



Republic of Botswana

**REPORT ON THE EVALUATION OF INDOOR
RESIDUAL SPRAYING (IRS) IN BOTSWANA**

**NATIONAL MALARIA CONTROL PROGRAMME
MINISTRY OF HEALTH
REPUBLIC OF BOTSWANA**

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ABBREVIATIONS AND ACRONYMS

DDT	Dichloro-Diphenyl Trichloroethane
DEH	Department of Environmental Health
DHMTs	District Health Management Teams
EHOs	Environmental Health Officers
ELISA	Enzyme-linked immunosorbent Assay
GIS	Geographical Information System
GPS	Global Positioning System
GR	Geographical Reconnaissance
IEC	Information, Education and Communication
IRS	Indoor Residual Spraying
IVM	Integrated Vector Management
LLINs	Long-lasting Insecticidal Nets
LSM	Larval Source Management
MAL	Malaria
MoH	Ministry of Health
MoLG	Ministry of Local Government
M & E	Monitoring and Evaluation
NMP	National Malaria Program
NPO	National Program Officer
NTD	Neglected Tropical Diseases
PCR	Polymerase Chain Reaction
PDA	Personal Digital Assistants
QA	Quality Assurance
QC	Quality Control
RBM	Roll Back Malaria
SOPs	Standard Operating Procedures
TOT	Training of Trainers
WCO	World Health Organization Country Office
WHO	World Health Organization

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EXECUTIVE SUMMARY

Indoor residual spraying (IRS) program in Botswana was reviewed to assess the national and district capacities to organize, coordinate and implement the program. Routine annual IRS is conducted in ten districts. The 2010-2015 National Strategic Plan aims to eliminate malaria in Botswana by 2015 through the implementation of a combination of strategies including IRS. The assessment was conducted through consultative meetings with National Malaria Program (NMP) Team, field visits to three districts to meet with District Health Management Teams and literature desk review.

Among the findings of the assessment were that the NMP structure is strong with offices in Gaborone and Francistown. The district councils implement IRS with supplies, training and supervision from the Entomology Unit of NMP. The NMP has the capacity to organize and coordinate implementation of IRS program. However, the recent relocation of IRS activities from Ministry of Local Government to Ministry of Health poses a challenge that requires urgent attention.

Although NMP infrastructural, technical and logistical capacities are adequate, annual IRS operational coverage over the past ten years has remained below 77%. The IRS program performance is wrongly calculated on the basis of rooms sprayed against the rooms found. The district plans do not contain target sprayable rooms and timelines of activities. The target sprayable rooms and estimates of IRS requirements are not determined as part of planning using geographical reconnaissance (GR) information. GR is not conducted in target areas and planning is based on previous years' consumption. GR should be conducted to guide IRS planning and operations.

According to the 2009 malaria stratification, only Okavango is in Zone A, Chobe, Ngami, Boteti and Bobirwa in Zone B and Tutume, Charleshill, Kgatlieng, Letlhakeng and North East are in Zone C. Based on this, blanket spraying in districts in Zones B and C is not cost-effective. Targeted IRS and other anti-vector measures should be deployed on the basis of in-depth stratification of the malaria problem to a focal level.

The supervision from NMP is irregular and there is no close supervision of spray operators by team leaders. Supervision from district and national levels should be carried out routinely and consistently throughout the period of the spraying and spray team leaders should constantly and closely monitor spray operators in order to ensure high quality spraying coverage.

The NMP has a well-established vector surveillance system which generates entomological data from six sentinel sites. However, both the entomological laboratory and insectary are not functional because there is no humidifier in the insectary and PCR and ELISA machines in the laboratory. In order to define and map the vector distribution towards implementation of targeted anti-vector measures, the two facilities must be equipped.

In conclusion, the Botswana NMP has adequate capacity to deliver timely and quality anti-vector control interventions towards malaria elimination. However, challenges that relate to capacity at district level, planning of IRS operations, supervision, equipment in the insectary and laboratory and focal malaria stratification for targeted application of anti-vector measures including larval control need immediate attention. This report gives some recommendations to address the challenges and the adoption and implementation of the recommendations will help the program to achieve a malaria free Botswana by 2015.

1 INTRODUCTION

Vector control interrupts malaria transmission by reducing the vector life span and overall population density. Indoor residual spraying (IRS) and long-lasting insecticide-treated net (LLIN) are the primary malaria vector control interventions. Larval source management (LSM), while effective in specific ecological settings in the context of Integrated Vector Management (IVM), is less generally applicable across most of the malaria endemic countries.

The National Malaria Program (NMP) in Botswana combines IRS and LLINs strategies towards malaria elimination. The main objective of malaria vector control in the country is to achieve universal coverage of IRS and LLINs by 2012 in all targeted districts in order to increase the number of malaria free districts to 100% by 2015.

