Federal Democratic Republic of Ethiopia
Ministry of Health

Vector Control Operational Manual for Malaria Elimination in Ethiopia

April 2017
Addis Ababa

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ETHIOPIA - NMCP

Preface

The effort towards eliminating malaria requires appropriate targeting and quality implementation of vector control interventions. As Ethiopia is committed for eliminating malaria by the year 2030, strengthening the existing vector control interventions and introduction of new vector control tools as appropriate are very crucial undertakings for ending the disease for good. The intensity and timing of application of vector interventions is determined based on local situation and the expected impact of interventions. Learning from the existing best experience and new evidences, this vector control manual for malaria elimination in Ethiopia was developed.

The aim of this manual is to guide all health cadres involved in planning and implementation of vector control activities in malaria elimination. It also helps to improve targeting and implementation of interventions that suit local context and improving of utilization of vector control commodities by at risk communities. A village-level/Kebele level stratification will be prepared to guide targeting of interventions.

To achieve the objective, the overall capacity building, system establishment, entomological monitoring and establishment of relevant database, at district, regional and national levels is instrumental. Training of personnel will be conducted at all levels and entomological monitoring activities will be carried out in selected sentinel sites. Accordingly, the focus will be on capacity development at initial phase as well appropriate targeting of interventions.

While developing this manual, local and international guidelines has been referred and local knowledge and experiences are incorporated. This manual will be used by all partners and stakeholders that will be involved in malaria elimination vector control activities. The manual could be reviewed and updated based on new evidence that would emerge in the implementation process.

Finally, the Ministry of Health would like to acknowledge all organizations and individuals who have been involved in the preparation of the manual.

Acknowledgments

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Abbreviations

ACSM	Advocacy Communication and Social Mobilization
AFRO	African Regional Office
AIRS	African Indoor Residual Spraying
CS	Capsule Suspension
EPHI	Ethiopian Public Health Institute
FMOH	Federal Ministry of Health
GF	Global Fund
GIS	Geographic Information System
GPS	Global Positioning System
GR	Geographic Reconnaissance
HDA	Health Development Army
HEW	Health Extension Workers
IDP	Health Facility
IRS	Indoor residual spray
IVM	Integrated Vector Control management
LLIN	Long-lasting insecticide-treated mosquito nets
LSM	Larval Source Management
MIS	Malaria Indicator Survey
MPR	Malaria Performance Review
PFSA	Pharmaceutical Fund and Supply Agency
PHEM	Public Health Emergency Management
PPE	Personal Protective Equipment
SBCC	Social Behavioral Change and Communication
SO	Spray Operator
SOP	Standard Operating Procedures
SUFI	Scale Up for Impact
WHO	World Health Organization
WHOPES	World Health Organization Pesticide Evaluation Scheme

1. Background

In Ethiopia, organized efforts have been taking place in the fight against malaria since the 1950s. The intervention strategies include early diagnosis and prompt treatment, indoor residual spraying (IRS), environmental management, prevention and control of epidemics, and, recently, scale-up of long-lasting insecticidal nets (LLINs). Larval source management (LSM) through larviciding and environmental management was implemented at small scale in some limited localities, where breeding sites are few and manageable.

Since 2005, the two major vector control interventions implemented in the country are IRS and LLINs. Additional vector-control, LSM, is implemented in localized breeding areas. Ethiopia maintains universal coverage of LLINs for all localities, which are at risk of malaria transmission. In addition, high malaria transmission areas (as described in the elimination roadmap) are also covered with IRS to reduce the burden of malaria.

Because of scaling-up and sustenance of the proven interventions, health facilities have been reporting reductions in both malaria cases and malaria-related deaths, even during the peak of the transmission season. Moreover, there have been no epidemics reported in the country for the last decade. Thus, encouraged by the significant progress in the fight against the disease, the Federal Ministry of Health (FMOH) is committed to eliminating malaria by 2030. The elimination program will be implemented in a phased approach, initially targeting low transmission stratum.

The country is preparing malarious districts for elimination through the process of optimization of interventions emphasizing on targeting and effective utilization of interventions in order to move towards pre-elimination and elimination. Although the elimination of the parasite, not the vector, is the ultimate goal of malaria elimination, integrated vector control is a key strategy towards driving down transmission to the point where parasite elimination becomes feasible. Therefore, optimizing existing vector control interventions and targeting quality services will be the cornerstone to substantially decrease malaria burden and re-orient the program towards elimination along with surveillance, and other core interventions.

Stringent monitoring is essential to ensure high quality delivery of interventions. Thus to ensure high quality and effectiveness of implementation of vector control activities, frequent supervisory support visits will be carried out during the implementation of all vector control interventions and a robust system of periodic monitoring will be established. Post intervention assessment will also be carried out.

This manual is primarily prepared to District Health Offices and lower levels of the health system to implement targeted and quality service to the communities in order to optimally use vector control services. This manual is also useful for National Malaria Control Programme (NMCP), Regional Health Bureau, Zone Health Departments and partners to ensure standards of IRS, LLINs and LSM interventions as mentioned in this manual. It also ensures that communities and other stakeholders including irrigation projects, municipalities, development projects and other interested and relevant parties implementing vector control services to consider the required operational, technical, and logistical issues necessary for the programme in line with this manual.

2. Vector control in different phases

As indicated above, vector control interventions play an important role in the reduction of disease burden in high transmission areas and in interruption of transmission. The choice and the implementation of vector control interventions in the control, optimization, pre-elimination, and elimination phases in different parts of the country should be guided by the intensity of transmission determined by epidemiological parameters, socio-economy situations and the bionomics of the vector in the specific areas. Generally, the use of LLINs and IRS will play a major role in the country's endeavor towards elimination. Application of LSM supplements LLINs and IRS where applicable to enhance impact.

2.1 Vector control in optimization phase

The aim of vector control in optimization phase is to reduce malaria parasite transmission, focusing on targeting of interventions, building up systems, strengthening capacities through training and intensifying interventions in the targeted areas. The aim also includes working on the identified gaps in terms of coverage, quality and timeliness of vector control services. These gaps are addressed in the sections below.

2.1.1 Long lasting insecticidal nets

LLIN remains to be a major vector control intervention in Ethiopia. The country has distributed more than 90 million nets since 2006 and about 45 million since 2013 to achieve and maintain universal coverage. A special emphasis will be given to ensuring high utilization of LLINs through sustained intensive community education and monitoring of usage at a household level.

Purpose

The purpose is to intensify LLINs use, achieving at least 85%, by communities and contribute to fast and further reduction in malaria burden in areas with relatively high transmission, and to sustain low transmission where it has been achieved.

