that Social resistance to DDT application was due to bedbug infestation, and Mnzava et al (1998) documented that sprayed walls were replastered because of the presence of DDT stains which reduced effectiveness of IRS coverage.

A study done in India, Malkangiri district revealed that, Some householders refused to allow spraying of their houses mainly because of a traditional custom of not allowing outsiders to enter their prayer rooms Wall decolourization, bad smell, increase in bed bug nuisance, contamination of food grains stored above the false ceiling and social caste feelings against the spray-men were also some of the reasons attributed for the refusal (Gunasekaran 2005).

Lack of proper supervision and/or skilled personnel is another mitigating factor because effective application of residual insecticides requires properly trained individuals (Musawenkosi 2004). Also reduction in the impact of IRS has been attributed to environmental factors, biological and social constraints (Le Sueur et al 1996). This has led to a debate over vector control verses malaria resurgence and it should include all the relevant evidence for countries with social weaknesses. Also there are other insecticides other than DDT that have proven to be effective like pyrethroids but cost and resistance is another factor influencing their use. Organophosphate or carbamate insecticides, e.g. Malathion or bendiocarb, are considerably more expensive than DDT, and Malathion requires more frequent respraying. Pyrethroids such as Deltamethrin and lambdacyhalothrin are also more expensive than DDT, but due to their much greater coverage per unit weight, the net cost per house is about the same (Curtis 1986).

A study done in south Africa revealed that villagers object to DDT spraying because it does not kill cockroaches (Curtis 1998) or bedbugs; (Mabaso et al 2004) rather, it excites such pests making them more active, so that often use of another insecticide is additionally required (Tren and Bates 2004).

A similar observation was reported in Zambia by Simpungwe (2007). Pyrethroids such as Deltamethrin and lambda-cyhalothrin, on the other hand, are more acceptable to residents because they kill these nuisance insects as well as mosquitoes. Ongoing research has shown widespread pyrethroid resistance (Casimiro 2003) and indicates low levels of carbamate resistance in *Anopheles funestus* and the long-term sustainability of insecticide based vector control in the area is of concern. However in Zambia the issue of pyrethroids resistance does not exist as shown by a study done by Chanda et al (2008) who reported that there was a 100% susceptibility of insecticides.

1.10 NATIONAL PERSPECTIVE

Effective malaria control was achieved in Chingola and Chililabombwe project area prior to 1980 by consistent spraying and at that time malaria was officially a notifiable disease. IRHS with DDT reduced annual malaria prevalence from 74% to less than 1% over a 2 year period in Konkola copper mine in Zambia (Tren & Bate 2004). Also Sharp et al (2002) reported 99% of IRS coverage in Chingola and Chililabombwe due to co-operation from the community as a result of intensive IEC and use of insecticides with proven efficacy. The study revealed protective incidence rate of 0.65 (95% CI 0.44, 0.97) when comparing the post spraying with the previous 2 years.

A feasibility assessment of integrated vector management (IVM) pioneering district confirmed the occurrence of three major Afro-tropical vectors of malaria in Zambia; *Anopheles Gambiae* s.s, *Anopheles Arabiensis* and *Anopheles Funestus* in varying proportions (Gillies & Demeillon 1968 in Chanda et al 2008). A study done by Chanda et al (2008) on insect susceptibility test on three species revealed that there was 100% susceptibility with DDT 4%, Deltamethrin 0.05%, alpha-cyhalothrin 0.05%, malathion 5% and propoxur 0.1% according to the WHO (1998) standard protocol.

A study done on transmission attributes of peri-urban malaria in Lusaka by (Chanda et al 2003 unpublished) revealed that 46.2% of the respondents were

knowledgeable about vector control. Despite being knowledgeable acceptability is not guaranteed as residents may have their own reservation on IRS.

Currently the researcher has not come across studies that have been done on implementation challenges of IRS. MOH/CSO (2006) survey revealed that IRHS activities were done in January and February 2006, instead of being administered prior to the malaria transmission season, which begins after the rains in November and December in Zambia. This could affect the outcome of the intervention. Effectiveness may be diminished if spray rounds are inappropriately timed in relation to the transmission season. Also implementing effective spraying is expensive and requires specialized skill and efficient organization (Hanson K et al 2004).

In Ndola IRS program in 2007 experienced some resistance in a few compounds which affected coverage in which only 65,640 structures were sprayed out of 72,548 targeted eligible structures in the district. Also Complaints about the itching effects of Icon after spraying has been done and rat flea in informal structures were reported (Simpungwe 2007). These operational challenges need to be considered if IRS coverage is to be improved. Also community's perception and attitude has to be explored if challenges are to be eliminated.

1.11 CHALLENGES IN IRS PROGRAMS

1.11.1 LAW CHALLENGES

Previously the malaria vector control programme in Zambia was largely governed by the mosquito extermination Act CAP. 557, 1944 which stipulated that the urban centers be covered 100% with two rounds of residual insecticide application every year. This led to success in eradication of malaria and by then it was a notifiable disease. This act needs review though it is supported by the public health Act cap 295. However, the current law focuses on Environmental safeguards. The main Act is the Environmental Protection and Pollution Control Act No. 12 of 1990 (CAP 204 of the Laws of Zambia). PART VII & Pesticide

Toxic Substance (PTS) statutory instrument (SI) No. 20 of 1994 Covers: Importation, exportation, manufacture, storage, distribution, sale, use, packing, transportation, disposal and advertisement of pesticides and toxic substances. Even though Ndola has adequate storage facilities for pesticides it has no vehicles for transportation of pesticides and relays on hiring. There are no wash bay, shower and cloaks for sprayer men (Dr. Simpungwe 2007). However there could be other challenges on environmental safe guards which this study may establish. These may posse operational challenges.

1.11.2 POLICY¹ CHALLENGES

There is an intense debate in the United Nations Environment Program (UNEP) concerning the ban on DDT and 11 other persistent organic pollutants (Ross 2005). However, there are regions in the world where DDT use is the only malaria vector control strategy, as in some countries in Africa, Asia, and Latin America. In principle, DDT was banned due to its adverse effects on the environment, like the high persistence in different environmental compartments and bioaccumulation and biomagnifications in living organisms, including human beings. Also there are reports that this practice is currently threatened by the emergence of DDT resistance.

Rogan & Chen (2005) revealed that when the global ban on DDT was proposed in 2001, numerous countries in Sub-Saharan Africa claimed that DDT was still necessary as a cheap and effective form of vector control, especially contributing to the reduction of child mortality. However, since the appointment of Arata Kochi as head of anti-malaria division, WHO has shifted its position in this controversy, from primary reliance on bed-nets to a policy more favorable to DDT. Until 16 September 2006, the policy had recommended indoor spraying of insecticides in areas of seasonal or episodic transmission of malaria, but a new policy also advocates it where continuous, intense transmission of the disease causes the most deaths. (WHO 2006: WHO 2007: Rogan 2000) WHO cited

¹ What policy challenges exist in the execution of IRHS?

many reasons for using DDT for this purpose, including that DDT has a longer action time, and thus fewer household sprayings are needed, so that it is capable of repelling mosquitoes from inside dwellings and killing those present on sprayed surfaces (UNICEF 2003). The continuous use of DDT for vector control, but not for agriculture has been approved by the Stockholm Convention on Persistent Organic Pollutants and this has proven to be a good alternative for malaria control. Despite the worldwide ban on agricultural use of DDT, some farmers in India are known to still use it in crop production (Imphal Free Press, 2008). However on the contrary, in 2007, WHO clarified its position, saying it is "very much concerned with health consequences from use of DDT" and reaffirmed its commitment to phasing out the use of DDT http://www.yubanet.com/artman/publish/article_56180.shtml. In view of above professional debates on IRS programme and the use of DDT have not been conclusive and this may contribute to implementation challenges.

In line with the Stockholm convention, Environmental council of Zambia (ECZ) allowed the MOH to import and use DDT for malaria control. The Stockholm convention is the International Instrument that regulates pesticides organic pollutant (POPs) e.g. DDT, Chlordane, PCBs. Zambia signed the instrument in 2001 and was ratified in 2006.

Currently ECZ is developing NIP, DDT permitted for use in public health while we look for alternatives. Need to report to Stockholm Convention secretariat on quantities used annually (Kapindula 2006).

Regulations and procedures were put in place to ensure that DDT is used safely and judiciously for IRS. However since the re-introduction of DDT for malaria control in 2000; no studies have been done to collect baseline information on levels of DDT in different matrices and monitor adverse effects it might have on the environment and human health (ECZ 2006). Also in Zambia IRS programme is only done once a year in contrast to the duration of effective action of the insecticide of 3-6 months. However there are factors that influence IRS

intervention in malaria control. These factors have been classified as; Law and policy challenges, institutional challenges and operational challenges.

1.11.3 INSTITUTIONAL² CHALLENGES

Institutional factors influencing indoor residual household spraying range from poor quality of care and service delivery, resistance of insecticide, sustainability Of IRHS programme, poor timing and organization. These factors are valid as shown below:

1.11.3.1 Quality of care

Technical quality is defined in terms of professional standard and the effectiveness of health care in improving health outcomes. Shortage of qualified staff to oversee the training may compromise quality. MOH (2008) action plan reported that there was inadequate district supervision. Low quality of care during IRS would affect the outcome negatively as the intended outcome would not be achieved. A study done in Thailand revealed that Spray men were more likely to use high dosages of DDT powder in the morning than afternoon in order to lighten the weight of DDT that has to be carried from house to house (Hansen K. et al 2004). This would mean over dilution or under dilution of the chemical thereby compromising the efficacy of the insecticide. Also lack of quality DDT in Botswana led to introduction of pyrethroid as an alternative.

1.11.3.2 Service delivery

IRS to be effective and efficient must be done according to the transmission season. However effectiveness may be diminished if spray rounds are inappropriately timed in relation to the transmission season (Smith A et al 1995; Mills A 1992). It also require efficient organization and timing of residual spray application in order to obtain maximum benefit and must be completed within a short period of time before the onset of transmission peak (Coosmans and Carnevale² 2000). Also proper planning is cardinal in the successful

² What institutional challenges are associated with implementation of IRHS?

implementation of IRS programme. This is justified by Hanson et al (2004) who revealed that both Namibia and Zimbabwe reported decreasing efficiency and effectiveness of spraying programmes due to constraints of planning and management.

1.11.3 Resistance to insecticide

To achieve a lethal dose of IRS the vector must be susceptible to the insecticide in use. Hansen et al (2004) documented that resistance is less in Africa because of very few and large scale campaigns of IRS. However some studies in Kwazulu natal south Africa detected that *Anopheles funestus* was resistant to pyrethroid, this further revealed reasons for the reduced effectiveness of IRS (Hargreaves et al. 2000; Craig M.H et al 2004) However in 2000 DDT was re-introduced in the region and *A.funestus* has been eradicated (MOH 2003) . Another important factor has been general disapproval of DDT use, due to fears of its harmful effect on the environment and on human health, fears which are unjustified when DDT is used appropriately for IRS. According to MOH (2006), absence of an insecticide resistance monitoring and management plan in Zambia poses a great challenge to determine level of resistance. Lack of consistency in the spray rounds may also lead to resistance of the mosquito vector to certain insecticide being used.

1.11.3.4 Sustainability

According to Hansen et al (2004) implementing effective spraying is very expensive and requires specialized skill. However sustained and large scale spraying campaign have never been done in Africa because the target is so large and due to financial and infrastructural resources are so weak. Sustainability of IRS programme in Zambia when the donor agencies and co-operating partners pull out would be the biggest challenge due to financial constraints. The biggest concern should be on how this intervention can be sustained locally.

1.11.4 OPERATIONAL CHALLENGES

Operational challenges include; Low coverage, and poverty, low level of knowledge of service providers, resistance of mosquitoes to insecticides, community's acceptance of IRS and inadequate logistics for IRS programme, replastering of houses and attitude of both service providers and community members. In view of the above, we can see that IRS implementation presents with many operational and logistical challenges. It requires strong management capacity to run an effective and well timed programme. Human, technical and financial resources are often lacking to maintain a sustainable coverage (Coosmans and Canavale² 2000).

1.11.4.1 Drug resistance

At a time when effective antimalarial drugs are sorely needed, malarial parasites are showing remarkable genetic ingenuity in escaping them, and the vector, too, is proving to be very creative in escaping insecticides. The heart of drug resistance is in Southeast Asia where resistance has developed to what are called first line treatment, second line and third line antimalarial treatment. There is justifiable fear that, particularly in Southeast Asia, we could be facing a situation where *P. falciparum* may not be treatable or curable by any drug available [White, N.J. (1992)- Bloland, P.B (1993)]. It should be noted that Zambia banned the use of chloroquine in 1998, it's now replaced with coartem as the first line of treatment.

1.11.4.2 Logistics

IRS is particularly important in Zambia considering the highly urbanized population and the logistical challenges of programming to high coverage in sparsely populated but high-risk rural areas (NMCC 2006- 2011). Logistics like timely arrival of funds, procurement of insecticides and their use, geo-coding of structures and early arrival of equipment for use helps to start and complete IRS campaign before onset of rains. However MOH (2006) documented delay in release of funds, prolonged procurement procedure, non availability of trained

³ What operational challenges are associated with implementation of IRHS?

staff and attrition during spraying campaign and inadequate storage facilities. IRS activity must be permanent with specialized teams going from one household to another. Delayed procurement of spray pumps posed a challenge in the implementation especially in the larger districts, as well as inadequate transport and storage facilities in most IRS districts (NMCC Action Plan 2008). Also even when spray men are trained they may not be available during spray time and this may impact on IRS intervention.

1.11.4.3 Knowledge

A study done by Sikazwe (2003 unpublished) revealed that community members had high level of knowledge 85% on preventive measures against malaria but their actual practice was low as they indicated that they would not institute any preventive measure. Chanda et al (2003 unpublished) case study done in Lusaka revealed that 46.2% of the respondents noted that they were knowledgeable about vector control interventions. Professor Baboo's report (2007) on cascade training revealed that the spray operators were found to be weak in using their theoretical knowledge to practical practice. This could influence effectiveness, efficiency and coverage of IRS negatively. Also lack of skill and knowledge may influence practice towards safety measures in handling the insecticides. Exposure of the worker or resident to the pesticides during preparation can be greatly reduced if the worker follows best practices. Indoor Residual Spraying conceptual model for exposure from IRS is mainly through: Inhalation of aerosol vapors during spraying is the main process for worker exposure during IRS. Residents are mainly exposed through dermal contact with sprayed surfaces and incidental ingestion of insecticide after their houses have been sprayed, especially when food or drink are left in the house during spraying. Leaky equipment can also lead to insecticide exposure through dermal contact with the floors and incidental ingestion by children who may come in contact with the spills before they are cleaned up (Biscoe et al 2007 in RTI international 2007).