Botswana has maintained the use of IRS for many decades with significant success. The existing National Strategy Plan (2010-2015) (NSP) aims to achieve malaria elimination in the country by 2015. In this regard, the NMP conducted a Malaria Program Performance Review (MPR) in 2009 whose report recommended among others to review the IRS program with a view to reorient it towards malaria elimination. The present mission reviewed the malaria vector control in Botswana with emphasis on IRS to guide the NMP to implement selective and targeted anti-vector measures.

2 TERMS OF REFERENCE

- To assess the implementation process of the IRS program in Botswana
- To assess the NMP capacity to organize, coordinate and implement the IRS program
- To assess the capacities of the District teams for IRS implementation
- To review IRS SOPs and data collection tools
- To produce an assessment report with recommendations to improve IRS program.

3 METHOD OF WORK

The method of work involved consultative meetings with NMP and field visits to districts to meet with District Health Management Teams (DHMTs). At these meetings presentations on malaria vector control in Botswana were made with particular emphasis on IRS. At national level two presentations were made; one on the overview of malaria and the strategies used to eliminate malaria and the other on malaria vector control in Botswana. The two presentations were followed by a discussion to obtain more information on the processes of implementation of malaria vector control with focus on technical, infrastructural and logistical capacities for planning, implementing, monitoring and evaluating malaria vector control in the country. To supplement the presentations, relevant national strategic documents were provided.

At district level presentations and discussions were carried out to assess the processes and capacities for implementation of malaria vector control. Emphasis was on planning, implementing, monitoring and reporting the IRS program. A visit to the Entomology Unit in Francistown was made. The unit is responsible for providing technical support for malaria vector control in the country. Technical, infrastructural and logistical capacities were assessed through presentations by the Head of the unit and visits to facilities (insectary,

insecticide storage and laboratory). The above activities ended with the writing of the assessment report and debriefing on the mission findings to the NMCP.

3.1 Meeting with NMP Team to assess process of IRS implementation

The objective of the meeting with the NMP Team was to assess the process of IRS implementation in Botswana including the selection of areas for spraying, geographical reconnaissance, estimation of required resources and procurement, collection of entomological data and vector surveillance system, training of spray operators, conducting spraying and supervision, quality and coverage of spraying and reporting.

The NMP organized a meeting which was attended by 8 NMP members. The WHO/NPO/MAL was also in attendance. The meeting was officially opened by NMP Manager who also was the chairperson. Dr S Chihanga, the NMP Public Health Specialist made a detailed presentation on malaria elimination in Botswana followed by a presentation by Dr Masendu, the Entomology Unit Head on the capacity and role of the Entomology Unit in malaria vector control in Botswana. The two presentations were thoroughly discussed.

To assess the capacity of the NMP to organize, and coordinate the IRS program in Botswana, a second consultative meeting was held on the following day with the NMP Manager and her team. Discussions centered on the organizational structure of the NMP, the existing infrastructural, technical and managerial capacities of the NMP, the process of IRS implementation including planning, implementation, monitoring and evaluation. The roles of the NMP unit in Gaborone, the Entomology unit in Francistown and the district councils were further elucidated.

3.2 Meeting with Director of Ministry of Local Government

The objective of the meeting with Mr S Ludick, Acting Director, Primary Health Care Department, Ministry of Local Government (MoLG) was to assess government policy direction on IRS program at district level in view of the relocation of malaria vector control activities from MoLG to Ministry of Health (MoH).

3.3 Literature review to assess IRS program management tools

The NMP made available strategic documents that provided background information on malaria vector control in Botswana. These documents also served to assess the availability of policy documents, guidelines, manuals and data collection tools for IRS. The documents that were made available included Malaria Strategic Plan (2010-2015), Malaria Policy (2011), Guidelines for Malaria Vector Control in Botswana (2007), Malaria Program Performance Review Report (2009), Advocacy and Communication Strategy for Malaria (2009), Entomology Unit Annual and Operational Reports and data collection tools and SOPs.

3.4 Field visits to the Districts to assess district capacity to implement IRS

In the company of members of NMP, North East, Boteti and Kweneng districts were visited to assess the capacities of the districts for implementing the IRS program. In each district, meetings were held with the DHMT where presentations on the implementation of the vector control program were made with particular emphasis on IRS. The DHMTs were asked to

describe the district capacities that included human resource, supplies and logistics. In addition, the districts were also asked to give a description of how they plan and implement IRS and to highlight the challenges which they face in the implementation of IRS.

4 MISSION FINDINGS

4.1 Country profile

Botswana is a landlocked country situated in central Southern Africa and shares borders with Zambia, Zimbabwe, Namibia and South Africa. The country has an estimated population of 1,755,246 people who are unevenly distributed with most of them residing along the eastern part of the country. Despite the fact that north-western part of the country constitutes 61% of the country's surface area, only 13% of the population live in the area.

Climate is largely semi-arid with the average annual rainfall from October to April ranging from 250mm in the southwest to 650mm in the North West. Average daily temperature ranges from 22°C to 33° C in January and the daily minimum temperature ranges from -5°C in July to 19°C in January.