Distribution of LLINs

Distribution of LLINs will continue with same approach as in the control. Mass distribution of LLINs through periodic campaigns to all population at risk of malaria remains the major strategy. Maintaining universal coverage with high level (≥85%) of usage is the target. However, in this phase, the use of LLINs will be intensified in all areas with ongoing malaria transmission through addressing the current gaps and challenges, i.e., low utilization and misuse. In order to ensure high coverage and use by all populations at risk of malaria for impact on transmission estimation of the required number of LLINs will take the number of sleeping places into consideration, including outdoor where it applies. This is intended to address the possible gap in the actual use of LLINs that can be created due to different sleeping behaviors and cultures in different households and communities, respectively. In some communities, family members do not share sleeping places and the notion of one LLIN protecting two individuals is not applicable. In addition to the periodic mass distribution, the health extension program and the Health Development Army (HDA) networks will be used to routinely deliver LLINs to the general population at risk of malaria transmission.

Utilization of LLIN

Optimal use of LLINs has been a challenge in the country. The disparity between level of ownership and actual use of LLINs has been significant. For instance, the MIS 2015 reported a 64% of coverage and the percentage of children U5 who had slept under a mosquito net the night preceding the survey in households that own at least one net was 70%. Misuse of LLINs has also been observed in many instances though systematic documentation on the extent of the problem. In order to address these major challenges and increase impact of the intervention on malaria transmission, intensive and sustained community education and engagement

through various media will be a major component of the promotion and management of LLINs intervention in the optimization phase guided by the national Advocacy, Communication and Social Mobilization (ACSM) implementation manual.

Special emphasis should be given to the provision of information to the users on proper handling and caring for LLINs to minimize the negative impact on bio-efficacy and physical durability (integrity) of the LLINs. Households also should be made aware of their responsibility and accountability for using and maintaining the LLINs provided to them.

In addition to that, Health Extension Workers (HEWs) and Health Development Army (HADs) - one-to-five networking leaders will routinely visit households and ensure that the beneficiaries utilize LLINs properly. Visit to households would be conducted every week particularly during the transmission season. HEWs would report outcomes of the weekly follow up to the district on a monthly basis. Households that are not properly using their LLINs should be educated on the importance of using the tools regularly to eliminate malaria from the country. They should be reminded of their role and expected responsibility towards this achievement.

In order to monitor retention and proper utilization of LLINs by the communities and reduce the risk of illegal practices, batch numbers and serial numbers will be included in the purchase order.

Indicators for coverage and use of LLIN

The standard indicators of coverage and utilization of LLINs will continue to apply in the optimization phase. However, additional indicator that would be introduced in the optimization phase to include a measure of the proportion of sleeping places covered by LLINs. All malaria transmission areas should achieve the maximum possible coverage and actual utilization rate by the target communities. To ensure this, all malaria transmission areas should achieve the following targets in the optimization phase.

- ✓ 100% coverage of households with at least 2 LLINs
- ✓ ≥85% actual utilization by the general population at risk of malaria transmission
- ✓ ≥85% coverage of all sleeping places

Table 1: Additional indicators to monitor the success of LLINs implementation.

Indicator	Numerator	Denominator
Proportion of households with at least one LLIN	Number of households surveyed with at least one LLIN	Total number of households surveyed
Proportion of households with at least one LLIN for every two people	Number of households with at least one LLIN for every two people	Total number of households surveyed
Proportion of population with access to LLIN within their household	Total number of individuals who could sleep under LLIN if each LLIN in the household is used by two people	Total number of individuals who spent the previous night in surveyed households
Proportion of population that Slept under LLIN the Previous night	Number of individuals who slept under LLIN the previous night	Total number of individuals who spent the previous night in surveyed households
Proportion of children under five years old who slept under LLIN the previous night	Number of children under five years old who slept under LLIN the previous night	Total number of children under five years old who spent the previous night in surveyed households
Proportion of pregnant women who slept under LLIN the Previous night	Number of pregnant women who slept under LLIN the previous night	Total number of pregnant women within surveyed households
Proportion of existing LLINs used the previous night	Number of LLINs in surveyed households that were used by anyone the previous night	Total number of LLINs in surveyed households

Quality control and assurance for LLINs

Only WHOPES fully recommended LLINs would be purchased and used in Ethiopia. Pre- and post-importation quality control in relation to product specifications of LLINs will be undertaken per WHO guidelines (WHO 2012). Accordingly, assessment of identity and content of the active ingredient(s), fiber and filament type, denier, impregnation technology, colour, size, shape, active ingredient retention index, seam stitching (number and location), netting mesh size and shape, dimensional stability of netting to washing, bursting strength and storage stability at elevated temperature will be evaluated.

LLIN durability will also be assessed as per WHO guidelines (WHO 2011) following distribution and throughout the duration of their predicted useful life (i.e. 3 years) at community level. This assessment includes survivorship and attrition, fabric integrity and insecticidal activity (bio-efficacy).

- ***Pre- and post-shipping quality control***

The WHO guidelines on the procurement of appropriate and good quality public health pesticide products will be followed for the procurement and importation of LLINs (WHO 2012). Accordingly, pre- and post-importation quality control of LLINs will be conducted during every procurement. The entity procuring the LLINs (PFSA/Government, GF, UNICEF, etc.) facilitates and ensures the pre-shipment quality control on samples of the consignment before their shipment. Shipment is allowed when the LLINs pass the standard quality control test at a laboratory with such capacity. Nonetheless, pre-shipment quality control may not guarantee importation of good quality of all consignments. Consequently, post-shipment quality control is carried out applying the same procedures.

To ensure importation of quality LLINs, purchase agreement should include conditions such as in the event that the product supplied is found to be of unacceptable quality, the supplier should take the consignment back at its own cost and replace, within a specified time, the rejected consignment with one that meets the standard specification of LLINs. Failing this, the supplier should refund to the Government of Ethiopia or any other institution procured the LLINs all the expenses incurred in procuring the product. In addition, the bid bond provided as a guarantee of satisfactory completion of the contract should be forfeited.

All required precautions to avoid factors that can affect the quality of the LLINs from arrival at port to the point of delivery at community level should be put in place. These include fast custom clearance, safe transportation, proper storage, etc.

- ***Monitoring bio-efficacy and physical integrity of LLINs at community level***

The expected bio-efficacy and durability of currently available LLINs is three years. However, LLINs effectiveness and durability (physical integrity) will be monitored using WHO guidelines (WHO 2012) at certain time intervals after nets received by beneficiary communities. Trained vector control officer and entomologists will conduct bio-efficacy tests and an inventory of the physical integrity of the LLINs in use by the communities in selected sentinel sites (that are used for routine vector surveillance) preferably once every six months but at least once a year. Outcomes of such tests will inform the program on frequency of distribution. It can also provide information on the manner of handling the LLINs including washing practices by the beneficiaries. This will provide guidance on the type of messages that can be formulated in SBCC about the proper use and handing of LLINs to optimize effectiveness.