1.11.4.4 IRS coverage

This can be influenced by lack of supervision and /or skilled personnel are another mitigating factor because effective application of insecticide requires properly trained individuals (Sharp et al 1988). This was also confirmed by MOH action plan (2006) that there was weak supervision of spray personnel including their record keeping and quality assurance of the spray programme in Zambia. Inadequate supervision at district level for IRS activities and inadequate community sensitization at district level for IRS activities was reported among IRS challenges for 2007 (NMCC Action Plan 2008). A study by Gunasekaran et al (2005) revealed that, Spray coverage of households and rooms in different villages of Malkangiri District ranged from 74.2% and 48.6% respectively. The corresponding values for Koraput District were 86.2% and 56.6%. Some householders refused to allow spraying of their houses mainly because of a traditional custom of not allowing outsiders to enter their prayer rooms. Wall decolourization, bad smell, increase in bed bug nuisance, contamination of food grains stored above the false ceiling and social caste feelings against the spray-men were also some of the reasons attributed for the refusal.

1.12.4.5 Poverty

This may influence the sprayer men to charge people for the service after spraying and the poor may not access the IRS services and they are the most vulnerable to malaria. A study done on spray men behavior revealed that DDT was given to villagers for agricultural use in turn for food or as courtesy (Hanson et al 2004). This may have a negative effect on the coverage and IRS intervention outcome,

1.11.4.6 Replastering of sprayed walls

After spraying the houses the community has a tendency of replastering the walls because of the presence of DDT stains (Mnzava et al 1998; Musawenkosi 2004). The stain causes some villagers to avoid spraying of their homes (Gladwell 2001; Tren and Bate 2004) or to resurface the wall, which eliminates

the residual insecticidal effect of the spraying (Mabaso ML, et al 2004: Tren and Bates 2004). This practice compromises the effectiveness of IRS programme.

1.11.4.7 Acceptability of IRS services

The first spray is generally well accepted by the householder, but if the comments of the population are not considered, doors will be closed the following spray rounds and spray coverage will be insufficient. Refusal would be due to unsightly deposit of powder and the smell of insecticide. Involvement of householders in collaboration with community representatives in IRS intervention is important (Coosmans and Carnevale2 2000). MOH (2008) action plan reported inadequate community sensitization and this may lead to refusal of IRS. In areas where resistance from residents prevents a high percentage of the homes being effectively sprayed, the effectiveness of the intervention is greatly reduced (Curtis1986: Gladwell 2001). Many residents resist spraying of DDT for various reasons. For instance, the smell lingers, and DDT leaves a stain on the walls.(Musawenkosi 1994: Curtis 1986: Thurow 2001) "Pyrethroids such as Deltamethrin and lambda-cyhalothrin are usually much more acceptable to householders because they leave no visible deposit on walls, therefore rates of refusal of spraying by householders are lower with pyrethroids than with DDT," (Curtis 1986). A study by Rowland et al (2000) on use of alphacyperthrin in IRS in Pakistan further revealed that, many people expressed appreciation for the spray campaign, since no persistent odour or residue was evident after spraying, and because both nuisance and vector mosquitoes were controlled. However without householders' acceptability this activity may be doomed to failure.

1.11.4.8 Attitude

Past experience towards IRS may influence refusal of IRS services, especially if there was no positive result in reducing mosquito density. Therefore IRS must be effective to promote community's acceptance. Winch P. et al 1992 revealed that at community level men as heads of households may not be aware of the

impact of malaria on the health of young children or pregnant women may refuse IRS as they may not see the value.

1.11.4.9 Season variation

This may influence IRS outcome either negatively. Reduction in the impact of IRS has been partly attributed to weather disturbances linked to global climatic events such as El Nino (Le Sueur et al 1996). Also Winch P. et al (1992) pointed out that health professionals may assume that the risk of malaria is greatest when mosquito population is at its maximum, and negligible during the dry season when there are few mosquitoes and self protection measures may be reduced leading to high risk of transmission. Also MOH/CSO (2006) malaria indicator survey reported that IRS was done in the beginning of 2006 and ideally it should be administered prior to malaria transmission season which begins in the rains in November and December in Zambia

1.11.4.10 Non availability of occupants

Household members who are famers are less likely to be found in their homes in rain season and those in formal employment are less likely to be home during the day. Population migration from un controlled area also lead to deterioration of malaria situation in neighboring countries that have brought malaria under control (Sharp et al 1988). This may affect coverage and effectiveness of this programme. Sometimes spraying is not done as a result of non preparedness by the occupants, funerals, sickness or presence of a new born baby in a home.

1.12 TYPES OF INSECTICIDES

WHOPES recommended insecticides for IRHS against malaria vectors

Insecticide	Formulation	Class	Dosage (g/m ²)	Duration of effective action
Alphacypermethrin	WP/SC	P	0.02-0.03	4-6 months
Bendiocarb	WP	C	0.1-0.4	2-6 months
Bifenthrin	WP	P	0.025-0.050	3-6 months
Cyfluthrin	WP	P	0.02-0.05	3-6 months
DDT	WP	OC	1-2	Up to 12 months
Deltamethrin	WP	P	0.01-0.025	Up to 6 months

Etofenprox	WP	P	0.1-0.3	3-6 months
Fenitrothion	WP	OP	2	3-6 months
Lambdacyhalothrin	WP	P	0.02-0.03	3-6 months
Pirimiphos methyl	WP/EC	OP	1-2	2-3 months
Propoxur	WP	C	1-2	3-6 months

P=Pyrethroid; C=Carbamate; OP=Organophosphate; OC=Organochlorine

The IRS programme in Zambia is using DDT and pyrethroids chemicals for indoor residual spraying (WHO 2004). DDT is being used on porous surfaces (informal structures) while pyrethroids is being used on plastered non porous surfaces (formal structures). However, from above table, effective action of IRHS programme is questionable as the spray programme is done once a year when the duration of effective action of the insecticides is up to 6 months for pyrethroids.

1.13 PROBLEMS WITH INSECTICIDE

The impact of pesticides on human health has received worldwide attention from the scientific community. A first class of pesticides that was widely used in public health consisted of the organochlorines, among which the most widely known example is dichlorodiphenyltrichloroethane, or DDT. Despite the benefits, the indiscriminate use of this class of substances led to serious ecological problems.

It was formerly believed that DDT and its metabolites did not possess endocrine effects, but in the 1970s and 80s several studies Bitman (1970): Bryan et al (1989) suggested that DDT mimics estrogens, i.e. possessing similar pharmacological properties to -estradiol. This gave rise to extensive investigation on the possible hormonal effects of human exposure to DDT and its byproducts.

The range of studies shows the great variability in DDT resistance, according to the target area. DDT use thus remains as an issue for decision-makers in endemic malaria areas due to its historical success in malaria control. To make an evidence-based decision, health system managers face the difficult task of estimating the risk and benefits. The association between DDT and certain types

of cancer (e.g., of the breasts, endometrium, ovaries, prostate, testes, and thyroid) and other endocrine effects is still a controversial issue (Yang 2006; Cocco 2002) provides a review of experimental and epidemiological studies suggesting or refuting the associations, but which were modeled and designed differently.

Pyrethroid resistance in malaria is complex and presents at different levels, and causes three effects that is "mortality, repellency and exiting behavior". The selection for pyrethroid resistance in anophelines was reported soon after the widespread use of these chemicals, mainly in agriculture (Georghiou 1990). In Africa, resistance was first reported in Ivory Coast (Elissa et al. 1993) and soon found to be widespread in that country (Curtis et al. 1998; Chandre et al. 1999a; Guillet et al. 2001). This concerns in particular the malaria vector *Anopheles gambiae*, but such resistance has also been reported in other anophelines and in different geographical areas *A. funestus* (Hargreaves et al. 2000). However in Zambia insecticide resistance is not an issue as baseline susceptibility test conducted by the Chanda et al (2008) showed 100% susceptibility.

1.14 ADRESSING CHALLENGES⁴

To date there is renewed interest and political commitment to controlling malaria in Africa through RBM partnership. While malaria is a very complex issue, not all of the biologic and epidemiologic complexity is relevant to developing effective control strategies. Malaria control must address the foremost challenge: to improve the management of malaria disease and to accomplish this in the context of strengthening the local and national health services. Malaria epidemiology varies throughout the world on the basis of the disease itself, as well as institutional determinants; there is no single control strategy applicable for all situations. Successful malaria control will depend on appropriate local action. Malaria control programs can best allocate resources to prevent mortality and reduce morbidity and social and economic losses, through progressive

⁴ How can the challenges be addressed?

improvement and strengthening of local and national capabilities. Deressa et al (2007) further highlighted that indoor residual spraying can substantially reduce the incidence of malaria and its associated economic consequences, and should be promoted. However problems of insecticide resistance have been reported. To address this problem, alternative vector control strategies such as rotational or mixed use of insecticides can be employed (Mabaso et al 2004). For instance Ministry of Health in Mozambique did not approve the use of DDT alone, a rotational method of spraying which has proven effective in Mexico (Hemingway et al. 1997) in containing resistance levels needs to be evaluated against the African vectorial systems as a matter of urgency. Spraying costs would decrease if a pyrethroid was used in rotation with carbamate, organophosphates and DDT also remains a possible insecticide choice for use in rotation. Also new technologies using GIS as a platform to plan, implement and assess control activities are now available to help rationalize malaria control in time and hence minimize cost (Mabaso et al 2004). Acceptance and cooperation by house owners are higher with better health education and more involvement in planning. The cost for personnel is much reduced although the local health service or a community-based organization may have to give the workers some financial or other compensation. The health services, however, have to be strengthened in order to provide health education as well as the supervision and evaluation of activities. The responsibility for equipment, spare parts and insecticide also has to lie with the health services. Vector control experts are needed to provide advice on techniques and equipment, appropriate insecticides and the time of spraying (WHO 1995). There is need to find ways to improve sustainability, both financially and technically in IRS.

Table 1.15 Methodological Approaches in the Field

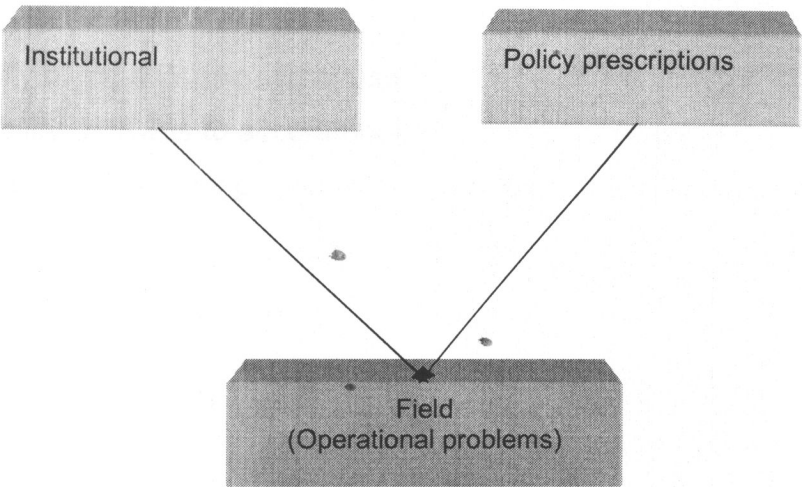
Author	Title	Research design	Sampling	Data tool	Data analysis
Abdinassir et al 2003	The use of formal curative services in the Mgt of pediatrics fever.	Cross sectional survey	Stratified sampling	Structured questionnaire	SPSS -Wallis test -chi square
Rowland et al 2002	Prevention of malaria in Afghanistan through social marketing of ITNs; evaluation of coverage and effectiveness	Cross sectional survey passive surveillance	Simple random	Parasite prevalence	Logistical regression
Brooker et al 2004	Spatial clustering of malaria & associated risk	Case control	Cluster sampling	Morbidity questionnaire	Multiple regression
Marianela et al 2008	Household burden of malaria in S. Africa & Mozambique. Is there catastrophic impact?*	In-depth household survey	Cluster sampling	Questionnaire	Principal component analysis
Collins et al 1997	Malaria related beliefs & behaviour in southern Ghana; implication for RX prevention & control	Cross sectional survey	Simple random	FGD Semi-structured questionnaire	Content analysis Data base4 & SPSS
Rowe et al 2007	Evaluating impact of malaria control efforts on mortality in sub-Saharan Africa.	Randomized clinical trial	Probability sampling	Mortality register, Verbal autopsy sample or sentinel vital registration.	Meta analysis & statistical modeling
Deressa et al 2007	Economic cost of epidemics malaria to households in rural Ethiopia	Community based sectional study	Simple random	Structured questionnaire	Descriptive statistics -mean value & standard deviation
Gunasekaran	DDT IRS, still an effective tool to control anopheles fluviatilis-transmitted plasmodium falciparum malaria in India	Randomized controlled trial (case control study)	Random sampling	Thick blood smear for malaria parasite	Stratified analysis using MH chi-square Test
Rowland et al 2000	IRS with alphacypermethrin controls malaria in Pakistan	Community randomized controlled trial	Random sampling	Active case detection. Cross section parasite survey. Entomological analysis.	Non parametric test -kruskal Wallis and wilcoxon rank sum test. Analysis of variance

Methodologies from different scholars were analyzed as a basis for development of a data collecting tool for this study. However no particular study methodology has been adopted, as they are different and were done in different settings.

1.16 CONCLUSION

IRS is a method for community protection, and given its mode of action, the highest possible level of coverage is required to achieve the maximum impact on malaria transmission. Achieving this level of coverage and timing IRS correctly are crucial to realize the full potential of IRS. IRS is indicated only in those settings where it can be implemented effectively, which calls for a high and sustained level of political commitment. Transmission control operations based on IRS, or any other vector control intervention, have to be maintained at high coverage levels for extended periods of time, for as long as impact is needed. IRS requires effective leadership and management for planning, organization and implementation. Operations must be managed by skilled professional staff and trained spray operators, based on an analysis of local epidemiological data and a sound understanding of transmission patterns, vector behavior and insecticide resistance status. Significant strengthening of human and technical resources, accompanied by sufficient financial resources, is needed to develop or reorganize existing IRS operations.

Figure 1.1 Institutional, Policy and operational problem nexus



CHAPTER TWO: OBJECTIVES

2.1 GENERAL OBJECTIVES

To determine challenges associated with IRHS in Ndola urban district, with the view to improve IRHS intervention in malaria control.

2.2 SPECIFIC OBJECTIVES

1. To determine if acceptability of IRS by the community affect IRS implementation.
2. To assess whether IRS guidelines are being adhered to by service providers.
3. To establish the extent to which availability of IRS logistics affect operations.

2.3 RESEARCH QUESTIONS

1. What policy problems exist in the execution of IRHS?
2. What operational problems are associated with implementation of IRHS?
3. What institutional problems are associated with implementation of IRHS?
4. How can the problems be addressed?

2.4 CONCEPTUAL DEFINITION OF VARIABLES

2.4.1 Knowledge is the information required

2.4.2 Compliance is simply obedience to set standards or guidelines.

2.4.3 Service delivery is carrying out a task

2.4.4 Quality care excellent service

2.4.5 Availability of logistics is ease of use

2.4.6 Acceptability of IRS is to accommodate

2.4.7 Indoor residual spraying challenges are difficulties experienced during spraying.

2.5 VARIABLES, CUT OFF POINTS AND INDICATORS

VARIABLES		CUT OFF POINT	INDICATORS
INDEPENDENT			
Compliance with IRS guidelines	Always		If one scores 20- 27 points
	Sometimes		If one scores 10- 19 points
	Rarely		If one scores 1- 9 points
	Never		If no score
Availability of IRS logistics	Always available		If one scores 16 points
	Sometimes available		If one scores 9- 15 points
	Rarely available		If One scores 1-8 points
	Not available		No score
Service delivery of IRS	Very good		If one scores 11- 14 points
	Good		If one scores 8- 10 points
	Average		If one scores 7 points
	Poor		If one scores 3- 6 points
	Very poor		If one scores 0-2 point
Acceptability of IRS services	Very high		If one scores 5 points
	High		If one score 4 points
	Average		If one scores 3 points
	Low		If one scores 2 points
	Very low		0-1 score
DEPENDENT			
Indoor residual spraying challenges	Yes		If one scores 1-2 points on IRS
	No		If no scores on questions for IRS

CHAPTER THREE - RESEARCH METHODOLOGY

3.0 INTRODUCTION

This chapter describes the research methodology comprising the variables, study design, study setting, study population, sample selection, data collection instruments, data collection techniques, ethical consideration, pre-testing, dissemination and utilization of results and limitation of the study.