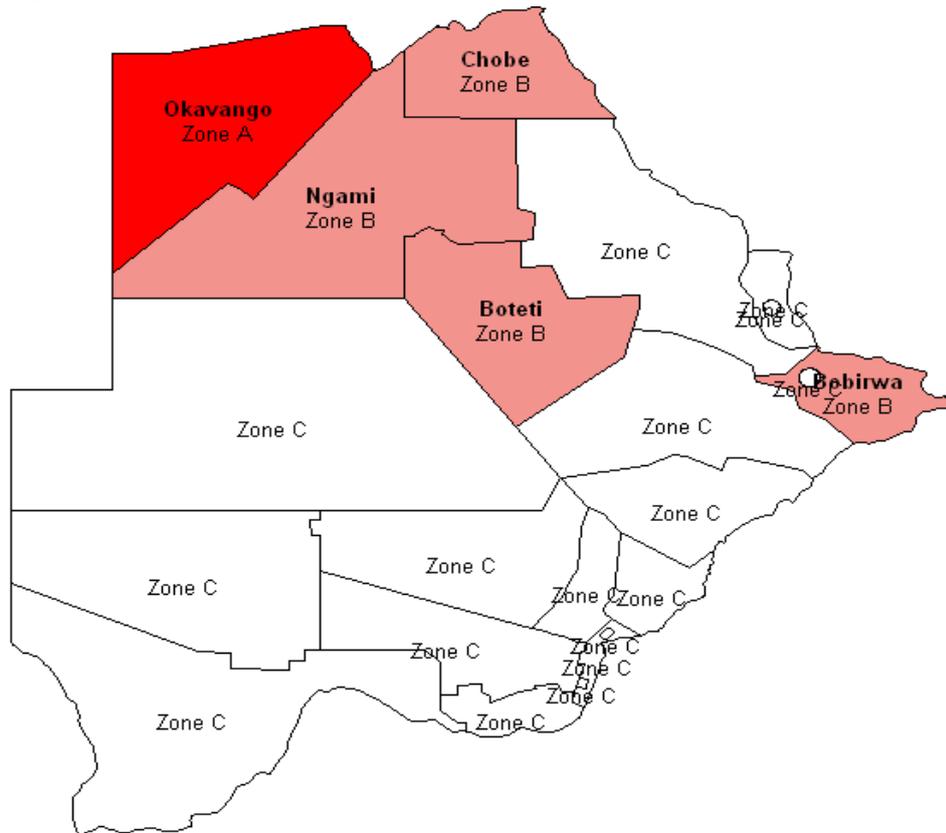
4.2 Malaria profile in Botswana

Malaria transmission in Botswana is seasonal and unstable and is related to the level of rainfall which varies considerably from year to year. Malaria transmission occurs between November and May with a peak in March and April. About 32% of the population live in malarious areas. Transmission is endemic in Okavango and low in Chobe, Ngami, Boteti, Tutume, Bobirwa and North East (Fig 1). In years of heavy rainfall, the malaria transmission belt can move southwards causing sporadic malaria cases in the traditionally non-malarious areas.

4.3 Malaria epidemiological zones

The current operational classification of malaria epidemiology in Botswana is based on 2007-2009 malaria cases per 1000 population. Three zones are recognized in the country (Fig 1). Malaria epidemiological profile shows a marked focal distribution with a mixture of new in Zone C, moderate high in Zones A and low in Zone B. Malaria transmission is no longer homogeneous in Zone B but focalized. As Botswana moves to elimination, finer epidemiological stratification in Zone B is essential for determining the most feasible vector control tools. The current WHO classification of foci is based on their age (residual or new) and presence of malaria transmission (non-active or active). As Botswana moves towards malaria elimination, in-depth operational stratification of foci in each zone is imperative for guiding the selection and extent of focal application of anti-vector measures.

Fig. 1. Malaria Transmission in Botswana



Zone A – Endemic areas
Zone B – Non-endemic areas with significant malaria cases
Zone C – Non-endemic areas with sporadic malaria cases

4.4 Malaria Parasites and Vectors

In Botswana, *Plasmodium falciparum* is responsible for over 98% of all reported malaria cases. *Plasmodium vivax* and *Plasmodium malariae* constitute the remainder. The main vector of malaria in Botswana is *Anopheles arabiensis*. Historical data suggest that *Anopheles gambiae* s.s. and *Anopheles funestus* existed in Botswana but were decimated by IRS. *An. arabiensis* breeds in temporary and sunlit freshwater and feeds both indoors and outdoors and rests both indoors and outdoors making it a difficult vector to eliminate with IRS and ITNs.

4.5 Malaria control in Botswana

Malaria elimination strategies in Botswana combine vector control, case management, epidemic preparedness and response, information, education and communication (IEC) and surveillance, monitoring and evaluation. Malaria control started in the 1950s focusing mainly on vector control. A comprehensive NMCP was launched in 1974 as a vertical program but later decentralized to the district level in 1998. The program has offices in Gaborone and Francistown. The Gaborone office is responsible for overall co-ordination of the program, malaria surveillance, IEC, and case management. The Francistown office is responsible for entomological work and vector control. At the district level malaria vector control activities are implemented by the DHMTs without a malaria specific focal point.