Disposal of old LLINs

Safe disposal of old LLINs has been an issue in Ethiopia as it is in other NMCPs in the Africa region where large scale use of LLINs is a major malaria control strategy. However, currently WHO's recommendation is to leave old LLINs at the community level and allow households to use the old nets for various purposes (such as curtains, mattress cover, etc.) rather than NMCPs creating an expensive system of collection, storage and disposal of such nets that would require additional resources that should otherwise be committed to malaria control activities. According to WHO's recommendation, it is not advisable to divert limited resources of malaria control to such an expensive exercise. This is because currently LLINs and their packages (plastics) are known to contribute only 1% of the similar nature of materials that are available in the environment. This level of contribution towards any kind of environmental impact may not warrant such a huge investment that is required for the collection and disposal of old LLINs. Ethiopia will adopt this recommendation and encourage communities to utilize old LLINs for other purposes as indicated above while ensuring the appropriate intended use of LLINs for at least three years through intensive community education, engagement and household visits by HDAs as indicated above.

2.1.2 Indoor residual spraying

IRS plays an important role in interrupting malaria transmission in targeted foci. The impact of good quality IRS with the recommended high coverage levels is felt quickly. Decentralization of this intervention is vital for easy access and building of capacities at community level. The fact that IRS is usually undertaken as an institutional activity makes high coverage achievable within the decentralization framework.

IRS can dramatically reduce malaria prevalence from low baseline to zero transmission levels, particularly in localities where vector populations are highly endophagic and endophilic (feeding and resting indoors) as well as when the vector population is susceptible to the insecticide in use.

Effective planning, preparedness, timing and frequency are key to the success of IRS. These aspects should be informed by evidence generated on the level and extent of malaria transmission in the country.

Purpose

The aim of IRS is to reduce malaria burden in the shortest possible time in areas with high transmission, achieving at least 85% of targeted households or population and containing malaria surge timely, ensuring zero transmission in areas where malaria has been reduced.

Targeting IRS

IRS will be targeted in the optimization phase to push malaria transmission to pre-elimination level in relatively high transmission localities. Targeting IRS will consider the following:

- ✓ Selection of areas for IRS will be based on the epidemiological criteria established by the national malaria elimination roadmap. Entomological information such as insecticide susceptibility status and bionomics of the vector should be well established and continuously monitored. Evidences from geographical reconnaissance should guide the planning and implementation of IRS in the targeted sites.
- ✓ Residual efficacy of insecticides and quality of IRS operations should be continuously monitored.
- ✓ Re-classification of areas for IRS operations based on emerging evidence from epidemiological assessments on vector bionomics, climatic conditions and advocacy/ community mobilisation. Re-classification of the locality should be conducted every 3 years.

When to spray

IRS implementation will be conducted based on data derived from transmission patterns guided by various factors including environmental and socio-economic factors timing, etc. IRS should be targeted mainly in rural communities, development projects, etc. where permanent structures are available. The number of spray rounds, i.e., once or twice a year should depend on the transmission pattern and insecticide type. To date, propoxur and bendiocarb are the main insecticides in use in the country. But pirimiphosemethyl CS 300 (actellic) is also being sprayed in few places. The timing of spraying in relation to the peak transmission period will depend on the expected residual life of the insecticide in use. The table below summarizes factors to determine the number of spray rounds per annum and timing of spraying.

Table 2: Spraying rounds and timing in areas of different transmission patterns

Transmission pattern / Insecticide	One long transmission season (> 4 moths)	One short transmission season (≤ 4 months)	Two transmission seasons	Timing
Propoxur	2 rounds IRS per annum	1 round IRS per annum	2 rounds IRS per annum*	Target peak transmission time
Bendiocarb	2 rounds IRS per annum	1 round IRS per annum	2 rounds IRS per annum*	Target peak transmission time
Actellic 300 CS	1 round IRS per annum	1 round IRS per annum	2 rounds IRS per annum*	Target beginning of transmission time

*The two rounds of IRS target two different transmission seasons in areas where these occur. This should apply even in a situation where one is long and the other is short transmission season because three rounds are not feasible and manageable.

Note: Cost of insecticide should be considered when determining choice of insecticide in maximizing operational coverage.

Combining IRS with LLINs

The current status of insecticide resistance in Ethiopia is a limiting factor for a comprehensive insecticide management strategy across the nation. Resistance against DDT and pyrethroids is widespread, and resistance to malathion has been detected in some parts of the country. IRS will be combined with LLINs to limit intensity and expansion of pyrethroid resistance and to delay that of organophosphates and carbamates. The combination should take into account the classes of insecticide in use for each of these interventions and should be in line with the country's insecticide resistance management strategy (FMOH 2016). Therefore, combination of IRS and ITNs in high transmission areas to reduce transmission should be based on a rotation of carbamate (bendiocarb, propoxur) and organophosphate (primiphos methyl) in cognizance of resistance management.

Table 3: Indicators for combined IRS with LLINs

Indicator	Numerator	Denominator
Proportion of households with at least one LLIN and/or sprayed by IRS in the last 12 months	Number of households that have at least one LLIN and/or have been sprayed by IRS in the last 12 months	Total number of households surveyed
Proportion of households with at least one LLIN for every two people and/or sprayed by IRS within the last 12 months	Number of households with at least one LLIN for every two people and/or have been sprayed by IRS in the last 12 months	Total number of households surveyed

Management of IRS

Figure 1 adapted from WHO Indoor Residual Spraying Operational Manual p. 41, summarizes information on IRS management applicable in the optimization phase. It provides step-by-step management aspects such as annual review, assessment and baseline on epidemiology and entomology profile, re-stratification/reclassification (geographical reconnaissance), procurement, planning and preparations (timing), organization and logistics supplies, communication and mobilization (developing education materials, training for community mobilisers), organization of spray teams (operators, squads/team leaders), spray implementation (supervision and reporting), etc.