This study determined challenges associated with implementation of IRS in Ndola Urban District.

3.1 VARIABLES

1. DEPENDENT VARIABLE

- Indoor residual household spraying challenges

2. INDEPENDENT VARIABLES

- Availability of logistics
- Acceptability of IRS
- Compliance with IRS guideline

3.2 RESEARCH DESIGN

This is a descriptive cross section study, which involves description and analysis of researchable objects with no intervention required. It is cross-sectional because the phenomena under study were captured during one data collection period. It also describes what exists about the phenomena and gives a clear picture of the situation. The study involved collection and presentation of data in a systematic manner, about evaluation of IRHS; challenges faced by service providers in Ndola urban district

3.3 RESEARCH SETTING

The research was conducted in Ndola urban district in Copperbelt province. Ndola city is 320 kilometers north of the capital city Lusaka, Zambia. The study

was conducted at Ndola District council and public health offices along Broadway, where the service providers report before and after going into the field. Ndola district has a total population of 462,459 (Ndola DHMT HMIS 2008). The targeted structures for IRHS were 72,548 and sprayed structures were 65,640 in 2007 according to Ndola RBM (2007). Ndola was chosen as it is one of the intervention districts where IRHS is being done. Malaria incidence in Ndola is still high 434/1000 in 2006 above the national incidence of 358/1000 despite the high (88%) coverage of IRS in the past four years. The investigator chose Ndola urban district as a study site with the view of evaluating IRHS and challenges faced by service providers in Ndola urban district.

3.4 STUDY POPULATION

The sample consisted of all Program officers and spray operators (service providers) trained in IRS and participated in 2008 IRS spraying campaign, period October to November. The population has been selected because they include service providers of IRHS who are able to make decisions on this intervention and are more knowledgeable. Also their attitude and practice towards IRHS may lead to effectiveness or ineffectiveness of this intervention in malaria control.

3.5 SAMPLE SELECTION AND SAMPLE SIZE

3.5.1 Purposeful Expert Sampling (For service providers)

All program officers were selected based on purposive expert sampling and all spray operators were purposively selected into the study. The spray operators were those specifically trained in IRS by Ndola district council and Ndola DHMT from the community. Expert purposive sampling was chosen despite its disadvantage of having unrepresentative sample. This is due to limited sample as there were only 129 trained service providers in IRS in Ndola urban district currently available, of these 120 were spray operators and 9 were program managers (1 project manager, 1 co-ordinator, and 7 supervisors). All service providers were recruited for the study. However, out of 9 program officers only 8 (98%) were interviewed as one declined to be interviewed or answer the

questionnaire. Also out of 120 spray operators, only 114 (95%) were interviewed and 2 refused to be interviewed, while 4 of them stopped spraying before the exercise finished. A total of 122 respondents were accessed and there was 95% response rate.

3.5.2 Inclusion criteria

- All programme officers/ spray operators trained in IRS, residing in Ndola urban district and participated in 2008 spraying campaign.
- All those who were willing to participate.

3.5.3 Exclusion criteria

- All programme officers (supervisors) and spray operators who were trained in IRS but not residing in Ndola urban district and did not participate in 2008 spraying campaign.
- All those who were not willing to participate.

3.6 DATA COLLECTION TOOLS

For this project, the researcher used a semi-structured questionnaire with spray operators and program officers. Expert checklist was used on program officers to validate responses from the semi-structured interview schedule. The researcher used a semi-structured questionnaire (appendix IV and V) and an expert checklist (appendix VI)

3.6.1 Validity

This study employed two types of instruments, semi-structured interview schedule and a checklist. To ensure validity of data collection tool, pre-testing of the instrument was done in Luanshya to ensure clarity, precision and consistency of questions and where necessary adjustments were made on content and sequencing of questions. Expert checklist was used to validate responses from program officers. Triangulation method was used.

3.6.2 Reliability

The tool was modified from the national malaria indicator survey questionnaire. Reliability of the instrument was achieved by conducting a pre-test study in order to test the degree of accuracy with which the tools measured challenges in the implementation of IRS. After the evaluations of the pilot test to assess the extent to which the original questionnaire would grant us reliability, the researcher had an opportunity to perfect the questionnaire and checklist from the observed reactions of the respondents to the research instrument and their willingness to answer the questions. Deficiencies in the tool were overcome by making necessary changes where there were gaps. Also use of open ended questions helped to bring out in-depth information so that all issues relating to challenges in IRS were discussed. The pilot testing also helped to determine how much time was needed to administer the questionnaire and to analyse it. The lessons learnt from the pre- test, helped the researcher to develop a reliable and locally focussed modified questionnaire.

In this study a Cronbach alpha coefficient of 0.70 was selected as a measure of reliability). If the item scores agree very closely with the universal score, then they should also be very closely related to one another as well. This way of assessing reliability is referred to as internal consistency, and is the approach presented in this study. Some questions that scored below 0.75 were dropped. In this way, reliability may be achieved.

3.7 DATA COLLECTION TECHNIQUE

In this study two techniques (triangulation) were used to collect data. Face to face interview using semi-structured questionnaire, and observation using a checklist were conducted by the investigator. This enhanced collection of quality data and reduced information biases.

Table 2 Profile of data collection methods

Research Questions	Data collection Tools
1. What policy challenges exist in the execution of IRHS?	Checklist and semi-structured questionnaires.
2. What institutional challenges are associated with implementation of IRHS?	
3. What operational challenges are associated with implementation of IRHS?	
4. How can the challenges be addressed?	

3.7.1 Checklist: A checklist containing policy, institutional and operational variables was used to obtain data from program officers. This tool was developed based on review of IRS guidelines and consultation from IRS experts. See appendix VII.

3.7.2 Semi-structured interview schedule: The tool was modified from the national malaria indicator survey questionnaire (MOH/CSO 2008). It was modified as the questionnaire items were different and only two questions were on IRS. The questionnaire items were identified and adapted from review of the literature, statements and findings from previous studies, such as Hanson et al 2004; Musawenkosi 2004; Prof. Baboo 2007; Tren & Bates 2004 to mention a few. The researcher will interview the experts in IRS (Program officers) and spray operators. The purpose of these interviews is to develop a detailed understanding of challenges and possible adaptations. The Semi-structured interview schedule contained all the study variables on which data was to be collected which included; acceptability of IRS; availability of IRS logistics; service delivery of IRS; compliance to IRS guidelines and knowledge. The purpose of the study was explained to the participants and permission was sought from them to allow the researcher to conduct the interview. Privacy and confidentiality and anonymity were maintained by not writing names on interview schedule, instead serial numbers were allocated to all participants. Interview lasted for 10 to 15 minutes. Interviews were conducted during working hours from 11.00 hours- 16.00 hours using face to face method.

This kind of responses can be useful in interpreting responses. The presence of an interviewer can influence responses and this is its main limitation. This was taken care of through use of a checklist. Questionnaires consisted of both open and closed ended questions.

Data was collected from 4th week of October to 1st week of December 2008.

3.8 PRE-TEST

Pre-testing was done in Luanshya district at Thompson Hospital which was one of the IRS intervention areas, and had similar characteristics with those of the main study sites. The site was conveniently selected. Service providers were selected using expert purposive sampling and 12 participants were selected accounting 10% of the sample for the main study (1 program officer and 11 spray operators). Pre-test helped the investigator to determine whether the variables were realistic, measurable and attainable. It also help to make revisions in order to strengthen methodology, detect errors in the tool, and assess duration of interview schedule and appropriateness and clarity of questions. After the pre-testing of the research instrument, some questions were removed and other questions were included in order to ensure quality data collection

3.9 ETHICAL CONSIDERATION

Ethical clearance was obtained from University of Zambia Biomedical Research Ethics Committee. Since this study involves human subjects, verbal and written consent was obtained from the participants and from Luanshya district Health management team (pre-test), Ndola district council, Ndola district health management team and copperbelt provincial health office. The purpose and nature of the study was explained to study participants. Those who refused to participate were assured that no privilege was going to be taken away from them. Those who agree to participate were requested to sign a consent form. There were no risks and immediate benefits to those who participated in the study. Respondents were in a natural setting and hence were not exposed to

emotional or physical harm. Confidentiality and anonymity were maintained to all respondents as their names were not appearing on the questionnaire. Privacy was maintained as all interviews were done in a private room. All questionnaires were kept under lock and key after each interview session.

3.10 DATA PROCESS AND ANALYSIS

Textual data that was derived from open ended questions was analyzed using **qualitative content analysis**. A basic issue when performing qualitative content analysis of textual data is to decide whether the analysis should focus on manifest (visible) or latent (hidden) content only or both (Downe, 1992). This study covered both forms of content analysis. An analysis of what the text says deals with the content aspect and describes the visible, obvious components, which are referred to as the *manifest content*. In contrast, analysis of what the text talks about deals with the relationship aspect and involves an interpretation of the underlying meaning of the text, and this is referred to as the *latent content* (Kondracki et al., 2002). Both manifest and latent content deal with interpretation of what has been constructed by the producers of the data but the interpretations are done by both the producers and the researcher invariably in terms of depth, level of abstraction and purpose. Since the data was in textual form, the data was categorized into themes and analyzed on the computer using the Non numerical Unstructured Data Indexing (NUD*IST) computer package.

Quantitative Data

Numeric non textual data that was derived from the Expert checklists and semi-structured questionnaires, each day, all interview schedules were sorted out and edited for internal consistency, completeness, legibility and accuracy. This was done to ensure quality data. Incomplete questionnaires the investigator asked the respondents for clarification just their and then before leaving the room. Closed ended questions were coded and Coding was done to ensure easy entry and analysis of data using a computer. Variables were defined; pre coded and analyzed on the computer using the Social Science Statistical Package and Epi-

info version 6. This study was analyzed by univariate analysis to make frequencies then bivariate analysis to make cross tabulations.

Chi-square was used to determine the association of the qualitative variables and the outcome (IRS challenges). The qualitative variables include availability of IRS logistics, and acceptability of IRS. Confidence interval was set at 95% which was provided together with estimates. Cut off point for significance was set at 5%, statistical significance was achieved if P value was 0.05 or less, thereby rejecting the null hypothesis. The data was presented using tables, graphs and pie charts for easy communication.

CHAPTER FOUR: PRESENTATION OF RESULTS

4.0 Introduction

A total of 122 respondents were interviewed and there was a 95% response rate. There were 9 program officers and only 8 were interviewed as one (1) declined to be interviewed. Spray operators were 120, however, only 114 were interviewed, two refused and four could not be traced as they stopped spraying before the exercise could finish. Data for 8 program officers has been presented in narrative form and frequencies have been used instead of percentages as the sample was very small.

4.1 Demographic Characteristics

In this study, Most of the program officers were relatively new to the IRS program as more than half served for less than three years (n=5). Majority of them were Environmental Health Technicians (n=7) and of these three quarters were males (n=6).

Table 4.1.1 Sex in relation to experience in IRS of spray operators (n= 114)

Sex	Experience in IRS		Total
	0-2yrs	3-4yrs	
Male	56 (85%)	10(15%)	66 (100%)
Female	41 (42%)	7(41%)	48 (100%)
Total	97 (85%)	17 (15%)	114 (100%)

Majority (66) of the spray operators were males and most of them 85% (56) had 0-2 years of experience, compared to 42% (41) of the females (table 4.1.1). Sex was not associated with experience in IRS (p value = 1.000).

Table 4.1.2 Age (n= 114)

Age of spray operators	Frequency	Percent
18-30 years	96	84.2
31-40 years	18	15.8
Total	114	100

Most of these spray operators were between 18- 30 years 84.2% (96) (table 4.1.2).

4.2 Policy Problems that Exist In the Execution of IRHS.

Table 4.2.1 compliance to DDT guidelines

Challenge	Problem area	Response Type	
		Yes	No
If you do use DDT, to what extent do you apply procedures in case of storage guidelines?	Policy challenge	7	1
If you do use DDT, to what extent do you apply procedures in case of use of guidelines?	Policy challenge	4	4
If you do use DDT, to what extent do you apply procedures in case of disposal guidelines?	Policy challenge	7	1
If you do use DDT, to what extent do you apply procedures in case of environmental safe guards?	Policy challenge	4	4
If you do use DDT, to what extent do you apply procedures in case of transportation guidelines?	Operational challenge	6	2

The table shows that program officers complied with most guidelines, except for use guidelines and environmental safeguards where (n=4) said they complied, whereas 4 claimed they did not comply (table 4.2.1).

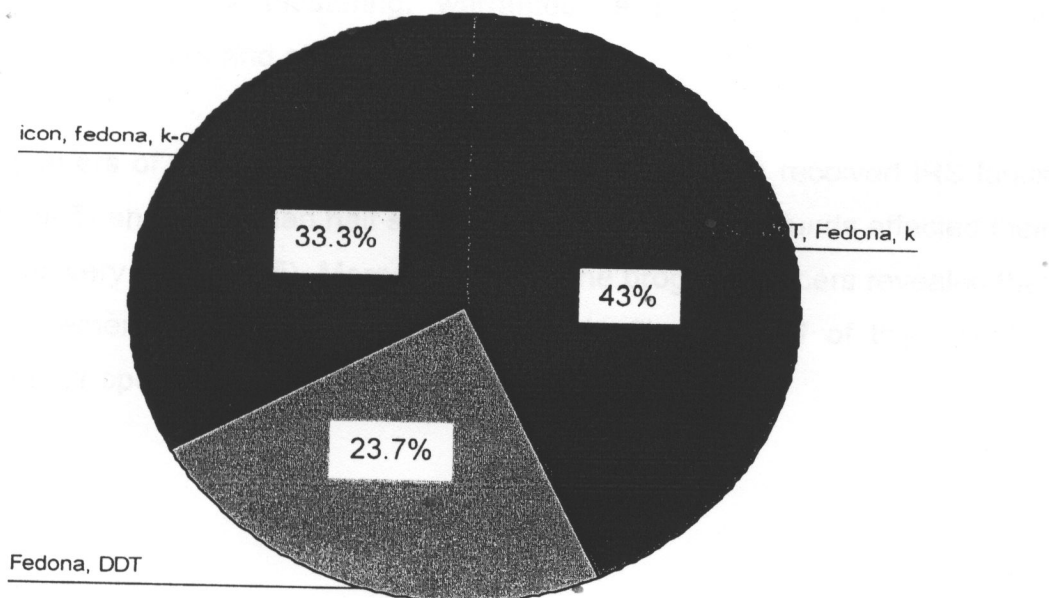
When interviewed concerning the use of DDT and the problems program officers faced, it was noted that even though the policy guidelines were followed, there were serious problems with environmental safeguards and use guidelines. The program officers cited the following: Spillage of DDT on the ground, mechanisms of disposing off of DDT not yet established, DDT was not disposed off correctly as it was being spilled by the spray operators, spray operators used to refuse to carry DDT and could spill it on the ground.