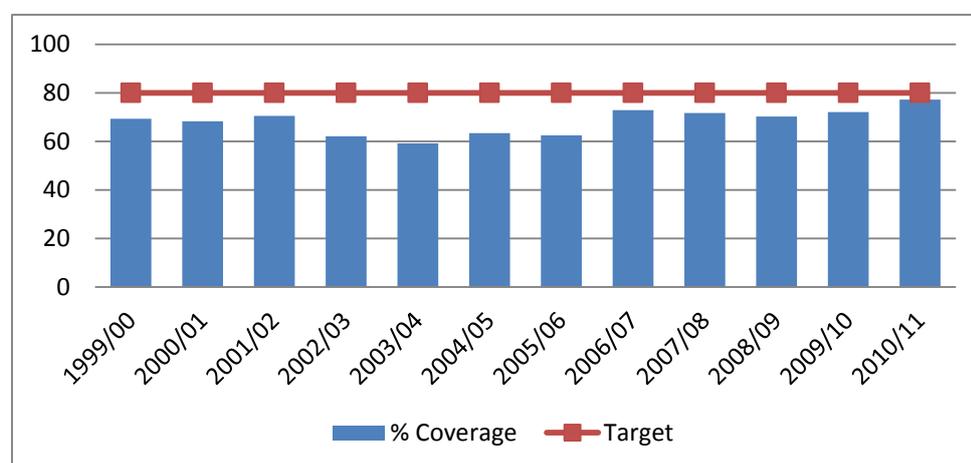
4.6 Malaria Vector Control

4.6.1 Indoor Residual Spraying

The main vector control strategy in Botswana is IRS. The use of IRS dates back to the 1950s when DDT was the insecticide of choice until it was replaced by lambda-cyhalothrin in 1998. Lambda-cyhalothrin remained in use until 2010 when DDT was reintroduced. Currently both insecticides are used for IRS in the country. The district councils conduct IRS with technical inputs on insecticides, training and supervision from the Entomology Unit.

Routine annual IRS is conducted in ten districts: Ngami, Okavango, Chobe, Tutume, Boteti, Tonota, Bobirwa, Ghanzi, Charleshill and North East. All households are targeted for spraying in all the districts except in Bobirwa where only some parts of the district are sprayed. Over the past ten years, annual IRS operational coverage has remained below 77% (Fig 2).

Fig 2. IRS Coverage Botswana 1999 – 2011



4.6.2 Long-lasting Insecticide-treated Nets

Insecticide treated nets were first introduced as a pilot in Chobe district in 1992 and extended to other endemic districts in 1994. However, since 1994, ITN coverage in endemic areas remained low until 2009 when LLINs were distributed in Okavango, followed by Chobe, Ngami, Tutume, Boteti and Bobirwa to universal coverage in 2010 (Table 1). There is no routine distribution of LLINs through ANC clinics and EPI outreaches to maintain universal coverage.

Table 1. LLINs distribution

District	Target population	Total accumulative LLINs	LLINs gap
Bobirwa	22,128	12,903	0
Tutume	44,291	32,000	0
Chobe	21,412	29,750	0
Okavango	63,302	407,750	0
Ngami	72,358	47,750	0
Boteti	52,776	26,000	0

4.6.3 Larviciding

Larviciding has not been implemented on a large scale in Botswana. Preliminary surveys have been undertaken to assess the role of the bio-larvicide Bti (*Bacillus thuringiensis israelensis*) in Tutume district. As Botswana moves to malaria elimination, larval control becomes extremely important to complement the primary interventions in all the identified malaria foci in Zones A and B and in malaria free areas to prevent re-establishment of transmission.

The purpose of anti-vector measures at the stage of pre-elimination and elimination of foci is to achieve sustainable interruption of malaria transmission and to prevent the re-establishment in malaria-free areas. The deployment of anti-vector tools should be based on the in-depth stratification of the malaria problem to a focal level. Elimination of residual foci in which transmission is caused by the exophilic fraction of the anopheline mosquitoes is by the use of anti-larval measures. In endemic malaria zones, a combination of IRS, LLINs and larval control is preferred. The combination compensates for deficiencies of each individual method.

5 THE IMPLEMENTATION PROCESS OF IRS PROGRAM

5.1 *Strategic Policy Direction on IRS Program in Botswana*

The goal of the NMP in Botswana is to achieve zero local malaria transmission in the country by 2015. The main objective of malaria vector control in the country is to achieve universal coverage of IRS and LLINs by 2012 in all targeted districts in order to increase the number of malaria free districts to 100% by 2015. To guide the implementation of the malaria vector control, NMP in collaboration with partners developed a Malaria Strategic Plan (2010-2015), Malaria Policy (2011), Guidelines for Malaria Vector Control (2007), Advocacy and Communication Strategy for Malaria (2009) and conducted a Malaria Program Performance Review in 2009.