Figure 1: IRS management cycle during the optimization phase

(Source: World Health Organization IRS Operational Manual)

Planning IRS

IRS should be contained in annual plans at national, district up to cluster levels. Clear IRS operational plans should cover the following:

- Appropriate targeting (unit structure/house measurements, population to be protected).
- Budgeting, timing and resources (human, finance, commodities, etc.).
- Procurement of commodities (insecticides, spray equipment, etc.), tender taking into account timelines.
- Logistic management (shipments, transportation, storage facilities at all levels, distribution to operational sites, etc.).
- Inventory of distributed insecticides and reporting; analysis should be made on the use and planning for the following year.
- IRS quality (supervision, bioassays, and training) at all levels.
- Environmental compliance (solid and liquid waste disposals).
- Advocacy and community mobilisation.
- Monitoring inputs, processes and impact of IRS implementation.
- Reporting channels on progress and final feedback on the IRS campaign.

Planning, implementation and reporting of IRS should follow the existing organizational structures with clear terms of reference for each position (including adequate training of the team) and supervision plan as indicated in the national IRS training manual (FMOH 2007).

Quantification

As per the inventory of the previous year, stock balance the district coordinator should quantify the amount of insecticide, spray equipment and PPEs needed and communicate to the next level (NMCP). The NMCP review and compile the request at national level for procurement in line with the national insecticide procurement protocol at the Pharmaceutical Fund and Supply Agency (PFSA) in accordance with national tender and procurement procedures. The insecticide quantification should follow the national IRS training manual formula (P. 13) as stated bellow

Box 2: formula for insecticide quantification

$$\text{Amount of insecticide required in kgs (A)= (Without safety margin)} \quad \frac{100 \times u \times s \times d}{1000 \times c}$$

Where u= total number of unit structures,
s= average spravable surface area in m^2 per unit structure.
d= dosage of insecticide's active ingredient in gm/m^2,
c= insecticide concentration in percentage.

(Further explanation or definition should be included regarding the above formula, i.e., what 100 & 1000 stand for.)

Amount of insecticide required (with safety margin of 10%) = A+0.1A

Training in IRS

The training for IRS should be guided by a clear action plan, that will provide information on various aspects such as "who to train", "where", and the duration of the IRS training. The training will target all involved (spray operators, squad leaders, storekeepers, managers or supervisors, and physician's orientations on poison management) according to the national guidelines. The training should also target to build capacities in monitoring vector bionomics (behaviour, etc.) and susceptibility to insecticides and efficacy (bioassays) as well as health educators or mobilizers who are important to prepare the community targeted for spraying. The number of spray operators and teams would depend on the number of structures to be sprayed and the average number of structures one spray operator can spray in a day. Another important issue to be considered particularly in spraying of propoxur is that the need to complete the operation in the shortest possible time targeting the peak transmission. This means, it is useful to consider the shortest possible period of spraying operation to maximize the impact on transmission.

Training for optimization: Details on the day-to-day aspects of the training of IRS operators

is contained in the SOPs (Ref: Training Manual for Residual Insecticide House Spraying FMOH 2007). IRS training for spray operators covers at the Kebele covers 6 days and involves the following aspects; proper mixing of insecticides, actual spraying techniques using rehearsal wall; cleaning of spray pumps; basic trouble shooting of the pumps, public relations with householders, environmental safety (personal and households), key messages on IRS, including on re-plastering etc. The operation should be fully complemented by community education and mobilization in line with ACSM manual.

Selection of spray operators: Competent spray operators should be selected based on the following practical IRS spray operator selection checklist. Trainees should be evaluated using standard IRS training wall (3m height and 6.35m width).

Table 4: Spray operator selection checklist

S. No.	Evaluation elements	Yes	No
1	Was the sprayer filled correctly?		
2	Was the correct pressure applied to start?		
3	Did the trainee agitate the sprayer before spraying? If necessary		
4	Did the trainee address the wall correctly?		
5	Did the trainee check the pressure gauge frequently?		
6	Did the trainee take proper steps from swathe to swathe?		
7	Was the pressure maintained within the operational limits?		
8	Was the correct distance maintained (45cm)?		
9	Was the trainee able to demonstrate maintenance of sprayer and explain trouble shootings of spray pumps?		
10	Did the trainee take between 58 and 62 seconds to cover swathes (Judge three best times)?		

IRS personnel - roles and responsibilities

IRS is organized in a well-organized bottom-up manned with different roles and responsibilities for the various personnel involved. Some of the roles and responsibilities are listed in Table 5. Details are also available in the national IRS training manual (FMOH 2007). This operational manual should have a clear direction of command at all levels.

Table 5: Personnel and role in the management of IRS

Personnel	Role
District health IRS Management Team (Consisting of senior district officers - Health office Head / Deputy; District Health Malaria Focal Person; District Health PHEM Focal Person; District Health Environmental Health Focal Person; District Health IEC Focal Person; District Logistics Focal Person):	• Oversees overall IRS planning and implementation in the district to the kebeles. • Determines IRS kebeles; • Builds IRS operation team • Facilitates IRS training • Advocacy and community mobilization • Monitoring the day-to-day IRS operation and ensuring that the IRS campaign is accomplished as planned.
Malaria Focal Person (MFP):	• Coordinates planning and ensures smooth and timely implementation of IRS in the districts • Provides overall supervision • Manage logistics • Coordinates training • Provide linkage between district and lower levels.
IRS Team Leader (TL) /Supervisor: **(Reports to District Malaria Focal Person)**	• Provides linkage with local administrators/leaders • Assigns each squad to spray areas (daily) and supports squads in technical and administrative matters • Ensures adherence to safety procedures and waste management • Monitors quality of IRS and spray output • Compiles daily squad leaders report • Evaluates overall IRS progress at the Cluster level.
IRS Squad Leaders **(Reports to the IRS Team Leader/ Cluster Supervisor)**	• Manages spray equipment and insecticide for use in the field • Ensure the needs of the squad members to operate IRS are fulfilled • Monitors SO performance • Ensures quality of spraying • Enforce strict environmental compliance procedure (house preparation before and after spraying) and personal safety. • Compiles and submits daily work of each spray operator to the team leader

Personnel	Role
Spray operators (SO)	• Mix appropriate concentration of insecticides • Prepares structure readiness • Conducts spraying • Collects all materials for use in indoor spraying • Informs household members about the key IRS messages and collaborates with householders to ensure a friendly atmosphere during spraying • Maintains spraying equipment in clean condition • Observe safety procedures
Health educator or community mobilizers	• Responsible for education the community on the importance of IRS for malaria control • Provide health information to preparation required and precaution to minimise exposure to insecticide and environmental contamination • Educate the community on what preparation is require before, during and after spraying the house • Transmit relevant IRS Health messages through appropriate media (community meeting, radio broadcasting and house to house mobilization)

Implementation

IRS operation will be implemented at the community level observing Spray Operators (SOs) in existing national guidelines (FMOH 2010). However, in the optimization phase, the process will be decentralized at the cluster and *Kebele* level and will involve spray operators and supervisors/squad chiefs drawn from their respective communities to increase ownership and sustainability, community access to the intervention, accelerate implementation and early detection of epidemics. Health extension workers would be directly involved in the supervision of IRS in their respective villages. Households will be targeted covering all sprayable structures including animal shades if they have sprayable walls and roofs (Please refer conducting a house spray SOP).