Table 4.2.2 store room checklist

No	Item	Present (+)	Absent (-)	Comments
1.	Thermometer	(+)		
2.	Insecticide <ul style="list-style-type: none"> Name Expiry date 	(+)		All had expiry dates
3.	Concrete floor <ul style="list-style-type: none"> Cracks No cracks 	(+)		Had cracks
4.	2 Doors	(+)		Only one door
5.	Sign post	(+)		
6.	Stock record	(+)		
7.	Ventilation	(+)		but inadequate
9.	<ul style="list-style-type: none"> Overall Rubber gloves Face shields/ goggles Masks Boots 	(+)		Adequate

The checklist showed that the concrete floor had cracks, ventilation was inadequate, and the store room had one door instead of two, while other requirements were available (Table 4.2.2).

Which insecticides do you use?



Spray operators used chemicals invariably and most of them used icon, DDT, Fedona, k-othrine 43% figure (4.2.1).

4.3 Operational Problems That Exist In the Execution of IRS

When asked about how insecticides were carried from one household to another, more than half of the program officers revealed that spray men either carried the insecticides in plastic bags (n=6) or in their pockets (n=2). Three quarter of the program officers said the target was above 85% (n=6), while quarter did not know (n=2). Program officers ranked their spray operator's level of knowledge to be above average (n=5). Majority of the program officers revealed that household members were less likely to be found in their homes in the rain season (n=6).

More than half of the program officers revealed that none of the insecticide is of much concern with resistance (n=5), while less than half said Icon (n=3). They also said that rate of acceptability in the community was average (n=4). Almost all Program officers revealed that residents in the townships refuse IRS (n=7). Program officers revealed that the reasons for the refusal of IRS by the community were that IRS made walls dirty, itching, not effective, excited bed bugs, affected recent plastering, warranted re painting of houses, spray operators are thieves and others just did not want.

Three quarters of the program officers said they sometimes received IRS funds on time (n=5) and more than half said the timely reception of funds affected their operations very much (n=5). More than half of the program officers revealed that the procurement procedure were very short (n=6), and half of them said it affected their operations very little (n=4).

Table 4.3.1 Facilities checklist

1	IRS guidelines		(-)	Were not available
2	Spray pumps	(+)		Not adequate only 117

The checklist revealed that IRS guidelines were not available while spray pumps were inadequate (table 4.3.1)

Table 4.3.2 Availability Challenges (n=114)

Question Type (Availability)	Response Type	
	Yes	No
Are hats available?	114 (100%)	0 (0%)
Are rubber gloves available?	114 (100%)	0 (0%)
Are face fields available?	102 (90%)	12 (10%)
Are masks available?	107 (94%)	7 (6%)
Are long sleeves overalls available?	114 (100%)	0 (0%)
Are gum boots available?	113 (99%)	1 (1%)

Table (4.3.2) shows that the spray men had almost all the protective clothes available.

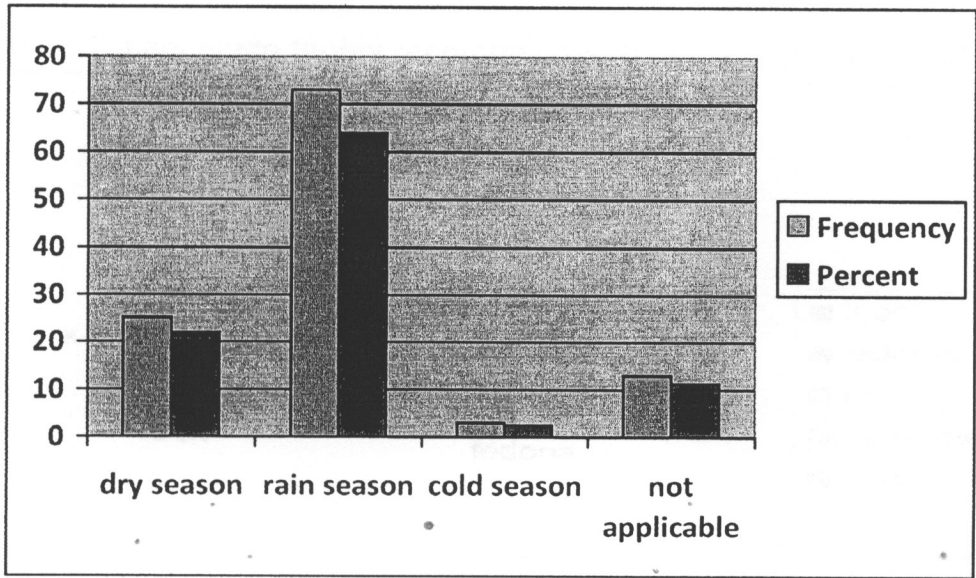
Table 4.3.3 Experience and availability of masks (n=114)

Availability of masks/ respirators	Experienced side effects		
	Itching or rash, sneezing, difficulties in breathing	No problem	Total
Yes	20 (18.7%)	87 (81.3%)	107(100%)
No	5 (71%)	2 (29%)	*7 (100%)
Total	25 (22%)	89 (78%)	114 (100%)

*Note: interpretation should be done with caution because denominator is less than 30.

Table 4.3.3 shows that majority 81.3% (87) of the respondents who said masks/ respirators were available experienced no problem while spraying compared to those who said they were not available 71% (5) experienced itching or rash, sneezing and difficulties in breathing. An association was done and (fishers exact test P value = 0.005 significant at $p < 0.05 \alpha$) **.

Graph 4.3.1 Season when household members are less likely to be found in their homes for IRS (n=114)



Majority 64% (73) of the spray operators said that household members were less likely to be found in their homes in the rain season (graph 4.3.1).

Table 4.3.4 training by level of contribution to operational problems

Rating of training	level of contribution to operational problems		
	Very much to average	Little to very little	Total
Average to poor	12 (70.5%)	5 (29.4%)	*17 (100%)
Good	18 (33.9%)	35 (66%)	53 (100%)
Very good	15 (34%)	29 (65.9%)	44 (100%)
Total	45 (39.4%)	69 (60.5%)	114 (100%)

*Note: interpretation should be done with caution because denominator is less than 30.

Table 4.3.4 shows that Majority 66% (35) of spray operators who rated their level of training as good acquired more skills and had little problems in implementing IRS, compared to 12 who said their level of training was average to poor, with less skill and had very much to average operational problems. (Chi-square = 8.10, df =2, p value = 0.017 significant at $p < 0.05$)**.

Figure 4.3.2 Insecticide highly recommended by the community (n=114)

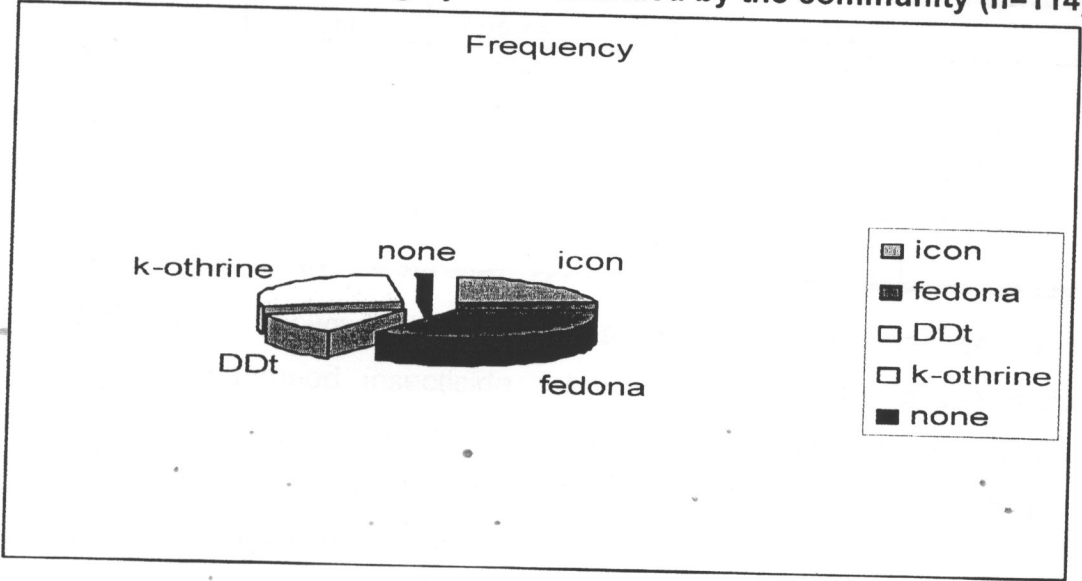


Figure 4.3.2 shows that the highly recommended insecticide by the community was fedona 36.8% (42).

Table 4.3.5 How does sex vary with insecticide highly recommended by the community (n=114)

Sex	Insecticide highly acceptable by the community?					Total
	Icon	Fedona	DDT	k-othrine	None	
Male	14 (21.5%)	29 (44.6%)	3 (4.6%)	17 (26.1%)	2 (3%)	65 (100%)
Female	11 (22.4%)	13 (26.5%)	10 (20.4%)	15 (30.6%)	0 (0%)	49 (100%)
Total	25 (21.9%)	42 (36.8%)	13 (11.4%)	32 (28%)	2 (1.7%)	114 (100%)

Table 4.3.5 shows that there was a relationship between sex and insecticide highly acceptable by the community. 44.6% (29) of the respondent who recommended fedona as the highly acceptable insecticide were males, compared to 26.5% (13) of the females. Chi-square = 10.307, df = 4, p value 0.036 (significant at $p < 0.05 \alpha$).

Table 4.3.6 How does sex vary with insecticide highly condemned by the community (n=114)

Sex	Insecticide highly condemned				Total
	Icon	Fedona	DDT	None	
Male	24 (36.9%)	2 (3.0%)	38 (58.5%)	1 (1.5%)	65 (100%)
Female	35 (71.4%)	6 (12.2%)	6 (12.2%)	2 (4.0%)	49 (100%)
Total	59 (51.7%)	8 (7.0%)	44 (38.5%)	3 (2.6%)	114 (100%)

Table 4.3.6 shows that there was a relationship between sex and highly condemned insecticide. Majority 58.5% (38) of the male respondents said the highly condemned insecticide was DDT, compared to 12.2% (6) females. Chi-square = 25.922, df = 3, p value = 0.000 (significant at $p < 0.05 \alpha$).

Table 4.3.7 Problem experienced with regard to use of IRS chemicals (n=114)

Problem with use of chemicals	Frequency	Percentage
Itching	65	57.0
skin rash and skin irritation	12	10.5
flue / sneezing	4	3.5
loss of appetite, dry mouth and weakness esp. with DDT	5	4.4
blockage of the nozzle with DDT	5	4.4
No problem	23	20.2
Total	114	100

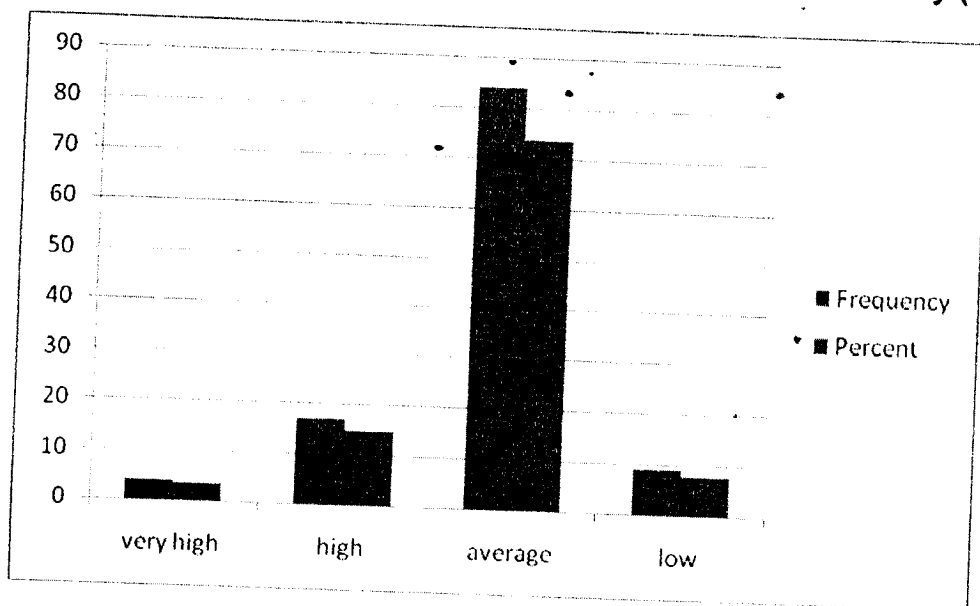
Majority 57% (65) of Spray operators revealed that they experienced itching with regard to use of IRS chemicals, while 20.2% (23) said they had no problems (table 4.3.7).

Table 4.3.8, Reasons for refusal of IRS by the community (n=114).

Reasons for refusal	Frequency	Percent
not effective, don't kill insects	2	10.5
bad smell, dirtens walls, itching effects	59	51.8
recent spraying/ replastering of houses	1	.9
itching effects/ not effective	18	15.8
Lack of information	24	21.1
Total	114	100.0

More than half 51.8% (59) of the spray operators revealed that reasons for refusal were due to bad smell, dirtens walls, and itching effects (table 4.3.8).

Graph 4.3.2 Level of acceptability of IRS in the community (n=114)



Majority 73.7% (84) of the respondents revealed that acceptability of IRS in the community was average (graph 4.3.2)



Table 4.3.9 Rating acceptability of IRS in the community by reasons for refusal (n=114)

Rate of acceptability	Reasons for refusal of IRS		
	itching effect, bad smell, dirtens walls, recent spray/ replastering of houses	Lack of information, not effective, don't kill insects	Total
Very high- high	11 (52.3%)	10 (47.6%)	*21 (100%)
Average – low	70 (75.2%)	23 (24.7%)	93 (100%)
Total	81 (71%)	33 (28.9%)	114 (100%)

*Note: interpretation should be done with caution because denominator is less than 30.

Table 4.3.9 shows that acceptability of IRS in the community ranged from average to low mainly because of bad smell, itching effect, dirtying walls and recent spray/ replastering of houses 75.2% (70), while 24.7% (23) said lack of information, not effective and don't kill other insects. However these proportions were significantly different. (Uncorrected chi-square 4.36 p= value 0.036 significant at $p < 0.05 \alpha$).

Table 4.3.10 Chemicals most recommended by level of acceptability of IRS in the community (n=112)

Chemicals recommended	Level of Acceptability of IRS		Total
	High	Average	
Fedona & K-othrine	9 (42.9%)	48 (52.7%)	57 (50.9%)
Icon & DDT	12 (57.1%)	43 (47.3%)	55 (49.1%)
Total	21 (100%)	91 (100%)	112 (100%)

Table 4.3.10 shows that, 52.7% (48) of the respondents reported that acceptability of IRS in the community was average and the most recommended chemicals were fedona and k-othrine, compared to 42.9% (9) who said it was high. However these proportions were not significantly different (Corrected chi-square = 0.331, df = 1, P value = 0.565).