5.2 *Selection of Areas for malaria anti-vector measures*

There are 10 districts (Tutume, Boteti, Okavango, Charleshill, Ghazi, Ngami, Chobe, North East Torota and Bobirwa) are currently sprayed annually and 6 district (Okavango, Chobe, Ngani, Tutume, Boteti and Bobirwa) that received LLINs. According to the 2009 malaria stratification, only Okavango is in Zone A; Chobe, Ngami, Boteti and Bobirwa in Zone B; and Tutume, Charleshill, Kgatlieng, Kweneng and North East are in Zone C. Based on this, spraying in districts in Zone C is unnecessary. Our findings in North East district support this view: all reported cases were imported within Botswana (2 in 2009 and 2 in 2010) with 0 cases in 2011). The current blanket spraying of districts in Zone C is not cost-effective. In zones A and B, transmission is again not homogenous and the zones need to be further divided into transmission malaria foci.

The purpose of anti-vector measures at the stage of pre-elimination and elimination of foci is to achieve sustainable interruption of malaria transmission and to prevent the re-establishment in malaria-free areas. The deployment of vector control tools should be based on the in-depth stratification of the malaria problem to a focal level (Table 2).

- Implement universal coverage with IRS and LLINs in Zone A.
- Implement universal coverage with IRS and LLINs in identified residual active malaria foci in Zone B.
- Implement universal coverage with IRS in identified new active foci in Zone C
- Implement selective larval control in all the zones with focus in zones B and C.
- Conduct vector surveillance and larval control in malaria free areas to prevent re-establishment of transmission

Table 2. Differences in vector control approaches in pre and elimination modes

Phase	Strategy	Activities
Pre-Elimination	IRS	<ul style="list-style-type: none"> • Identify residual foci and produce maps • Conduct geographical reconnaissance in all residual foci • Collect entomological baseline data • Quantify commodities and procure • Conduct QA/QC on IRS commodities • Conduct TOT and cascade training • Conduct IRS campaigns in all residual foci • Supervise using supervisory checklist • Monitor quality of spraying using bioassay • Vector surveillance in each residual foci • IRS Review, planning and report
	LLINs	<ul style="list-style-type: none"> • Identify residual foci and produce maps through GR • Quantify commodities, procure and distribute • Conduct QA/QC on LLIN commodities • Mobilize and sensitize communities • Conduct LLIN distribution campaigns • Monitor quality of LLIN using bioassay
	LSM	<ul style="list-style-type: none"> • Conduct inventory of breeding sites and produce maps • Quantify and procure larval control commodities • Train larval control teams • Treat all larval positive sites and monitor • Modify / manipulate the breeding sites
Elimination	IRS	<ul style="list-style-type: none"> • Identify residual foci and produce maps • Conduct geographical reconnaissance in all residual, new foci • Quantify commodities and procure • Conduct QA/QC on IRS commodities • Conduct TOT and cascade training • Mobilize and sensitize communities • Conduct IRS campaigns in all residual and new foci • Supervise using supervisory checklist • Monitor quality of spraying using bioassay • Vector surveillance in each residual and new foci • IRS Review, planning and report
	LSM	<ul style="list-style-type: none"> • Identify breeding sites in all residual, new foci, • Train larval control teams • Treat all larval positive sites and monitor • Modify / manipulate the breeding sites

6 DELIVERY OF IRS CAMPAIGNS

6.1 Plan of action for operations

The NMP invites districts to annual planning and review meetings which provide a forum in which to review the planning and implementation progress. The districts produce their plans based on the NMP plan.

The district plans according to a district visited, focus more on the budget and logistics without mention of activities, target structures and time frames. This omission could be one of the reasons for the supply of inadequate of insecticide and logistics in some districts during 2010/2011. GR is not conducted in target areas and planning is based on previous years' consumption. Planning or quantifying annual IRS commodities based on previous consumption is not the correct method and will always lead to overestimation or underestimation of resources needed for IRS. Because the plans lack timelines, some districts do not start and finish spraying in time.

It is important that district teams should produce plans that contain target areas, required amount of resources, supplies and logistics; and timelines of activities (Table 3). NMP should procure commodities at least 4-6 months before the start of spraying.

6.2 Geographical reconnaissance

The current IRS program performance is based on calculating the rooms sprayed against the rooms found. This clearly shows that IRS requirements are not estimated on the basis of information obtained through geographical reconnaissance (GR). The target sprayable rooms and estimates of IRS requirements are not determined as part of planning using GR information.

GR provides the relevant information on the target area to guide planning and operations of vector control interventions. It provides map of the area with its boundaries showing the location of all the foci (active, non-active), hydrological features and road networks (available routes, cattle posts, roads to and within the area), landscape divisions, health facilities, all houses and mosquito breeding sites. The information is then used in developing district operational plans based on the number of structures in the malaria foci, type and distribution of the structures to be sprayed, total surface area to be sprayed and estimated IRS requirements.