Environmental compliance

Pre, mid, and post IRS operations environmental assessments will be conducted to ensure compliance at each stage. Pre- assessment should be conducted to identify and address gaps, whereas mid assessments will be performed to monitor the progress and the post IRS assessment will be done to learn lessons and enable the malaria programme to prepare for the following malaria transmission season. For liquid waste disposal purposes, soak pits should be constructed at the cluster level following national IRS implementation guidelines (FMOH Guidelines). Storage of waste materials including insecticides will be done at the cluster level in compliance with standard operating safety procedures.

Environmental and Personnel Safety: In accordance with WHO health and safety regulations, all persons working on IRS must be adequately protected against potential harm due to exposure from pesticides. Table 6 provides minimum requirement of PPE for different levels of IRS personnel. All persons with potential direct contact or exposure to pesticides during handling, transportation, storage, use and cleaning of pesticides or pesticide contaminated materials must wear appropriate personal protective clothing in accordance with the safety instructions on the product label. Spray operators should be checked for any side effects including compliance of skin burning and eye watering.

Safety of occupants and domestic animals: Apart from informing community members on the use of IRS and the required safety measure they need to exercise, it is important to remove out food items, drinking water and domestic animals during spraying operations in each structure. The materials left in the house should be brought to the center of the house and covered with plastic sheets to minimize contamination.

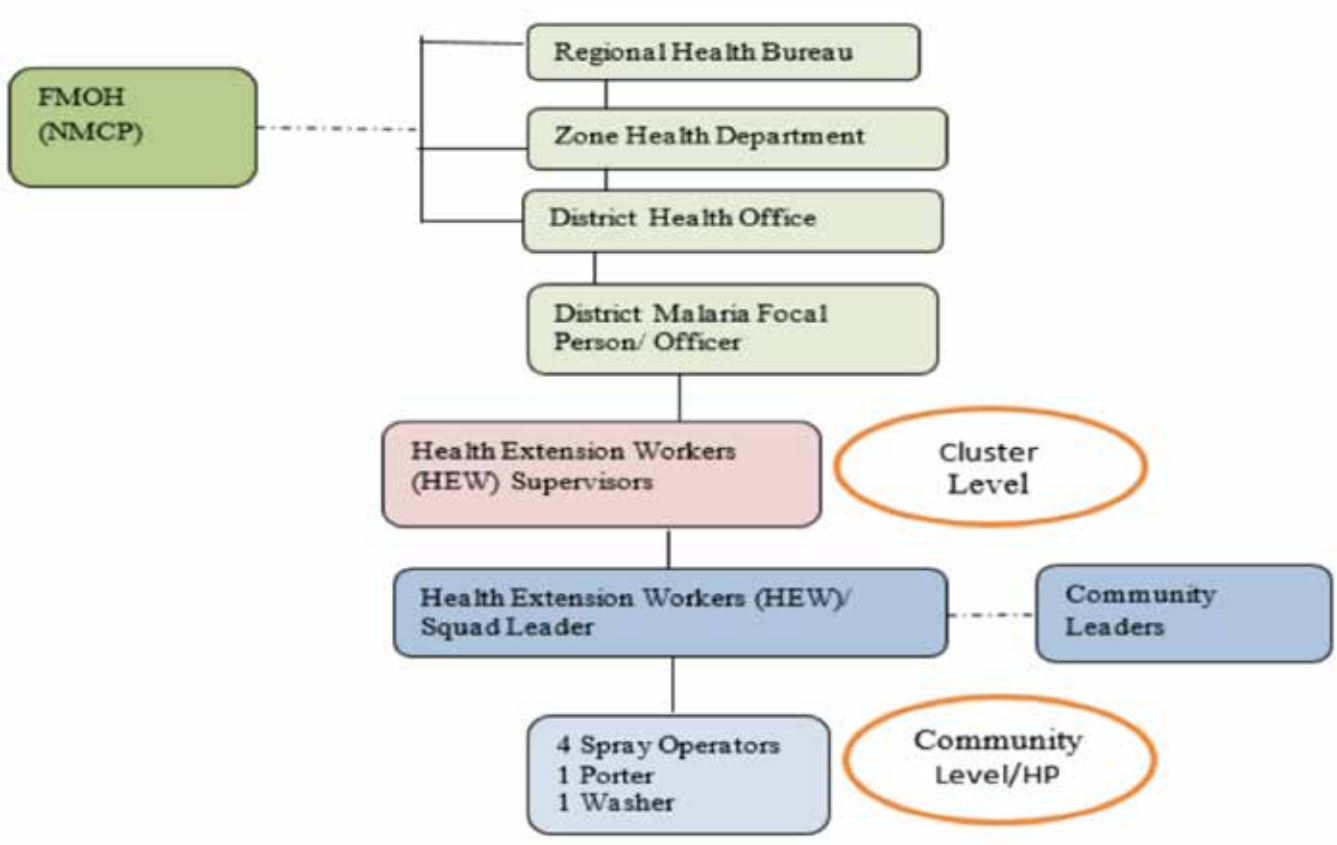

Figure 2: Organogram for the IRS operations Personnel

Soak pits should be constructed at the lowest level of IRS organization and used properly to dispose the liquid waste to avoid environmental pollution. Soak pits should be adjacent to or co-located with both the progressive rinse area and the wash area to avoid potential spills when transporting effluent to the pit. Box 3 and Figure 3 show basic components and an example of soak pit for the filtration.

Environmental compliance checklist: The checklist on environmental compliance, including all safety and related issues should be consulted shown in Annex I.