Figure 4.3.3 Extent of agreement that replastering of walls is an operational problem (n=114).

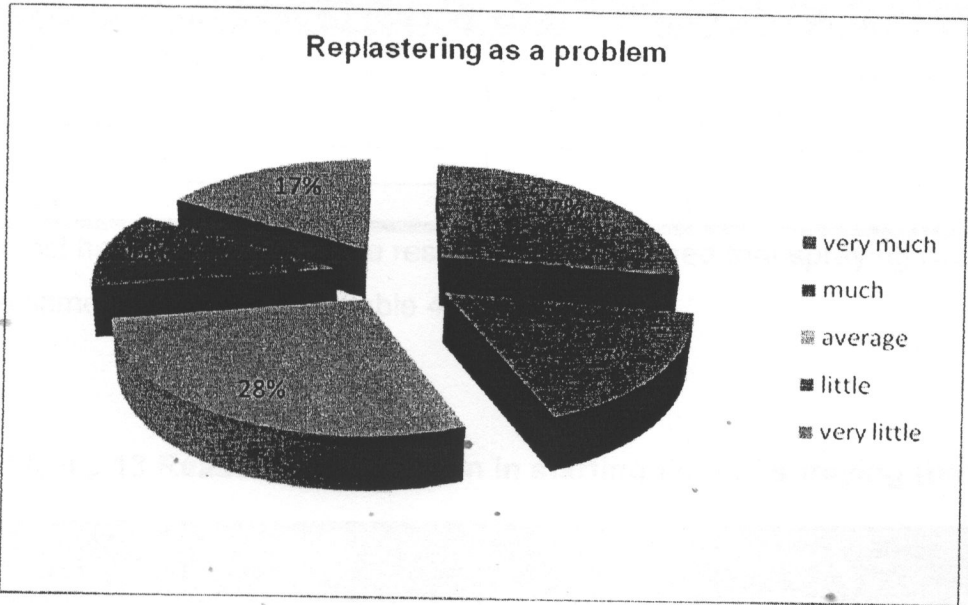


Figure 4.3.3 shows that, less than half 28.1% (32) of the respondents revealed that replastering of walls on average contributed to operational problems.

Table 4.3.11 level of agreement that repainting of walls as an operational problem (n=114)

Level of agreement	Frequency	Percent
very much	32	28.1
Much	27	23.7
Average	27	23.7
Little	9	7.9
very little	19	16.7
Total	114	100.0

28.1% (32) of the Spray operators revealed that Repainting of walls was very much an operational problem (table 4.3.11).

Table 4.3.12 Extent of agreement that spraying is done at the same time every year (n=114).

Level of agreement	Frequency	Percent
strongly agree	15	13.2
Agree	41	36.0
Disagree	51	44.7
strongly disagree	7	6.1
Total	114	100.0

Almost half 44.7% (51) of the respondents disagreed that spraying was done at the same time every year (table 4.3.12)

Table 4.3.13 Reasons for variation in starting time of spraying (n=114)

Reasons for variation	Frequency	Percent
late arrival of funds/ logistics	78	68.4
poor timing/ planning	7	6.1
problems at national level	7	6.1
do not know	22	19.3
Total	114	100.0

Majority 68.4% (78) of the respondents revealed that reasons for variation in spraying time were due to late arrival of funds and logistics (table 4.3.13)

Table 4.3.14 Extent of agreement that spraying is done at the same time every year by reason for variation (n= 114)

Extent of agreement that spraying is done at the same interval	Reasons for variation in spraying		
	Late arrival of funds/ logistics/ poor timing/ planning	Problems at national level/ do not know	Total
Strongly agree/ agree	27 (71%)	11 (28.9%)	38 (100%)
Strongly disagree/ disagree	58 (76.3%)	18 (23.6%)	76 (100%)
Total	85 (74.5%)	29 (25.4%)	114 (100%)

Table 4.3.14 shows that more than half 76.3% (58) of the spray operators strongly disagreed/ disagreed that spraying was done at the same time every year and said reasons for variation were due to late arrival of funds/ logistics / poor timing/ planning, while 23.6% (18) said problems at national level. (Chi-square = 0.37, p value = 0.54).

4.4 Institutional Problems Associated With Implementation of IRHS

The program officers revealed that staffing levels were adequate (n=7) and the numbers fulfilled the establishment needs of the institution much (n=3). The program officers agreed that they provided good services (n=5). Almost all program officers said trained staffs were always available (n=7) during spray time and more than half said trained staff availability affected operations very little (n=5). Program officers said that Personnel attrition rates were very low n=5 and as such, operations were very little affected (n=4). When asked about adequacy of storage facilities, more than half of the respondents disagreed (n=5) that they had adequate storage facilities and half of them said it affected their operations much (n=4).

The program officers claimed that they supervised spray operators daily (n=7) and none had a spray schedule (n=8). The program officers claimed that they adequately sensitized the community (n=4), though none of them had a sensitization plan n=8. More than half of the program officers said that infrastructure resources were sometimes available (n=5).

Table 4.4.1 Facilities Checklist

No.	Item	Present (+)	Absent (-)	Comments
1.	Disposal bay		(-)	Being constructed
2.	Wash bay		(-)	Being constructed
3.	Shower	(+)		Not adequate
4.	Change room		(-)	
5.	Preparation bay		(-)	Being constructed

Facility checklist revealed that, showers were present (+) but inadequate, whereas disposal bay, wash bay, change room and preparation bay were absent (-). All these were being constructed except for a change room (table 4.4.1).

Table 4.4.2 Adequacy of spray men (n=114)

Adequacy of spray operators	Frequency	Percent
very adequate	39	34.2
Adequate	62	54.4
Inadequate	10	8.8
very inadequate	3	2.6
Total	114	100.0

About half 54.4% (62) of the Spray operators revealed that they were adequate to undertake the sought activities (table 4.4.2).

All 100% (114) spray operators revealed that transport was available.

Table 4.4.3 Problems experienced regarding transport (n=114)

Problems experienced	Frequency	Percent
It affects my work	6	5.3
It does not affect my work	9	7.9
Knock off late	3	2.6
No problem	96	84.2
Total	114	100.0

Majority 84.2% (96) of the spray operators revealed that they had no problem with transport, while 2.6% (3) said they knocked off late (table 4.4.3).

Table 4.4.4 Adequacy of wash bay and shower clog (n= 114)

Level of agreement	Frequency	Percent
strongly agree	4	3.5
Agree	29	25.4
Disagree	50	43.9
strongly disagree	31	27.2
Total	114	100.0

Table 4.4.4 shows that 43.9% (50) of the spray operators disagreed that wash bay and shower clog existed while, 3.5% (4) strongly agreed that they existed.

Table 4.5.1 Areas of improvements (n = 114)

Area of improvement	Frequency
1. Give IEC on importance of IRS and community sensitization	51 (44.7%)
2. IRS Program to start early around august to October before the rainy starts	24 (28.8%)
3. Need for adequate funding	18 (15.8%)
4. Government to distribute bed nets for those who agree to have their homes sprayed	7 (6.1%)
5. Government to put more effort in sensitizing the community such as involving the church leaders and traditional rulers, councilors and ward chairmen in IRS programs	4 (3.5%)
6. Government to improve in public partnership	1 (0.8%)
7. Supervision should improve to counter check with work done in the field	5 (4.3%)
8. To change chemicals like DDT as people complain that it dirtens homes, instead K-othrine & Fedona to be used as they kill other vectors.	3 (2.6%)
9. To stop reducing spray days like this year they reduced to 44 days & most houses won't be sprayed as time would not be enough	4 (3.5%)
10. Need to build a shower, changing room & store room to be expanded	3 (2.6%)
11. Also improve on payment of spray operators like K100, 000 per day	5 (4.3%)
12. Also giving enough milk to neutralize the chemicals as the chemicals are very strong	1 (0.8%)
13. No suggestion	10 (6.7%)
14. Need for management & spray operators to work together, supervisors to be involved	1 (0.8%)

Table 4.5.1 shows varied solutions on the area of improvement given by program officers and spray operators. Most respondents indicated that areas needing improvement were giving IEC on importance of IRS and community sensitization 44.7% (51). The least suggested solution was the need for management and spray operators to work together and that supervisors needed to be involved in field work (table 4.5.1).

However one would note that some recommendations (table 4.5.2) were cross cutting and this is because of a relationship based on simultaneous occurrence.

Table 4.5.2 Possible Solutions

Solution to the Challenge	Domain
<ol style="list-style-type: none"> 1. Construction of a wash bay to have a drain where pumps are stored, chemicals and pumps to be separated 2. Renovated available infrastructure 3. Proposed to council management to be given another room for IRS material storage and to improve ventilation as it is very hot 4. Partners have come in to improve the wash bay and showers 5. Extend the store room to cater for all requirements on IRS 6. Chemicals to be placed on the middle to leave room for air circulation in the store room 7. Separate ablution block to be built, build another store room for pumps, have transport for program officers to ease movements, and to have a separate account for IRS as it is put in DHMT account. 	Institutional
<ol style="list-style-type: none"> 8. IEC to be continuous in the community even before IRS starts 9. Integrated vector management- Boam or Doom to be sprayed together with the chemicals 10. To provide transport for program officers to ease movements, and must have a separate account for IRS as it is put in DHMT account. 11. Funding should be done on time from stakeholders, NMGC & MOH 12. Need to procure equipment like printers & photocopiers in place 13. Tender procedures in Lusaka to be done early so that spraying starts early 14. Funding to be increased to enable them procure 2 light vehicles. 1 for the staff & 1 for the water bulser since there is no horse 15. Increase community sensitization 16. Increase number of spray days from 44 days to 70 days 17. If our budget are given or respected the way we have planned 18. Procure more spray pumps 19. Need for adequate sensitization to start prior to spraying 20. Attitude of spray operators to be monitored – spray water instead of chemicals affecting success of IRS 21. Changing of supervisors as they over stay 22. Need for inventory of used & unused chemicals to match with original supply after the exercise 	Operational
<ol style="list-style-type: none"> 23. Ventilation to be improved in the store room 24. Construction of a wash bay to have a drain where pumps are stored 25. chemicals and pumps to be separated 	Policy

CHAPTER FIVE- DISCUSSION OF FINDINGS AND CONCLUSION

5.0 Introduction

The main objective of the study was to determine implementation challenges associated with implementation of IRS in Ndola urban district.

This chapter discusses the findings in line with the research questions. The frame work that is used to present the research findings is driven by de⁵ Vaus, (2001) advice to researchers doing cross sectional research. The sound advice is that, critical issues that are similar are easily organised under a research question and that in this way, critical issues are unlikely to be missed. In this study therefore the themes that represent the key research questions were used to show the findings and these are;

- a. Theme I Policy Problems that Exist In the Execution of IRHS
- b. Theme II Operational Problems that Are Associated With Implementation of IRHS
- c. Theme III Institutional Problems that Are Associated With Implementation of IRHS
- d. Theme IV Solutions to the Problems (Social Actors Accounts)

The chapter is composed of the discussion of the findings using extant data of previous research. This is done in order to illuminate the research problem, to elaborate and support facts with existing data. In this way, the study would grant convergent validation to the data. Limitations and strengths of the study are presented since these play an important role in making suggestions for future research. Then we wind up with the conclusion and recommendations. However, prior to these presentations it is prudent to describe the sample characteristics. This leads us to the demographic characteristics of our respondents.

⁵ De Vaus, A.D. (2001) *Research Design in Social Research*. London: Sage.

5.1 Demographic characteristics of service providers and spray operators.

In this study, majority of program officers were Environmental Health Technicians $n=7$ and Most of them were relatively too new to the IRS program as more than half had served for less than three years $n=5$, noting that it has been in operation for six year. This could influence their supervisory skills to guide the spray operator. Just like program officers, most 85% (96) of the spray operators were males and were relatively new in the IRS program as three quarters of them had served less than three years, compared to 42% (41) of the females (table 4.1.1) and this could affect their skills negatively. The reason could be that exposure to insecticide limits the number of years one has to work as a spray operator which is 2-3 years and not beyond. However sex was not associated with experience in IRS (p value 1.000). Majority 84.2% of the spray operators were in the age group 18-30 years (table 4.1.2) and most of them were males. The explanation could be that, this is the productive age group which is more energetic to move from one place to another in the field and could be unemployed. CSO (2003) documented that youth unemployment is still high with 21% of youths aged 20-24 years being unemployed. The reason for having more males could be that they are readily available and had to provide for their families, than females of the same age group who could be married.

5.2 policy challenges

Our findings revealed that insecticides were not used and disposed off according to the dictates of the policy. The IRS program seems to fare well when it comes to complying with storage, disposal and transport guidelines ($n=7$). However, the IRS program managers have a serious problem in offering guidance in ensuring that the policy guidelines are adhered to. Program officers comply with most guidelines, except for use guidelines and environmental safeguards, $n=4$ said they complied, whereas $n=4$ claimed they did not comply (table 4.2.1). When asked why they were not able to comply with DDT guidelines they revealed that Spray operators used to spill DDT on the ground $n=4$. Basically all the spray

operators are trained during cascade training programme. This is carried out before the start of IRS campaign. The performance of the spray operators depends on the skills of the master trainers and supervision during training and field exercise during the campaign. There was spillage during chemical mix and washing of pumps after spray exercise because there was overcrowding at the wash bay because everyone was rushing and tired. Also there were no plastic sheets used on the ground where these drums were put to prevent spillage of chemicals into the ground since the ground was not paved. During this time supervision lacks resulting in careless behaviour of spray operators. The MOH and NMCC has placed a lot of emphasis on prioritizing adherence to environmental monitoring and safeguards as shown in 2006-2008 action plans for national malaria control, however inadequate infrastructure has been a challenge in most IRS district. In Ndola this could be attributed to inadequate infrastructure like absence of a wash bay where washing of spray pumps can be done, than the drums which were being used to clean and dispose off of the left over chemicals in the pumps. Chapin and Wasserstrom (1981) documented that Spraying programs (especially using DDT) were curtailed due to concerns over safety and environmental effects, as well as problems in administrative, managerial and financial implementation.

A cursory look at their operational office using a checklist showed that most critical elements were adhered to whereas others were not adhered. The Concrete floor had cracks, ventilation was inadequate, and the store room had one door instead of two. A sign post, thermometer, insecticides and a stock record card were available (Table 4.2.2). We believe that construction of a wash bay and shower clog and refurbishment of store room will greatly reduce these policy challenges.