To help with the detailed recording of structures during GR or room counting, households should be rapidly geo-referenced, mapped and recorded in the field using integrated handheld personal digital assistants (PDA) fitted with a global positioning system (GPS). This data can then be added to base maps to provide detailed map of target IRS areas. Base maps can be obtained using computer software such as the WHO Health Mapper for use by district malaria management teams. This mapping database can be updated with information on the location of households by entering household numbers, together with their details on a handheld GPS and or PDA.

6.3 Estimation of IRS Requirements

Several factors need to be considered while establishing the quantities of required resources. In establishing the number of structures for spraying, population figures from the target areas will be used. The number of house units per household will be determined using Population and Housing Census data. With the above information, the total sprayable surface area for the target areas can be estimated which will guide calculation of amount of insecticide required, number of spray operators, sprayers, protective clothing, transport needs, supervisors and spraying duration. Tables 4-8 show examples of the calculation of sprayable surface and IRS requirements.

Table 4: The required information to calculate sprayable surface areas by district

District	Population	# Households	#Target structures	Sprayable surface (m ²)
Total				

Table 5: IRS Supplies estimates

District	Insecticide needed (g)	Sachets needed	Pumps needed	Spare parts needed	Personal protection kit	Shoulder bag	# Trucks	vehicles
Total								

Table 6: IRS Accessories Estimation

District	Basins	Drums	Jerry cans	Calico cloth	Bar soap	Sieves	Funnels	Measuring cylinder	Storage facility
Total									

6.4 IRS Manpower needs estimates and organization

The success of the IRS campaign lies on the spray teams and their supervisors. In order to maximize the efficiency and effectiveness of the spray teams, they should consist in no more than six persons per team. Each team will have a team leader to report all team activities and submit the spray record to his or her field supervisor. The field supervisor will have no more than five teams under his control (this structure can be modified according to field conditions and the amount of area that a team needs to cover). The field supervisor will collate and summarize all his or her team's activities and provide his Districts Supervisor with the information. This district supervisor will use the information to keep track of the spray progress to determine the coverage achieved and inform the national supervisor.

Table 7: IRS manpower Estimates

District	No. of structures	# Spray operators	# Spray teams	# Drivers	# Supervisors (District)	# Supervisors (National)
Total						

Table 8: Summary Analysis of IRS spray requirements

Target population				
IRS needs	Item description	Quantity	Unit cost	Total cost
Manpower	Spray operators			
	Supervisors (District)			
	Supervisors (National)			
	Drivers			
Supplies	Insecticide (sachets)			
	Protective clothing			
	Shoulder bags			
Equipment	Pumps			
	Spare parts			
Transport	Trucks			
	Vehicles			
	Fuel and maintenance (trucks)			
Operations	Training (TOT)			
	Training of spray operators			
	M&E and IEC			
	Accessories			
Total				

6.5 Training of spray teams

The NMP conducts two levels of training. The first level training is the training of district supervisors as trainers (TOTs) which is conducted in August each year for 7 days by the Entomology Unit. The second level is the training of locally recruited spray operators in targeted areas. The training of spray operators is conducted for 14 days by trained district supervisors in September. The visit to North East District showed that the district sprays 43 villages using 36 spray operators divided into 2 teams of 14 with 1 supervisor, 2 drivers and a Field Assistant.

Spray operators are often casual or employed from the community for a short period (two to three months). Spray operators should be at least 18 years old, with no criminal record, be physically fit and healthy (with no skin conditions), have no obvious disabilities that would limit his or her mobility and be able to operate the sprayer. The operator should be able to read and write. Women who are breastfeeding, pregnant or planning to be pregnant are not eligible for recruitment. Training should be for a minimum of seven days.

6.6 Timing and duration of spray rounds

Spraying is done once per year from October to December. The procurement of supplies and logistics is done in May/June. Training of supervisors is in August and in September for spray operators followed by spraying between October and December. Supervision of spraying is done by local staff from MLG and by entomologists from the NMP.

There are still unresolved issues of relocating IRS activities in districts from MoLG to MoH. Discussions with the Acting Director, Primary Health Care Department in MoLG indicate that supervisors from MoLG may have to continue with IRS implementation until the 2011/2012 season when MoH will fully take over the responsibility of spraying in the districts.

The timing of spray applications or rounds is a critical factor in obtaining maximum benefit from IRS. It is also best practice to schedule to complete spray application just before the onset of the rainy season.

6.7 Vector Control Organization

The NMP is headed by a National Program Manager. The NMP has the responsibilities of national IRS planning, formulation of policy, guidelines and setting standards, coordinating all national IRS activities, monitoring and evaluating IRS program, providing IRS technical services to districts, procuring, storing and delivering supplies and logistics to the districts. The implementation of the program is done in collaboration with MoLG, Department of Environmental Health (DEH).