Box: 3

Basic items needed for the soak pit

- Adequate water supply and empty container
- Polythene sheet to cover the soak pit area
- Fence around the soak pit area

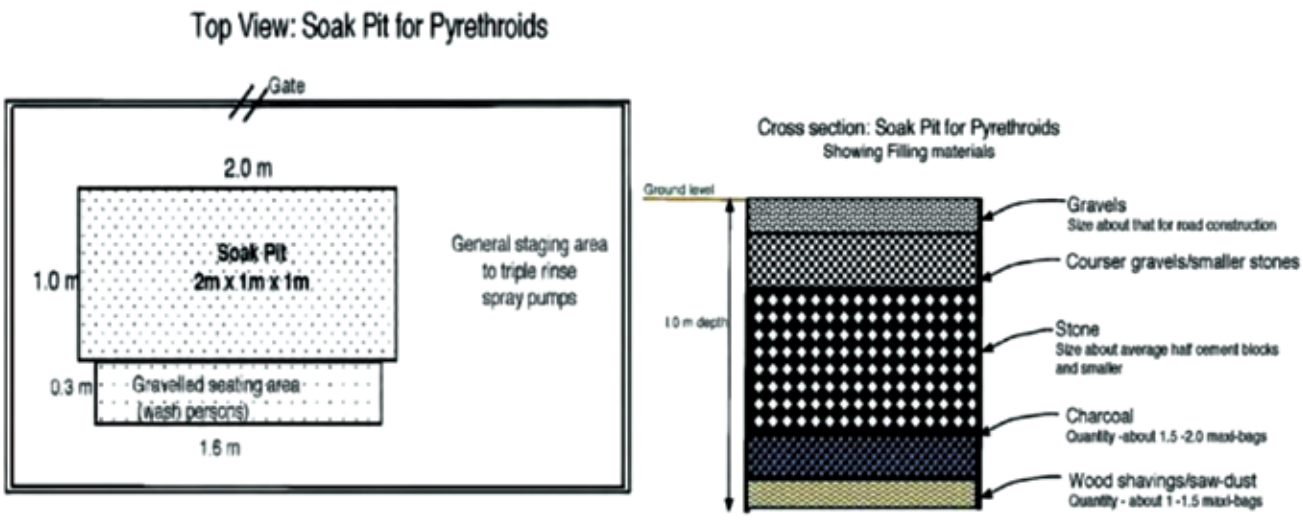

Figure 3: Soak pit design – Co-located with wash area

Table 6: Minimum requirement of PPE for IRS personnel

Role	Minimal PPE Required
Store manager & all workers handling equipment and pesticides	• Boots and overalls be worn at all times • Gloves and filter mask when handling • Goggles when cleaning up dry or wet pesticide spills
Team leaders/Squad leaders	• Overalls • Broad-rimmed helmet • Boots • Gloves • Respiratory Mask (when entering houses to supervise spray operations) • Torches
Spray Operators	• Respiratory Mask • overalls, • Face shield • Gloves, • Broad-rimmed helmet (to protect head, face and neck from spray droplets) • Face shield or goggles (protects face & eyes • Rubber boots or heavy canvas boots that are unlined and can be easily rinsed • Torches
Washers	• Overalls • Apron • Boots • Respiratory Mask • Gloves
Drivers/Cyclist	• Boots • Gloves, • Respiratory Mask (when washing vehicle after a spill)

Monitoring and Evaluation of IRS

Monitoring and evaluation of IRS activities for vector control in optimization phase should prioritize the following:

- IRS coverage of at least 85% of targeted structures.
- Protection of at least 85% of the IRS targeted population
- Cone bioassays to monitor the quality of spraying, residual efficacy and decay rate of insecticides on the sprayed walls
- Supervision of all the IRS activities involving all responsible (district IRS body, team, squad leaders) i.e., from the district to the *Kebeles* and provide regular feedback.

- Measurement of vector densities, habits in relation to IRS activities.
- Safety measures of the community and domestic animals and Spray personnel.

Indicators

A list of indicators of IRS in the optimization phase are provided in Table 7 below. Detailed monitoring and evaluation framework with additional malaria indicators is provided in the National Monitoring and Evaluation Plan 2014-2020, pp. 13-14.

Table 7: Performance framework for IRS use in optimization phase

Indicator	Numerator	Denominator	Data Source	Reporting Frequency	Responsible
Process					
Insecticide provided for IRS	Amount (kg) or Number of sachets/bottles used	Amount / Number planned	District Reports	Annually	Cluster coordinator
Spray operators trained	No. of spray operators trained	No. of required spray operators to be trained	District Reports	Annually	Cluster coordinator
Spray pumps	Number of spray pumps availed	Number of spray pumps planned/ needed	District Reports	Annually	Cluster coordinator
	Number of working pumps (functional)	Number of spray pumps planned to be maintained	District Reports	Annually	Cluster coordinator
Timing of spraying completed; (on time) / (Not on time)			District Reports	Annually	Cluster coordinator
Output Indicators					
Number of structures sprayed	Actual No. structures sprayed	Total No. structured planned to be sprayed	District Reports	Annually	Cluster coordinator
Number of training walls for IRS training	No. training walls actually prepared	No. training walls planned to be prepared	District Reports	Annually	Cluster coordinator
Outcome Indicators					
Proportion of population at risk protected by IRS	Number of people protected by IRS	Total number of population at risk in IRS targeted areas	District Reports	Annually	Cluster coordinator
Proportion of houses/structures sprayed	Number of houses/structures sprayed	Total number of houses/structures planned/targeted	District Reports	Annually	Cluster coordinator

Indicator	Numerator	Denominator	Data Source	Reporting Frequency	Responsible
Impact Indicators					
[a] *Entomological*					
Human blood Index	Number of mosquitoes with human blood	Total Number of mosquitoes examined	FMOH Reports	Annually	EPHI/ Partners
Percentage of Susceptible mosquitoes per insecticide	Number of mosquitoes susceptible per insecticide	Total number of mosquitoes tested per insecticide (minimum 100)	FMOH Reports	Annually	EPHI/ Partners
Human biting rate	Number of mosquitoes per man per night	Total number of mosquitoes collected from human bait (s)	FMOH Reports	Annually	EPHI/ Partners
Sporozoite rate	Number of mosquitoes with sporozoites	Total Number of mosquitoes tested	FMOH Reports	Annually	EPHI/ Partners

2.1.3 Larval source management

Larval Source Management (LSM) is the management of aquatic habitats (water bodies) that are potential larval breeding sites for mosquitoes, in order to prevent the completion of development of the immature stages.

LSM is an additional strategy that will be implemented to supplement IRS and LLINs. It is applicable where breeding sites are fixed, findable and manageable in terms of number in line with the WHO guidelines (WHO 2013). Unlike LLINs and IRS, which target the adult mosquito vector, LSM targets the immature, aquatic stages of the mosquito (the larvae and pupae), thereby reducing the abundance of adult vectors if all potential breeding sites were eliminated or treated in localities where the intervention is suitable and feasible. LSM, as a supplementary intervention in places it is suitable and feasible, can contribute to the control of *An. arabiensis*, (the main malaria vector in the country). The species is known to have a significant level of exophagic and exophilic behaviour that makes it less amenable for the two major vector control interventions compared to the other major malaria vectors in the African region.