The findings revealed that Spray operators used chemicals invariably according to the type of structure and 43% used icon, Fedona, k-othrine and DDT, figure (4.2.1). Icon, Fedona and K-othrine were used for formal structures and DDT

was used for informal mud houses. These chemicals were among the chemicals recommended for IRS by the WHO standard protocol (WHO 1998). When program officers were asked about resistance to chemicals used, more than half of the program officers revealed that none of the insecticide is of much concern with resistance $n=5$, while $n=3$ said Icon. This finding is in line with Chanda et al (2008) who documented that baseline insecticide susceptibility test conducted on the three malaria species to these chemicals in Zambia showed that there was 100% susceptibility. Therefore insecticide resistance was not a factor in this study

5.3 operational challenges

Spray operators noted that IRS was punctuated with a lot of operational problems. The findings of this study revealed that availability of protective materials does influence operational problems as shown in table 4.3.3 majority 81.3% (87) of the respondents who said masks/ respirators were available experienced no problems while spraying compared to those who said they were not available 71% (5) experienced itching or rash, sneezing and difficulties in breathing. An association was done and the result was statistically significant (P value = 0.005). Therefore we reject the null hypothesis which states that there was no association between availability of masks/ respirator and experienced problem with chemicals. Therefore availability of protective clothing is significantly associated with operational problems. This implies that those who had protective clothing and used them correctly were less likely to experience operational problem associated with exposure to chemicals unlike those who did not have masks/ respirators. Therefore there is need to ensure that adequate protective clothing are provided to each spray operator, at least two pairs instead of one pair which they are given, so that when one is lost, they can easily use the other pair in case of stealing. Some spray operators had their gum boats stolen and were using their own canvases, while others lost their respirators and were using pieces of clothes to cover their nose while spraying.

Also more emphasis should be placed on the importance of using protective clothing during spraying for the safety of the spray operators.

Majority 64% of the spray operators revealed that household members were less likely to be found in their homes for IRS in the rain season (graph 4.3.1) and this was confirmed by most program officers (n=6) who stated that household members were less likely to be found in their homes for IRS in the rain season. Similar findings were reported by Smith et al (1995) and Mills (1992) that effectiveness may be diminished if spray rounds are inappropriately timed in relation to the transmission season. Therefore in Zambia IRS campaign should start before the transmission season and should be completed before the onset of rains. This is justified by Hanson et al (2004) who revealed that both Namibia and Zimbabwe reported decreasing efficiency and effectiveness of spraying programs due to constraints of planning and management.

The findings of this study have revealed that level of training does influence operational problems of spray operators and the relationship was found to be statistically significant (p value = 0.017). 66% of Spray operators who rated their level of training as good acquired more skill and had less problems in implementing IRS than 12 who had average to poor training with less skills and had very much to average operational problems in implementing IRS (table 4.3.4). Therefore we reject the null hypothesis which states that there is no association between level of training and operational problems. The findings are in line with Musawenkosi (2004) who reported that lack of proper supervision and/or skilled personnel is another mitigating factor because effective application of residual insecticides requires properly trained individuals. Therefore there is need for NMCC to improve on supervision and training must be strengthened so that those with inadequate skills can be helped to acquire the necessary skills to ensure quality service delivery which can enhance effectiveness of IRS intervention in malaria control.

The findings revealed that, fedona (Alphacyperthrin) was highly recommended by the community 36.8% (figure 4.3.2). These findings are in line with Rowland et al (2000) on use of Alphacyperthrin in IRS in Pakistan who revealed that, many people expressed appreciation for the spray campaign, since no persistent odour or residue was evident after spraying, and because both nuisance and vector mosquitoes were controlled. Also Curtis (1986) documented that Pyrethroids such as Deltamethrin and lambda-cyhalothrin are usually much more acceptable to householders because they leave no visible deposit on walls. We can infer that when IRS is effectively done using the acceptable chemical by the community, IRS refusals are more likely to reduce thereby increase the coverage and reduce the disease burden.

The study discovered that there was a significant relationship between sex and insecticide highly acceptable by the community (p value 0.036). 44.6% (29) of the spray operators who said the most recommended chemical by the community was Fedona were males, compared to 26.5% (13) of the females (table 4.3.5). This result was statistically significant thereby rejecting the null hypothesis which states that there is no association between sex and insecticide highly recommended by the community.

However, when the most condemned insecticide was compared with sex, the study findings revealed that there was a significant relationship between sex and highly condemned insecticide (p value = 0.000). Majority 58.5% (38) of the male respondents said the highly condemned insecticide was DDT, compared to 12.2% (6) females (table 4.3.6.). These findings are in line with some studies highlighted by Newberry and Jansen (1986), Curtis (1986) and Thurow (2001) which reported that many residents resist spraying of DDT reasons being; the smell lingers, and DDT leaves stain on the walls. Even though DDT leaves stains on the walls, after a period of time and days the powder on the wall falls down and the walls become normal. Therefore there is need to improve on health education regarding the action of this intervention.

While the spray operators were in the field, they experienced adverse effects related to contact with IRS chemicals. The study findings showed that Majority 57% of the Spray operators revealed that they experienced itching with regard to use of IRS, while 20.2% said they had no problems (table 4.3.7). This could be attributed to Exposure of the worker to the pesticides during preparation or IRS, however this can be greatly reduced if the worker follows best practices, Biscoe et al (2007) in RTI international (2007). Unlike the spray operators, complaint of itching effect of Icon from the community was reported as some of the challenges experience during the spray campaign (Ndola RBM report 2007). Therefore lack of skill and knowledge may influence practice towards safety measures in handling the insecticides there by posing operational challenges.

The study revealed that almost all (n=7) program officers said that residents in the townships refuse IRS. Also more than half 51.8% of the spray operators revealed that reasons for refusal were varied and the most noted was due to bad smell, dirtens walls, and itching effects while 18.4% said lack of information (4.3.8). Lack of information on IRS implied that IEC messages were inadequate and poor and should be strengthened so that refusals are reduced and coverage increased to 100% in 2011. This finding was complimented by program officers who said that the reasons for the refusal of IRS by the community were that; IRS made walls dirty, itching, not effective, excited bed bugs, affected recent plastering, warranted re painting of houses, spray operators are thieves and others just did not want. This was in line with Simpungwe (2007) who documented that they faced resistance in some of the compounds during the 2007 spraying program. Similar findings were reported in other studies by Gunasekaran et al (2005) Mnzava et al (1998) and Musawenkosi (2004) that Wall decolourization, bad smell, increase in bed bug nuisance, were some of the reasons attributed for the refusal. Curtis (1986) and Thurow (2001) also highlighted that Many residents resist spraying of DDT reasons being; the smell lingers, and DDT leaves stain on the walls. This shows that residents' complaints

have not been addressed to solve this problem. It is a serious problem which needs immediate attention if IRS is to be successful in Ndola.

In this study, majority 73.7% of the respondents said that acceptability of IRS in the community was average (graph 4.3.2). This was also revealed by program officers who said that rate of acceptability of IRS in the community was average $n=4$. The explanation could be attributed to refusals. Therefore involvement of householders in collaboration with community representatives in IRS intervention is important Coosmans and Carnevale² (2000). Resistance from residents prevents a high percentage of the homes being effectively sprayed; the effectiveness of the intervention is greatly reduced Curtis (1986) and Gladwell (2001). Also Rowland et al (2000) revealed that use of Alphacyperthrin in IRS further revealed that, many people expressed appreciation for the spray campaign, since no persistent odour or residue was evident after spraying, and because both nuisance and vector mosquitoes were controlled.

The study also revealed that there was a significant association between acceptability of IRS and reasons for refusal of IRS by the community (P value 0.036). The findings showed that out of 93 spray operators who rated acceptability of IRS to be between average and low, more than half 75.2% (70) of them said reasons for refusal were mainly; bad smell, dirtying walls, itching effect and recent spray/ replastering of homes, while 24.7% (23) said it was due to lack of information, not effective and don't kill other insects (table 4.3.9). This was in line with Simpungwe (2007) who reported that complaint of rat flea in informal structures was among the challenges experienced in 2007 spray season. This is supported by varied reasons given by spray operators. In view of this NMCC in conjunction with MOH need to consider using of chemicals which are highly acceptable in the community so that acceptability of IRS in the community can be improved thereby increasing IRS coverage to 100% by 2011 and reduce malaria incidence.

The findings of this study have revealed that there was no association between most recommended chemicals and acceptability of IRS (P value = 0.565). More than half 52.7% (48) of the respondents reported that the most recommended chemicals were fedona and k-othrine and said acceptability of IRS in the community was average compared to 42.9% (9) who said it was high (table 4.3.10). However these proportions were not statistically different. Therefore we fail to reject the null hypothesis which states that there was no association between recommended chemicals and acceptability of IRS. This implies that acceptability of IRS could not be accounted to highly recommended chemicals but there could be other factors related to operational problems. This is in line with Musawenkosi (2004) who reported that, the first spray is generally well accepted by the householder, but if the comments of the population are not considered, doors will be closed the following spray rounds and spray coverage will be insufficient.

The study found that repainting / replastering of homes was a significant problem which could be occasioned by bad smell and wall staining and was not a new finding. 28.1% of the Spray operators revealed that Repainting of walls was very much an operational problem (figure 4.3.3). This finding supports that of Mnzava et al (1998) and Gladwell (2001) who reported that after spraying the houses, the community has a tendency of replastering the walls because of the presence of DDT stains. Other findings were those for Mabaso, et al (2004), Tren and Bates (2004) who documented that stains causes some villagers to avoid spraying of their homes or to resurface the wall, which eliminates the residual insecticidal effect of the spraying. A study by Gunasekaran (2005) further revealed that in re-plastered walls anophyles fluviatilis mortality were once or twice reduced to 27% and 13% respectively. At week 16, the mortality was only 19% on walls which had not been re-plastered and, during this period, re-plastering twice brought down the mortality to 5%. This practice compromises the effectiveness of IRS program and calls for evaluation of IRS messages targeted towards the community members. Therefore the communities under

this programme need to be educated not to plaster homes until after 6 months of spraying exercise, because if they did so, mosquitoes won't die and malaria will continue killing people especially pregnant women and children under -5 who are most vulnerable.

The study revealed that almost half 44.7% of the respondents disagreed that spraying was done at the same time every year table (4.3.12), and this was confirmed by both the program officers and spray operators. However, this is contrary to what the IRS guidelines stipulate. The IRS guidelines states that, spraying should be at regular intervals so as to ensure that an effective residue is in place during the whole transmission season. Smith et al (1995) and Deressa (2007) reported that effectiveness may be diminished if spray rounds are inappropriately timed in relation to the transmission season. There are various reasons why the situation is like this. Majority 68.4% of the spray operators said that reasons for variation in spray times were due to late arrival of funds and logistics (table 4.3.13). Program officers also confirmed that they sometimes received IRS funds on time n=5 and more than half said the timely reception of funds affected their operations very much n=5 and was significant. Similar findings were documented by MOH (2006) that there was delay in release of funds. WHO (2006), reported that full potential of IRS can be achieved through high coverage and good timing. Therefore there is need for NMCC to ensure that IRS logistics and funds are released on time so that IRS campaigns starts on time according to the action plan before the malaria transmission season.

The findings further revealed that there is no association between spraying time and reasons for variation in spraying (p value = 0.54). The study showed that more than half 76.3% (58) of the spray operators strongly disagreed/ disagreed that spraying was done at the same time every year and said reasons for variation were due to late arrival of funds/ logistics / poor timing/ planning though were influenced by many factors, while 23.6% (18) said problems at national

level. This shows that there could be other operational factors that influences spray time.

In general the operational problems that we have seen are due to lack of clear link between the program activities and the organization's key strategic priorities.

5.4 Institutional Problems Associated With Implementation of IRHS

The findings revealed that staffing levels were adequate and this was confirmed by all respondents. 54.4% of the Spray operators revealed that they were adequate to undertake the sought activities (table 4.4.2) and the numbers fulfilled the establish needs of the institution for effective implementation of IRS activities. Also program officers said trained staff were always available (n=7) and affected operations very little (n=5), while attrition of staff were low (n=5) and therefore staffing levels and attrition of trained staff were not a factor in this study.

Ndola has severe lack in infrastructural resources to support IRS. According to the findings of this study, almost half 43.9% of the respondents disagreed that shower and wash bay facilities were adequate, while 3.5% strongly agreed that they were adequate (table 4.4.4). Verification using a checklist confirmed that wash bay was not available and showers were present but inadequate causing institutional problems. The study also revealed that all (100%) of the spray operators revealed that transport was available though hired, however these transports used did not meet the transport regulations and were very expensive. The vehicles used, carried both chemicals and spray operators and did not have warning sign for chemicals. Also majority 84.2% confirmed that they had no problems regarding transport (table 4.4.3). However a few 2.6% reported knocking off late and 5.3% said it affected their work. A checklist showed that transport was not available for IRS but it was hired. Serious inadequacies were evident in transport, disposal bay, preparation bay, wash bay, and change rooms were not available and shower clog were not sufficient. As a result the spray operators used to bath and wash their overalls at their homes which was a

wrong practice, as all washing is supposed to be done in a washing bay. This finding was in line with challenges documented by MOH (2008) action plan that transport was inadequate in most IRS districts. Therefore insufficient logistic highly impinged on daily operations of service providers in IRS and contributed to non adherence to some of the policy guidelines. These findings were also highlighted by Simpungwe (2007) who said that transport was hired and there was need for a wash bay, shower and clogs for males and females. However, on the positive aspect the wash bay and shower clog were being constructed. Therefore MOH in conjunction with NMCC should consider procuring vehicles for transportation of chemicals and IRS logistics as well as IRS service providers during the IRS campaign.

When asked about adequacy of storage facilities, more than half ($n=5$) of the program officers disagreed that they had adequate storage facilities and half ($n=4$) of them said it affected their operations much. These findings are in line with what was reported by the MOH in 2008 national malaria action plan that there were inadequate storage facilities in most IRS district. However these findings contradict what was document by Simpungwe (2007) in the Ndola RBM report that Ndola had adequate storage facilities. However both the program officers and spray operators were in agreement that storage facilities were inadequate as highlighted in their recommendations (table 4.5.2), this was also verified using a checklist. Checklist also verified that storage facilities were inadequate such that chemicals and equipments like spray pumps were stored in the same room and ventilation was inadequate. Among issues identified for global funding round 7 was improving storage facilities in 2007 action plan, however this issue has not yet been addressed in Ndola as such storage facilities does not meet the standard guideline as stipulated by WHO and ECZ. Also Spray pumps were inadequate 117 were available against 120 spray operators. This is mainly the problem of inadequate logistics which needs immediate attention to improve IRS coverage. Also IRS guidelines were evidently missing and had negative impact on daily operations as they are guiding principles to effective implementation of IRS. In view of this there is need

for NMCC to ensure that money for building and refurbishment of store room is released so that the existing infrastructure can be improved according to WHO and ECZ guidelines. Also there is need to ensure that enough logistics are provided like spray pumps to the districts.

5.5 Solutions to the Problems (Social Actors Accounts)

When program officers and spray operators were asked as to how the various problems could be solved, there proposals were targeted at improving operations and institutional structures (table 4.5.1). There was very little related to policy though policy measures have a direct bearing on operations and institutional structures. Spray operators gave varying reasons and most 44.7% (51) respondents indicated that areas needing improvement was giving IEC on importance of IRS and community sensitization. The least suggested solution was the need for management and spray operators to work together and that supervisors needed to be involved in field work 0.8% (1). This is very crucial and shows that IEC messages on IRS are inadequate and need to be strengthened. However one would note that some recommendations (table 4.5.2) are cross cutting and this is because of a relationship based on simultaneous occurrence or sequential occurrence. There is need for policy and decision makers to carefully analyze and see how best the solutions suggested by service providers can be incorporated at national level to solve some of the challenges in the implementation of IRS.

5.6 Limitations and strengths of the study

The study was conducted without the involvement of communities who happen to be consumers of the service and as such their views could have added impetus to the study. The limitations of community involvement were obvious in academic research on account of time and cost. But we have the views of the program officers and thus, we do not feel that these limitations would have caused major changes in our findings.