The unit in Gaborone is made up of 1 Malaria Program Manager, 1 Public Health Specialist, 1 Entomologist, 2 IEC Officers, 1 Surveillance Data Manager and support staff. The Entomology Unit in Francistown is made up of 2 Entomologists, 2 Health Officers, 5

Technical Assistants, 6 Field Assistants and support staff. The NMP does not have malaria vector control focal persons at district levels, no Case Management Focal Point and a Logistician. In view of the recent relocation of health functions from the District Councils to the MoH, there is a need for the MoH to appoint District Malaria Focal Points to coordinate malaria vector control activities.

6.8 *Supervising spray teams and spray operations*

Supervision is provided by the NMP in collaboration with EHOs in the districts. The Entomology Unit has enough resources to support district EHOs to supervise IRS operations. The supervision from NMP appears to be irregular and supervision of spray operators by team leaders is unclear. Supervision from senior officials at district, and national levels should be carried out routinely and consistently throughout the period of the spraying using approved forms and checklists to ensure uniformity, accuracy and completeness. Team leaders should constantly and closely monitor spray teams members to ensure that team movements are on schedule and in order to ensure high quality spraying and coverage.

7 SUPPLYING INSECTICIDE, EQUIPMENT AND LOGISTIC

7.1 *Selection of insecticide for IRS program*

The NMP through the Entomology Unit considers insecticide efficacy, residual effect, formulation, robustness, safety, acceptability and cost-effectiveness in the selection of the insecticides for IRS. Susceptibility tests and bioassays are routinely done as a way of monitoring insecticide resistance and efficacy. The program currently uses DDT and lambda-cyhalothrin which are effective against the local vector.

7.2 *Protective equipment for IRS spray teams*

The MoLG procures protective clothing for spray operators. However, in Boteti there were reports of inadequate supply of protective clothing. It is a legal requirement for spray operators to wear protective clothing when handling insecticides and during all spray operations. Specific protective clothing must be worn in accordance with the safety instructions on the product label. Upon completion of the day's activity, all protection clothing including boots should be washed.

7.3 *Compressions pumps*

The program procures Hudson X-Pert and PIR compression pumps for IRS. Some reports indicate that the pumps are not enough. The pumps are not maintained and repaired at the end of the spraying season. Regular spray pump maintenance is important for the life span and performance of the pumps. Daily cleaning during spraying, monthly servicing and inventory and a final inventory, maintenance and repair at the end of spray season will maximize the life expectancy and performance of sprayers.

7.4 *Transport*

The NMP and the districts mobilize a fleet of vehicles for IRS from other sectors. Despite these efforts, transport is reported to be inadequate in Boteti.

7.5 *IRS Monitoring System*

Standard forms have been developed and are used by spray operators to collect daily IRS data during the annual spraying season. These standard forms are completed by individual spray operators to record the number of households they spray each day, their consumption of insecticide, the number of household residents, the number of rooms sprayed, the total number of rooms in the building(s) that comprise the household, and the presence and use of LLINs. Data collected includes spraying coverage, population protected by IRS as well as net coverage. These data are then submitted to and consolidated at the district level before being transmitted to national level.

In pre/ elimination phase the following should be operational coverage indicators:

- Number and proportion of at risk households that have been sprayed
- Number and proportion of reported active foci that were sprayed
- Proportion of population at risk protected
- Proportion of known/ potential breeding sites treated with larvicides
- Number of LLINs distributed
- LLINs ownership and utilization rates

7.6 *Entomological Surveillance*

The NMP established six sentinel sites from which routine entomological data on malaria vector bionomics including insecticide resistance and bioassays are collected. Current susceptibility test results show full susceptibility of the vector to all IRS WHOPEs recommended insecticides including DDT. Data on other vector parameters is also collected except human blood index and sporozoite rates. However, the entomological laboratory and insectary are not functional. There are no air conditioner, humidifier, humidistat, maximum and minimum thermometers and photoperiod time switch in the insectary. The Entomology Unit sends specimens to South Africa for a PCR and ELISA analysis because the facilities are not available in the laboratory.

It is a good malaria vector control practice to establish a vector surveillance system through sentinel sites to monitor changes in species composition, density, feeding and resting behaviour and insecticide resistance. In addition, bioassays on sprayed surfaces should be conducted during the first month of spraying then monthly thereafter to measure quality of spraying and insecticide persistence on sprayed surfaces, respectively.

Entomological surveillance forms an essential part of epidemiological evaluation in malaria elimination programs. The objectives of entomological and epidemiological surveillance in the pre-elimination and elimination programs is the measurement of program performance, delimitation of the malaria area by levels of endemicity in the various parts of the malarious area, and the demarcation of the malaria season. This information is important for furnishing data for defining the geographical extent and for the timing of vector control operations. The Entomology Unit should produce maps showing the composition and distribution of malaria

vectors in districts or foci to help in stratification for application of selective vector interventions.