The purpose of LSM

The purpose is to supplement the two major interventions and to contribute to further reducing burden and eliminate malaria in the country. The decision, the choice and application of LSM is guided by the nature of the breeding sites in all phases of malaria transmission. In areas where LSM is feasible, it can contribute to vector control by:

- Targeting high transmission foci: In some locations, malaria may persist even with high LLIN or IRS coverage. LSM may therefore be particularly useful in contributing to reduce malaria transmission in such persistent transmission localities and transform them from optimization to pre-elimination and elimination phases.
- Targeting outdoor resting and biting mosquitoes: IRS and LLINs can effectively reduce vectorial capacity of endophilic and endophagic vector populations. The main malaria vector in Ethiopia, i.e., *An. arabiensis* is known to bite and rest outdoors as much as it

does in doors. This biting and resting behaviour of the vector enables it to sustain low level of transmission that can be a challenge to completely interrupt by the application of only IRS and LLINs in which LSM can play role.

- Managing insecticide resistance: The use of different larvicides in combination with habitat modification and manipulation presents an opportunity to preserve the efficacy of existing insecticides and manage the spread of insecticide resistance once it has emerged. In view of the wide spread resistance of the vector against many of the available insecticides including pyrethroids, the only group of insecticide used LLINs LSM will be useful as one of the resistance management interventions where it is applicable. However, it should be noted that to date there are no documented evidences on the effective utility of LSM in the management of insecticide resistance. Therefore, impact of the method on pyrethriods and carbamates resistance should be closely monitored in areas of implementation.

LSM would be an important component of vector control intervention particularly in urban and per-urban areas and in dry areas with few and/or human made breeding sites. In rural Ethiopia, LSM will be targeted only to development projects, irrigation systems and other human made breeding sites where these are serving as breeding sites and contributing to malaria transmission.

Identification and defining of breeding habitats for LSM

Identify boundaries of target areas

Breeding sites for LSM should clearly be identified and mapped to ensure 100% coverage. Maps can be created simply, by members of the community and without electronic devices. Alternatively, breeding sites can be logged with high-precision hand-held GPS devices and maps created using computer software. The target area should be divided into small plots of land, each of which is assigned to a larval surveillance officer for weekly larval surveillance (size of target area and plots) depends on the terrain and the total number of habitats to be visited. Plots must be small enough to allow unambiguous description of all habitats in the plot, which can be easily identified by supervisors. Each plot can be described using a plot description form (Annex 4). Areas targeted for LSM should be regularly reviewed and updated based on impact of the intervention and environmental factors appearing through time. The update can include either increasing or decreasing the geographical size of target areas depending on the out of the reviews.

Map all potential larval habitats

Each potential larval habitat found should be identified and documented using a larval habitat surveillance form, in conjunction with a plot description form and the area map. When a larval habitat is first identified, it should be assigned a unique number, which is retained even if it becomes dry. During the mapping process, each larval habitat should be described by habitat type, size. Vegetation coverage also should be noted since this can affect the choice of intervention. When a habitat is revisited regularly, it is useful to note whether the habitat has changed from the last visit, if it is dry or wet on the date of visit, the type of plants present (none/short/long/floating) and the depth of water (shallow/deep).

Major types of LSM that will be applied in Ethiopia are:

- ✓ Habitat modification: a permanent alteration to the environment, e.g. land reclamation;
- ✓ Habitat manipulation: a recurrent activity, e.g. flushing of streams;
- ✓ Larviciding: the regular application of biological or chemical insecticides to water bodies

The methods discussed as follows:

Habitat modification

Habitat modification is a permanent alteration to the environment, defined as 'a form of environmental management aimed at preventing, eliminating or reducing the habitats of vectors

without causing unduly adverse effects on the quality of the human environment. The method is applied in urban and urban and pre-urban areas, development projects, irrigation systems, etc. where the intervention permanently avoids the breeding sites (Table 9). Abandoned ditches, ponds and borrow pits can be permanently removed through filling with soil, rubble, stones, ash or rubbish.

Habitat manipulation

Habitat manipulation is a form of environmental management aimed at producing temporary conditions that are unfavourable to breeding of vectors. Unlike habitat modification, habitat manipulation must be repeated to remain efficacious. The methods of habitat manipulation are: controlling water levels (including intermittent irrigation), stream flushing, shading, clearing of aquatic vegetation, straightening and steepening of shorelines. These would be applied where applicable by the responsible institutions and communities.

Larviciding

Larviciding is the regular application of biological or chemical insecticides to water bodies. Larviciding can be a useful supplement to IRS and LLINs in specific locations, where vectors tend to breed in permanent or semi-permanent water bodies that can be readily identified and accessed, i.e. breeding sites which are 'few, fixed and findable'. Only WHOPES fully recommended larvicides should be applied (Table 8). The Federal Ministry of Health should ensure national registration of the relevant WHOPES recommended larvicides unless the WHO's recommendation is adequate for importation and utilization the larvicides.

Currently, there are five main groups of larvicides including oils and surface agents; synthetic organic chemicals; bacterial larvicides; spinosyns; and insect growth regulators. Of these, synthetic organic chemicals and other that suit local context will be applied for LSM in Ethiopia.

Synthetic organic chemicals

These are chemicals that can kill mosquito larvae by interfering with the enzyme acetylcholinesterase, which is required to regulate nerve transmission in all organisms. Organophosphates are considered less persistent in the environment and are therefore recommended by WHO. However, individuals applying this chemical require proper training in safe handling. The organophosphate, temephos has been used extensively as a larvicide in Ethiopia and the use of this chemical will continues while resistance of the vector and impact of the application is monitored. The selection of larvicides should be consistent with insecticide resistance management principles, including consideration of the mode of action of insecticides vis-a-vis resistance mechanisms present in the target vector populations.

The use of temephos should be limited only to areas where only LLINs are used and no IRS is implemented. This is due to the fact IRS in the country is using propoxur and/or pirimiphosemethyl, which are carbamate and organophosphate groups of insecticides. These two groups of insecticides have similar mode of action in the way they affect the vector. Exposing the immature stages, the larvae, to insecticides of the same mode of action (organophosphate or carbamate) will accelerate appearance of insecticide resistance against both groups jeopardizing the IRS program. It should also be noted that recent reports indicate existence of significant level of organophosphate resistance in some parts of the country. Therefore, application of temephos even in only LLINs areas should be done after consulting the resistance status in order to avoid aggravation of the situation. This is critically important to sustain effectiveness of IRS. Resistance in non-IRS areas can easily expand to any part of the country.