Notable strengths of the study are that it is the first known research to focus explicitly on IRS in Ndola from a public health perspective. This study is an initial

step toward addressing the various problem areas that program officers and spray operators sighted that constrained service delivery. The study also contributes towards the scientific world knowledge on program evaluation and it is hoped that the results could be used by the program manager for purposes of program design improvements and operations. Population study has been done and findings can be generalized to Ndola urban district and other IRS districts in the country despite purposive sampling because they have similar characteristics like Ndola.

5.7 Conclusion according to research questions

The study was carried out in order to determine challenges associated with implementation of IRS in Ndola urban district.

The study revealed that there was lack of adherence to use guidelines and environmental safeguards. Insecticides were not used and disposed off according to the dictates of the policy as spray operators used to spill DDT on the ground. This was mainly due to inadequate or non availability of desired infrastructure.

The program had a lot of operational challenges, which included non availability of household members in the rain season, they declined their homes to be sprayed claiming that IRS made walls dirty, itching to household members, was not effective, excited bed bugs, affected recent plastering, warranted re painting of houses and others just did not want, as a result acceptability of IRS was average. Other operational challenges included replastering of houses; logistics and funds in most cases were partially available and contributed to the untimely IRS execution. We see that policy challenges and institutional factors eventually impinged on daily operations of IRS programme.

The IRS program has less institutional problems. It has adequate staff levels of all categories and the numbers fulfill the establishment needs of the institution. However, the institution fails to account for all its activities. There was no program officer for instance who had a sensitization schedule. It is six years now from 2003 the time IRS was launched in Ndola and there is a severe lack in infrastructural resources to support IRS. Serious inadequacies were evident in transport (hired), Spray pumps were inadequate (117 were available against 120 spray operators), storage facilities (inadequate), wash bay, change room (not available) and shower clog are not sufficient and IRS guidelines were evidently missing. These were noted to have an effect on the program's operations

A mechanism or framework to solve various IRS program related challenges was not advanced at all except that program officers and spray men were preoccupied with on spot solutions. Among others, include; Integrated vector management, intensify IEC on community sensitization in IRS, funding to be done early from stakeholders and NMCC as shown on (table 4.5.1 and 4.5.2).

5.8 General conclusion

The study findings have policy, operational and institutional implications. The high financial and economic burden which malaria places on households urgently requires effective IRS control measures. The MOH in conjunction with NMCC has put in a lot of resources to improve IRS intervention in malaria control. Evaluation of IRS program in Ndola has shown that IRS can substantially reduce the incidence of malaria and its associated economic consequences, and should be promoted. The findings have shown that IRS target can be maintained from 85% to 100% through increased IEC in the community which can reduce the percentage of refusals so that IRS coverage goes up. It has clearly demonstrated that acceptability of IRS in the community was average because the percentage of refusals was very high and reasons included mainly; dirtens walls, Bad smell, itching effect and lack of information on IRS as the IEC was poor. This protocol found that there are logistic problems surrounding IRS program which may hamper reaching 100% target by 2011 these mainly include; inadequate spray pumps, and infrastructure, lack of transport and late arrival of funds/ logistics for IRS program at the District. The skills of spray operators were negatively associated with their level of training. The data in this review also demonstrate a striking pattern relating to the negative implications of non adherence to policy and lack of program integrated monitoring and evaluation to address institutional and operational plans. It can be said that because of lack of strict adherence to policy guidelines and a poor institutional structure, have resulted into the serious operational problems that we have highlighted. The IRS program seems not to take account of the views of all stakeholders and this requires addressing through community participatory research action. In view of this, we would say that acceptance and cooperation by house owners are higher with better health education and more involvement in planning. Therefore one of the key challenges of IRHS program is supervision and ownership by districts to have plan B in evaluating that resources and funds have not arrived on time and there are no targets for the way forward. Therefore all the districts should have plan B in case there is delay in the arrival of funds.

5.8. Recommendations for improving IRS

- There is need for the districts to have contingency funds from their own funds. Resources should be mobilized from stakeholders as a contribution to maintain continuity of the IRS programme, so that there is no delay in starting of IRS campaign.
- Ndola DHMT should request NMCC in conjunction with MOH to prioritize early funding of IRS activities; procure more spray pumps and vehicles (2 light trucks) to ease movements during the spray time and transportation of equipment and chemicals.
- Need for NMCC and the district to ensure that there is continuous community sensitization on IRS throughout the year using different channels of communication, so that the messages reach the intended target groups in the community especially women. The message should include the importance of IRS, its action, and why walls should not be replastered after spraying and its benefits to the family, community and nation as a whole. This should involve the key people in the community like the chiefs or councilors to ensure strong advocacy and social support.
- Institutional structures like store room for IRS must be refurbished and where they are not available must be constructed according to the ECZ and WHO standard guideline on Infrastructure for IRS.
- NMCC in conjunction with MOH and ECZ should ensure that the DDT is handled with care without environmental contamination by ensure that wash bay, preparation bay, and shower clog are available in all IRS district to prevent environmental pollution.
- NMCC in conjunction with MOH need to consider using of chemicals which are highly acceptable in the community so that acceptability of IRS in the community can be improved thereby increasing IRS coverage to 100% by 2011 thereby reducing malaria incidence.
- There is need to invest in operational research resulting in malaria development of other types of insecticide and we are building up on this

point which was stated in previous research by Korrick et al., (2001); Rogan and Chen (2005) and Fenster et al., 2006).

- There is also need for improvement on capacity building and supervision must be strengthened to ensure that service providers in IRS are adequately trained for them to render quality service to the community.
- Also implementation of a monitoring and evaluation plan will show whether the programme was well implemented and conducting audits will investigate whether an activity met explicit standards as defined by an auditing document.
- The study must be duplicated on a larger scale in other geographical areas to enable generalization of results. Also a study should be done in the community to identify the gaps in IRS and how challenges can be addressed from the community point of view.

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APPENDICES

APPENDIX I: INFORMED CONSENT

EVALUATION OF INDOOR RESIDUAL HOUSEHOLD SPRAYING: CHALLENGES FACED BY NDOLA URBAN DISTRICT.

INTRODUCTION

I am Vivian Mwiinga; a student of masters in public health from university of Zambia kindly requesting for your participation in the research study stated above. Before you decide whether or not to participate in this study, I would like to explain to you the purpose of the study, any risks or benefits and what is expected of you. Your participation in this study is entirely voluntary. If you decline to participate, no sanctions or privileges will be taken away from you (Miley et al., 2007). If you agree to participate, you will be asked to sign the consent in my presence. Agreement to participate will not result in any immediate benefits.

Purpose of study

To explore implementation challenges related to indoor residual household spraying. The study will assist to obtain information on problems service providers experience in implementing indoor residual spraying. The study will help health care managers and policy makers to come up with strategic decisions that can improve IRS intervention in malaria control.

Procedure

This study involves a face to face interview with the staff that will ask you questions using a semi-structured questionnaire. After you have signed the consent form, I will ask you questions on implementation of IRS and your responses will be recorded on the questionnaire. The interviews may be recorded if you would be willing. A checklist will be used on programme officers to validate responses from the interview schedule. You will also be given a chance to make suggestions on how IRS implementation can be improved to attain desired results. The interview will take about 30 minutes.

Risks and discomforts

There are no risks or harm involved in this study though part of your time will be utilised to answer some questions. However, the researcher will endeavour to minimise any immediate and subsequent potential discomforts as a result of participating in this research. If you decide to take part in the study, you will be asked if the researcher could ask you some of the questions on IRS program, particularly about your experiences and observations. Your name will not be on any tape or paper or report if you agree to have the interview recorded and after the interview is typed, the tape will be kept under lock and will be destroyed three years after the study. However, if you feel uncomfortable or decide to

decline to take part or stop everything, you have to do so voluntarily. The researcher who would be responsible for the study is not a member of any health management or regulatory board and that your participation will not have any harm in any way.

Benefits:

Noting the many steps the ministry of health and local government are taking to reduce malaria infection, the study will make considerable contribution in public health by enhancing strategic planning. There is however no guaranteed direct benefits to you immediately on account of this research, but education will be given on how IRS can be effectively done.

Confidentiality:

Your research records and any information you will give will be confidential to the extent permitted by law. You will be identified by a number and personal information will not be released without your written permission except when required by law. The ministry of health, the University of Zambia Research ethics Committee or the School of Medicine may review your records again but this will be done with confidentiality.

Informed Consent form

The purpose of this study has been explained to me and I understand the purpose, the benefits, risks and discomforts and confidentiality of the study. I further understand that: If I agree to take part in this study, I can withdraw any time without any sanctions and that taking part is purely voluntary.

I.....agree to take part in this study.

Signed Date (Participant)

Witness's name sign

PERSONS TO CONTACT FOR PROBLEMS AND QUESTIONS

1. Vivian Mwiinga, University of Zambia Dept. of community medicine, box 50110, Lusaka. Cell: 0977415569
2. Professor K.S Baboo, University of Zambia Dept of Community medicine, box 50110, Lusaka, Zambia.
3. The Chair Person, Research Ethics Committee, University of Zambia, P.O box 50110, Lusaka. Telephone: 256067.

APPENDIX II: BUDGET

ITEM	QUANTITY	UNIT COST	TOTAL COST
1.Stationary			
(a) A4 paper	5 reams	K35,000	K175,000
(c) Pens	10	K1,500	K15,000
(d) Pencils	10	K1000	K10,000
(e) Rubbers	5	K1000	K5,000
(f) Tipex	4	K10,000	K40,000
(g) Files	5	K5000	K25,000
(h) CDs	2	K10,000 x 2	K20,000
(i) Flash disk	1	K300,000	K300,000
(j) Stapler	1	K40,000	K40,000
(k) Staples	1	K10,000	K10,000
z(l) Scientific calculator	1	K80,000	K80,000
(m) Flip charts	2	K40,000	K80,000
(n) Markers	6	K3,000	K18,000
(o) Tape recorder	1	K120,000	K120,000
(p) Tapes	5	K3000	K15,000
(q) Bags	2	K70,000 X 2	K140,000
(r) Note books	3	K8,000 x 3	K24,000
Subtotal			K1,117,000
2 Services			
(a) Statistical consultant	1	K750,000	K750,000
(b) Printing dissertation	1 x 100 pages	100 x K2000/pg	K200,000
(c) printing questionnaire	1 x 12 pages	12 x K2000/pg	K24,000
Photocopying dissertation	4 x 100 pages	400 x K300/ pg	K120,000
(d) Photocopying questionnaire	130 x 12 pages	1560 x K300/ pg	K468,000
(e) Data analysis	1	K1,000,000	K1,000,000
(f) Binding dissertation for examiners (spiral)	5	5 x K15,000	K75,000
(h) Binding final dissertation	5	5 x K250,000	K1,250,000
(i) Payments ethics committee	1	K250,000	K250,000
Subtotal			K4,137,000
3. Field work			
(a) lunch allowance			
(i) Principal researcher	1	K50,000 x 60days	K3,000,000
(ii) Research assistants	2 x 30,000	K60,000 x 60 days.	K3,600,000
b)Transport allowance- site locally			
i) Research assistants		K60,000 x 60 days	
ii) Principle researcher	2 x 30,000	K30,000 x 60 days	K3,600,000
c) Transport - Lusaka to Ndola	1 x 30,000		K1,800,000
i) Principal researcher		K150,000 x 8 trips	
d) Snacks for participants	1		K1,200,000
i) long life Milk		K4000 x 129	
ii) Pie	1 x 4000	K6000 x 129	K516,000
	1 x 6000		K774,000
Subtotal			K14,490,000
Total			K19,744,000
Contingency 10%			K1,974,400
GRAND TOTAL			K21,718,400

BUDGET JUSTIFICATION

A total of K21, 718, 400 (twenty-one million, seven hundred and eighteen thousand, four hundred kwacha) was required for stationary, services, and field work expenses in order to carry out this research successfully.

Stationary, other services and field work expenses were needed. Printing services were needed for printing of dissertation and questionnaire. Photocopying services were required for the questionnaires, draft dissertations for examiners and final dissertation copies for distribution. Also bags were needed for carrying questionnaires, calculators were used during data analysis, and tape recorder was used during interviews. Flash disks required for data storage and CDs for backup. Other accessories like pencils, books, pens etc were used during routine collection of data.

Field work

The researcher needed two research assistants to assist during data collection. The researcher and research assistants needed lunch allowance and transport allowance to facilitate movements from one place to another while in the field. Principal researcher also needed transport allowance outside Ndola, thus from Lusaka to Ndola which is the research site during data collection. **Contingency** of 10% of the total budget was required to cover extra costs or inflation of prices.

APPENDIX IV: INTERVIEW SCHEDULE (PROGRAMME OFFICERS)

**THE UNIVERSITY OF ZAMBIA
SCHOOL OF MEDICINE
DEPARTMENT OF COMMUNITY MEDICINE**

STRUCTURED INTERVIEW SCHEDULE (PROGRAMME OFFICERS)

**TOPIC: IMPLEMENTATION CHALLENGES ASSOCIATED WITH INDOOR RESIDUAL
HOUSEHOLD SPRAYING IN NDOLA URBAN DISTRICT.**

DATE.....

PLACE OF INTERVIEW.....

NAME OF INTERVIEWER.....

SERIAL NUMBER.....

INSTRUCTIONS FOR THE INTERVIEWERS

1. Introduce yourself to the respondent and explain the purpose the interview.
2. Do not write the respondent's name on the interview schedule to ensure anonymity
3. Get verbal consent from the respondents before the interview
4. Tick and complete responses in appropriate spaces provided
5. All information provided by respondent should be kept in strict confidence.
6. Allow respondents to ask questions at the end of the interview

SECTION A: DEMOGRAPHIC DATA

1. Sex

Male	Female

2. Number of years of experience in IRS

1-2 years	3- 4 years	5- 6 years	Above 7 years

3. What is your Profession?

Doctor	Nurse	Clinical officer	Environmental H.Tech.	Others specify

SECTION B: POLICY⁶ CHALLENGES^{*}

Guidelines

4.What chemicals do you use for IRS?

DDT	Icon	Fedona	DDT, Icon and Fedona

5. If you do use DDT, to what extent do you apply the procedures?

	Yes	No
1. Storage guidelines		
2. Use guidelines		
3. Disposal guidelines		
4. Environmental safe guards		
5. Transportation guidelines		

6. Depending on the response above, what problems are you facing?

.....

.....

.....

SECTION C: INSTITUTIONAL⁷ CHALLENGES

Quality of care

7. Are staffing levels adequate?

yes

No

⁶ What policy challenges exist in the execution of IRHS?

⁷ What institutional challenges are associated with implementation of IRHS?