7.7 Entomological indicators

In malaria control the principal entomological indicators to measure vector control program performance are vector population density by catching adult mosquitoes inside and outside houses and of assaying anopheles mosquitoes for the determination of sporozoite rate as an entomological indication of the degree of transmission. The two methods are adequate only when the vector control tools adopted aim at reducing the overall density of malaria vector population and when the degree of transmission is high to determine sporozoite rates.

The overall coverage of all habitations and man-made shelters with IRS and LLINs in Botswana has led to a decrease or disappearance of mosquitoes resting inside houses. Collection of vectors in large numbers and determination of sporozoite rates is now impossible. The low-grade of transmission requires assaying tens of thousands of vectors to pick up infected ones. Hence in malaria elimination, cases of persistent or renewed transmission, as ascertained by parasitological data, cannot be confirmed entomologically by finding mosquitoes that are infected.

The entomological criterion appropriate for assessing progress towards complete interruption of transmission and elimination of malaria is the elimination or reduction of man-vector contact and the shortening of the life of malaria vectors to such a degree that the extrinsic cycle of the parasite in them is not completed. The entomological assessment in Botswana should therefore aim at assessing the amount of man-vector contact and the probability of survival of any vectors found to enter sprayed houses and feed within. The main practical methods for this purpose are the determination of man-biting rates inside and outside houses, and window-trapping of mosquitoes leaving sprayed houses after biting their inmates. Samples collected in window-traps can yield a variety of useful information in terms of total catch, proportion surviving after holding period and proportion in the blood-fed condition. The absence of viable blood-fed and gravid females from window-trap collections is the index of the direct effectiveness of the sprayed rooms and LLINs against the vectors.

8 CHALLENGES

- There are no malaria focal points at district level to organize, coordinate and implement malaria vector control. This situation is now urgent in view of the recent re-location of malaria control activities from MoLG to MoH. In addition the NMCP has no Case Management Focal Point and a Logistician.
- The insectary and laboratory in Francistown are not functional because of lack of important equipment. In view of the goal to eliminate malaria in Botswana these facilities are critical for rearing and processing mosquitoes.
- Malaria epidemiology in Botswana is no longer homogenous but focalized. As a result, blanket spraying is not cost-effective in Zones B and C
- Geographical reconnaissance is not conducted in target areas and planning is based on previous years' consumption. Quantifying annual IRS commodities based on previous consumption is not the correct method and will always lead to overestimation or underestimation of resources needed for IRS.

- District plans contain no target areas to be sprayed, required IRS commodities and timeframes for IRS activities. Because the plans lack timelines, some districts do not start and finish spraying in time.
- There are no workshops in the districts for maintaining and repairing spray pumps
- Malaria vectors in the country are not clearly defined and their distribution not mapped.
- Operational coverage for both IRS has remained low for the past 10 years.
- There is no routine distribution of LLINs through ANC clinics in Zone A.
- Larval control is critical in malaria elimination and is currently not implemented.
- Supervision of spray operators by team leaders is not strong and supervision from NMP is not consistent.

9 RECOMMENDATIONS

- There is an urgent need for the MoH to appoint District Malaria Focal Points to coordinate district malaria vector control activities following the relocation of malaria vector control from MoLG to MoH. There is also a need to appoint Case management Focal Point and a Logistician for the NMP.
- The Entomology Unit should continue and expand vector surveillance to monitor vector bionomics including insecticide resistance and bioassays. In this regard, the insectary and laboratory should be fully equipped to allow rearing of mosquitoes and processing of all specimens, respectively.
- The Entomology Unit should further stratify malaria zones into foci using epidemiology and entomology information and produce vector distribution maps. The unit should use the recently acquired GIS skills. The database and mapping will support evidence-based decision making on targeting anti-vector measures. The following interventions are recommended:
 - Implement universal coverage with IRS and LLINs in Zone A.
 - Implement universal coverage with IRS and LLINs in residual active malaria foci in Zone B.
 - Implement universal coverage with IRS in identified new active foci in Zone C
 - Implement selective larval control in all the zones with focus in zones B and C.
 - Conduct vector surveillance and larval control in malaria free areas to prevent re-establishment of transmission
 - Establish routine distribution of LLINs through ANC clinics in Zone A to maintain universal coverage.
- The NMP should conduct GR to guide planning and the plans should contain target areas, required IRS commodities and timelines for all activities. GR provides the relevant information on the target area to guide planning and operations of vector control interventions.
- The NMP should procure commodities at least 4-6 months before the start of spraying to enable districts to start and finish spraying before the rain season.
- IEC campaign should be a sustained activity to maintain community acceptance of malaria vector control. As the burden of malaria continues to decline there may be a corresponding decline in community uptake of the interventions.
- Supervision from Entomology Unit and national levels should be carried out routinely and consistently throughout the period of the spraying using approved forms and

checklists to ensure uniformity, accuracy and completeness. There should also be a strong and close supervision of spray operators by team leaders.

- NMP should conduct inventory, maintenance and repair of spray pumps at the end of spray season to maximize the life expectancy and performance of sprayers. Regular spray pump maintenance is important for the life span and performance of the pumps.

10 REFERENCES

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