8. To what extent do the numbers fulfill the establishment needs?

Very much	Much	Average	Little	Very little

9. On average how many insecticides does each spray man carry on daily basis?

10. How are these insecticide carried from one household to another?

11. How would you rate the quality of service you provide?

Very good	Good	Average	Poor	Very poor

Service delivery

12. To what extent do you agree that spraying is done at the same time every year?

Strongly agree	Agree	Disagree	Strongly disagree

13. Please show me your spray schedule

Available	Not available

14. Depending on the response, I probe for variations?

15. To what extent, do you stick to your laid down action plan on IRS?

Always	Sometimes	Rarely	Never

16. Please show me your plan

Available	Not available

17. Depending on the response, I probe for variations from the laid down procedure?

IRS coverage

18. What is the coverage like of IRS?

High	Medium	Low

19. Kindly avail me with your recent targets.....

20. To what extent do you think the training received by spray men is adequate to grant them the required skill?

Very adequate	Adequate	Just average	Inadequate	Very inadequate

21. How often do you supervise the spray men when in the field?

Daily	Weekly	Monthly	Yearly

22. Please show me your supervisory notes and plan

Available	Not available

23. To what extent is community sensitization adequate?

Very adequate	Adequate	Inadequate	Very inadequate

24. Please show me your sensitization plan

Available	Not available

Sustainability

25. Depending on your past experience on funding, do you have adequate funds to sustain IRS programmes in Ndola?

Strongly agree	Agree	Disagree	Strongly disagree

26. How would you rate availability of infrastructural resources?

Always available	Sometimes available	Rarely available	Not available

SECTION D: OPERATIONAL CHALLENGES⁸

Knowledge

27. To what extent do you rate the level of knowledge of spray operators?

Very high	High	Just average	Low	Very low

28. Depending on your response above, to what extent does their knowledge contribute to operational problems?

Very much	Much	Just average	Little	Very little

29. During which season are household members less likely to be found in their homes for IRS?

Dry season	Rain season	Cold season	Not applicable

Acceptability

30. Depending on your experience, which insecticide is of much concern with resistance?

Icon	Fedona	DDT	None	Do not know

31. How would you rate acceptability of IRS in the community?

Very high	High	Average	Low	Very low

32. Do the residents refuse IRS? ☐ Yes ☐ No

33. Would you mention reasons for refusal of IRS by the community?

- Bad smell, dirtens walls
- Dirty on walls, itching, not effective
- Itching effects, not effective
- Recent plastering/ painting of houses, not effective

⁸ What operational challenges are associated with implementation of IRHS?

e) Not effective, do not want

Logistics

34. Do you receive funds for IRS programme on time?

Always on time	Sometimes	Rarely	Never

35. To what extent does the timely reception affect your operations?

Very much	Much	Just average	Little	Very little

36. How would you rate the procurement procedure?

Very long	Long	Short	Very short

37. To what extent does the procurement procedure affect your operations?

Very much	Much	Just average	Little	Very little

38. Are trained staffs readily available during spray time?

Always available	Sometimes	Rarely	Not available

39. To what extent does trained staff availability affect your operations?

Very much	Much	Just average	Little	Very little

40. To what extent is the attrition of trained staff?

Very high	High	Medium	Low	Very low

41. To what extent does the attrition of trained staff affect your operations?

Very much	Much	Just average	Little	Very little

42. Do you have adequate storage facilities?

Strongly agree	Agree	Disagree	Strongly disagree

43. To what extent do storage facilities affect your operations?

Very much	Much	Just average	Little	Very little

44. Depending on the above, what measures have you instituted?

.....
.....

45. In your opinion how best can these challenges be addressed if IRS programme is to be successful.....

The end.

APPENDIX V: INTERVIEW SCHEDULE FOR SPRAY MEN

THE UNIVERSITY OF ZAMBIA
SCHOOL OF MEDICINE
DEPARTMENT OF COMMUNITY MEDICINE

STRUCTURED INTERVIEW SCHEDULE

TOPIC: IMPLEMENTATION CHALLENGES ASSOCIATED WITH INDOOR RESIDUAL
HOUSEHOLD SPRAYING IN NDOLA URBAN DISTRICT.

DATE.....

PLACE OF INTERVIEW.....

NAME OF INTERVIEWER.....

SERIAL NUMBER.....

INSTRUCTIONS FOR THE INTERVIEWERS

1. Introduce yourself to the respondent and explain the purpose the interview.
2. Do not write the respondent's name on the interview schedule to ensure anonymity
3. Get verbal consent from the respondents before the interview
4. Tick and complete responses in appropriate spaces provided
5. All information provided by respondent should be kept in strict confidence.
6. Allow respondents to ask questions at the end of the interview

SECTION A: DEMOGRAPHIC DATA

1. Sex

Male	Female

2. Age

18 - 30 years	31- 40 years	41- 50 years	Above 51 years

3. Number of years of experience in IRS

0-2 years	3- 4 years	5- 6 years	Above 7 years

SECTION B: OPERATIONAL CHALLENGES⁹

Knowledge

4. Which insecticides do you use?

Icon, DDT, Fedona	Icon, DDT	Fedona, DDT	Icon, Fedona	Do not know

5. What problems are you experiencing with regard to their use?

.....

6. Regarding the answer above, what is the frequency of use?

Less than 6 months Icon & Fedona	6 months Icon & Fedona	More than 6 months DDT	Do not know

7. What are the dosages?

10 liters/ 2 sachets- Icon or fedona, 1 sachet DDT	10litrer water/ 2 sachets of icon & fedona	10 liters/ 1 sachet of DDT	Do not know

IRS coverage

8. To what extent do you rate the level of training you received?

Very good	Good	Just average	Poor	Very poor

9. Depending on your response above, to what extent does your level of training contribute to operational problems?

Very much	Much	Just average	Little	Very little

⁹ What operational challenges are associated with implementation of IRHS?

Acceptability

10. Depending on your experience, which insecticide is highly recommended by the community?

Icon	Fedona	DDT	None

11. Which one is highly condemned by the community?

Icon	Fedona	DDT	None

12. How would you rate acceptability of IRS in the community?

Very high	High	Average	Low	Very low

13. Would you mention reasons for refusal of IRS by the community?

Not effective does not kill cockroaches	Bad smell, dirtens walls, itching effects	Recent painting/ replastering of houses	Itching effects, not effective	Do not want	Lack of information

Service delivery

14. To what extent do you agree that spraying is done at the same time every year?

Strongly agree	Agree	Disagree	Strongly disagree

15. Depending on your response, what do you think contribute to such variations?

Late arrival of funds/ logistics	Poor timing/ planning	Problems at national level	Do not know

16. To what extent do you agree that replastering of walls is an operational problem?

Very much	Much	Average	Little	very little

17. To what extent do you agree that repainting of walls is an operational problem?

Very much	Much	Average	Little	very little

18. Depending on the above, what measures have you instituted to address replastering/painting of homes after spraying?

Logistics

19. To what extent do you believe that trained spray men are adequate?

Very adequate	adequate	Inadequate	Very inadequate

20. Do you have adequate shower and wash bay facilities?

Strongly agree	Agree	Disagree	Strongly disagree

21. Are rubber gloves available?

☐ yes

☐ No

☐ yes

☐ no

22. Are hats available?

☐ yes

☐ no

23. Are face fields available?

☐ yes

☐ no

24. Are masks available?

25. Are long sleeves overalls ☐ yes ☐ No available?

26. Are gum boots available?

☐ yes

☐ no

27. What do you experience regarding availability of rubber gloves?

Itching or skin rashes	No problem at all	Any other specify	

28. What do you experience regarding availability of hats?

Itching or skin rashes	No problem at all	Any other specify	

29. What do you experience regarding availability of face shields?

Itching or skin rashes	No problem at all	Any other specify	

30. What do you experience regarding availability of masks?

Itching or skin rashes	No problem at all	Any other specify	

31. What do you experience regarding availability of long sleeves overalls?

Itching or skin rashes	No problem at all	Any other specify	

32. What do you experience regarding availability of gum boots?

Itching or skin rashes	No problem at all	Any other specify	

33. Do you have transport?

Yes	No

34. What do you experience regarding availability of transport?

Delay in moving from one place to another	Delay in starting spraying	Knocking off late after spraying	No problem at all

35. On average how many insecticides do you carry in the field on daily basis?

.....

36. During which season are household members less likely to be found in their homes for IRS?

Dry season	Rain season	Cold season	Not applicable

37. What suggestions would you recommend that can improve your operational problems?

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

The end.

Thank you very much for participating in this study.

APPENDIX VI: CHECKLIST FOR PROGRAMME OFFICERS

**THE UNIVERSITY OF ZAMBIA
SCHOOL OF MEDICINE
DEPARTMENT OF COMMUNITY MEDICINE**

OBSERVATION CHECKLIST (PROGRAMME OFFICERS)

**TOPIC: IMPLEMENTATION CHALLENGES ASSOCIATED WITH INDOOR RESIDUAL
HOUSEHOLD SPRAYING IN NDOLA URBAN DISTRICT.**

DATE.....

PLACE OF INTERVIEW.....

NAME OF INTERVIEWER.....

SERIAL NUMBER.....

INSTRUCTIONS FOR THE INTERVIEWERS

1. Introduce yourself to the participant and explain the purpose the observation.
2. Do not write the name of the participant on the observation checklist to ensure anonymity
3. Get verbal consent from the participant before the observation
4. Tick the observations in appropriate spaces provided
5. All the observation notes should be kept in strict confidence.
6. Thank the participant at the end of each observation

COMPLIANCE TO IRS GUIDELINES SCORING SYSTEM FOR PROGRAMME OFFICERS

No	Action	Standard score
1.	Storage <ul style="list-style-type: none"> • Location-away from homes, water sources • Floor – concrete with no cracks • Emergency exist- two exists clearly marked • Adequate ventilation – no direct sunlight • Warning sign – no un authorized entry • Kept under lock and key 	6
2.	Use of insecticide <ul style="list-style-type: none"> • No woman who is pregnant or child under 16 years of age shall be employed in the handling of pesticides or toxic substances. 	1
3.	Disposal <ul style="list-style-type: none"> • Waste Solidification/Fixation • Packaging Materials Disposal • Export • Return To Manufacturer 	4
4.	Availability of protective clothes <ul style="list-style-type: none"> • Rubber gloves • Hat • Face shield • Mask • Long sleeved overalls • Gum boots 	6
5.	Availability of general practice guidelines <ul style="list-style-type: none"> • Do not eat, drink or smoke while working. • Wash hands and face with soap and water after preparing each spray pump and before eating, drinking or smoking. • Bath or shower after work each day and change into clean clothes. • Overalls should be washed at the end of every day's work. • Inform your supervisor immediately, if you feel unwell. 	5
6.	Availability of equipment <ul style="list-style-type: none"> • Spray pumps • Insecticides • Transport 	3
7	Availability of cleaning facilities <ul style="list-style-type: none"> • Wash bay • Bathing facilities 	2
8.	TOTAL SCORE	27

STORE ROOM CHECKLIST

NO.	ITEM	PRESENT (+)	ABSENT (-)	COMMENTS
1.	Thermometer			
2.	Insecticide <ul style="list-style-type: none"> Name Expirely date 			
3.	Concrete floor <ul style="list-style-type: none"> Cracks No cracks 			
4.	2 Doors			
5.	Sign post			
6.	Stock record			
7.	Ventilation			
8.	Spray pumps			
9.	<ul style="list-style-type: none"> Overall Rubber gloves Face shields/ goggles Masks Boots 			

FACILITIES CHECKLIST

NO.	ITEM	PRESENT (+)	ABSENT (-)	COMMENTS
1.	Disposal bay			
2.	Wash bay			
3.	Bathroom			
4.	Change room			
5.	Preparation bay			
	IRS guidelines			

APPENDIX VIII: LETTER TO THE DISTRICT DIRECTOR OF HEALTH

The University of Zambia
School of Medicine,
Department of Community medicine
Box 50110,
Lusaka.
14/08/08.

The District Director of Health
Ndola District Health office
Box
Ndola.

Dear sir/ madam,

Re: Application for permission to collect data on indoor residual spraying in Ndola Urban District

I refer to the above subject matter and would wish to apply for the same. I am a master of public health student at the above mentioned institution. In partial fulfillment of this program, I am expected to carry out a research study.

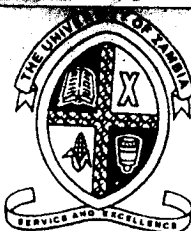
My research topic is **"Evaluation of Indoor Residual household spraying: challenges faced by Ndola urban district"**.

The study will involve interviewing program officers and spray operators. Data will be collected from September to November 2008.

Your earliest consideration will be highly appreciated.

Yours faithfully,

Vivian Mwiinga



THE UNIVERSITY OF ZAMBIA

BIOMEDICAL RESEARCH ETHICS COMMITTEE

Telephone: 260-1-256067
Telegrams: UNZA, LUSAKA
Telex: UNZALU ZA 44370
Fax: + 260-1-250753
E-mail: unzarec@zamtel.zm

Ridgeway Campus
P.O. Box 50110
Lusaka, Zambia

Assurance No. FWA00000338
IRB00001131 of IORG0000774

23 October, 2008
Ref.: 018-09-08

Ms Vivian Myiinga
Department of Community Medicine
School of Medicine
University of Zambia
LUSAKA

Dear Ms Mwiinga,

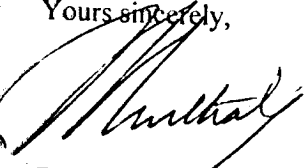
RE: RESEARCH PROPOSAL ENTITLED: "EVALUATION OF INDOOR RESIDUAL
HOUSEHOLD SPRAYING: CHALLENGES FACED BY NDOLA URBAN DISTRICT"

The above-mentioned research proposal was presented to the Research Ethics Committee meeting held on 30 September, 2008 where changes were recommended. We would like to acknowledge receipt of the corrected version with clarifications. The proposal has now been approved.

CONDITIONS:

- This approval is based strictly on your submitted proposal. Should there be need for you to modify or change the study design or methodology, you will need to seek clearance from the Research Ethics Committee.
- If you have need for further clarification please consult this office. Please note that it is mandatory that you submit a detailed progress report of your study to this Committee every six months and a final copy of your report at the end of the study.
- Any serious adverse events must be reported at once to this Committee.

Yours sincerely,


Dr E. Munalula-Nkandu, BSc (Hons), MSc, PgD R/Ethics, PhD
CHAIRPERSON

Date of approval: 23 October, 2008

Date of expiry: 22 October, 2009

Correspondence should be addressed to the
Permanent Secretary
Telephone: +260 1 253040/5
Fax: +260 1 253344



REPUBLIC OF ZAMBIA
MINISTRY OF HEALTH

In reply please

No.

NDEKE HO
P. O. BOX
LUSAKA

2nd June, 2008

The District Director of Health,
Ndola District Health Office,
NDOLA.

Dear Dr. Kakungu,

RE: AUTHORITY FOR MS. VIVIAN MWIINGA, A MASTER OF PUBLIC
HEALTH (MPH) STUDENT TO COLLECT DATA FOR HER STUDY
IN NDOLA URBAN DISTRICT

Ms. Vivian Mwiinga, a student pursuing a Master of Public Health (MPH) at the University of Zambia (UNZA). In partial fulfillment of the degree, she is required to conduct a research study and her topic is "Challenges Associated with Indoor Residual Household Spraying in Ndola Urban District." Therefore, she requires to collect data for her study from Ndola Urban District.

The purpose of this letter is to request your office to accord Ms. Ms. Mwiinga the necessary support to enable her collect the data for her study.

Dr. S.K Miti
PERMANENT SECRETARY

PM 12/15
Fya
09/06/08

DEHE : DHO
fya
09/06/08