Table 8: WHOPES-recommended compounds and formulations for control of mosquito larvae

Insecticide Compounds and Formulation(s)[a]	Class Group[b]	Dosage (Active Ingredient)	
		General (G/HA)	Container-breeding MG/L
Bacillus thuringiensis subsp. israelensis, strain AM65-52, WG (3000 ITU/mg)	BL	125-750[c]	1-5[c]
Bacillus thuringiensis subsp. israelensis, strain AM65-52, GR (200 ITU/mg)	BL	5000-20000[c]	-
Chlorpyrifos EC	OP	11-25	-
Diflubenzuron DT, GR, WP	BU	25-100	0.02-0.25
Novaluron EC	BU	10-100	0.01-0.05
Pyiproxyfen GR	JH	10-50	0.01
Fenthion EC	OP	22-112	-
Primiphos-methyl EC	OP	50-500	1.0
Temephos EC, GR	OP	56-112	1.0
Spinosad DT, EC, GR, SC, AC	SP	20-500	0.1-0.5

a DT= tablet for direct application; GR=granule; EC= emusifiable concentrate; WG= water-dispensable granule; WP= wettable powder; SC= suspension concentrate; AC= aqueous concentrate

b BL= Bacterial larvicide; BU= Benzoylureas; JH= Juvenile Hormone Mimics; OP= Organophospahe; SP= Spinosys.

c Formulated product.

Bacterial larvicide

Bacterial larvicides (BL) include products based on the insecticidal crystal proteins produced by Bacillus thuringiensis subsp. israelensis (Bti), and Bacillus sphaericus (Bs). Upon ingestion by mosquito larvae, these proteins are modified by enzymes in the larval midgut and then bind with specific receptors on the midgut epithelium, resulting in pore formation and interruption of feeding and homeostasis. This unique mode of action accounts for the specificity of bacterial larvicides and their utility in managing insecticide resistance to chemical insecticides. Bti, the specific strain AM65-52 will be applied in areas targeted for IRS and in areas only with LLINs where insecticide resistance against organophosphate and/or carbamate has been reported.

Application of larvicides

Temephos: is an organophosphorus compound. It is a brown, viscous liquid. It is effective in clean, moderately and heavily polluted waters. It is relatively safe and a low dose is sufficient to kill mosquito larvae. It is recommended for application to drinking water. Temephos is available as EC (46% and 20% w/v/ active ingredient) and granules (1% active ingredient). The dosage of active ingredient should be 56–112g/ha. 56 g active ingredient per ha for clean, open water and 112g/ha if there is dense aquatic vegetation. Granules are applied in breeding sites with dense aquatic vegetation and should be applied every 1 to 3 months. Granules and water suspensions of the EC are applied by spraying using knapsacks. Floating temephos-impregnated plastic pellets are also available. These can last for 6 weeks.

Bti: Frequency of re-treatment with bacterial larvicides can range from 1 to 4 weeks for Anopheles depending on formulation, habitat, temperature, and species. Typical re-treatment intervals with Bti are 7–10 days. For maximum efficiency, the re-treatment interval should be

determined by recovery of late fourth instar larvae to established thresholds, or the first appearance of pupae. Water-dispersible granule (WDG) diluted in water are applied as liquid with a knapsack sprayer. Corn granule (CG) are applied as granular, undiluted finished product by hand. Different formulations of Bti and their application to the various types of breeding sites to maximize impact is presented below (taken form WHO 2013).

Different formulations of Bti

- *Suspension Concentrate (SC)*: Biopotency is typically 600 or 1200 ITU/mg. Used for a variety of habitat settings but are used in open waters with minimal to no vegetation. Reapplication is typically at 7 to 14 days depending on program objectives.
- *Water Dispersible Granules (WG)*: Biopotency of WHOPES-recommended Bti strain AM65-52 WG is 3000 ITU/mg. This formulation can be applied as (i) a liquid spray to open habitats with little or no vegetation, (ii) an area-wide spray to control larvae in cryptic habitats and (iii) directly to artificial and natural containers. Residual efficacy depends on formulation quality, target habitat/species and a number of other abiotic/biotic factors. Reapplication can range from 7 to 14 days for surface water treatment for *Anopheles*, to three months or more for *Aedes* control in domestic water containers. In practice, retreatment should be done when 4th instar larvae reappear.
- *Wettable Powder (WP):* These powders come in a variety of biopotencies and must be mixed with water before application. Reapplication is typically 7 to 14 days.
- *Granules:* Bti granules come in a variety of carrier types and potencies with the primary purpose of delivering the maximum amount of Bti into the water. Biopotency of WHOPES-recommended Bti strain AM65-52 GR is 200 ITU/mg. Granules minimize drift for more targeted applications and are better a penetrating vegetation than liquid sprays. Reapplication is typically at 7 to 14 days.
- *Briquettes (BR):* Briquette biopotencies vary depending on the manufacturer and the technical powder used. These formulations release Bti for 30 to 180 days (residual depends on BR types and biopotency) and their effectiveness is not altered by alternate wetting and drying, making them appropriate for both permanent and temporary habitats. Briquette can be ring-shaped (which usually float) or in brick form (which usually sink). These formulations are less effective for open water (wind may blow them to the margins), so applications are generally used to treat small domestic larval habitats such as ponds, basins and tanks. Briquette become clogged in polluted water so should be used for relatively clean habitats.

Preparation and application

- *Liquid Sprays:* Suspension Concentrates (SC), Water Dispersible Granules (WG) and Wettable Powder (WP) can all be used for liquid spray application. The rates used will depend on formulation type, potency, vector species and habitat. SC formulations can be applied either diluted or undiluted, depending on the volume of water required to cover the habitat. WG formulations are typically mixed in water before spraying open habitats or applied directly to natural and artificial containers without pre-mixing in water. WP formulations require mixing with water for all target habitats. All formulations can be applied using hand compression pumps or other spray equipment. Recommended application rates for WHOPEs recommended Bti WG, strain AM65-52 are:
    - *Open habitats: 125-750g formulated product/ha (71)*
    - *Containers: 1-5mg formulated product/L (71)*
- *Granules:* These can be hand applied or applied with portable blowers to habitats with or without vegetation. Recommended application rates for WHOPES recommended Bti GR, strain AM65-52 are
    - *Open habitat: the dosage should be 5-20 kg formulated product/ha (71)*
- *Briquettes:* Floating ring formulations are applied by hand (1 unit/10m^2 surface area) and may need

to be attached to plants or other fixed objects with strings to avoid wind disturbance. Brick formulations typically sink to the bottom of the habitat and do not need to be secured. Rates for these BR forms are similar to the floating ring forms. Briquettes should be stored in sealed packages in a cool place to protect from humidity.

Quality control of the larvicides

Both pre- and post-shipment quality monitoring should be conducted on larvicides similar to as for LLINs and insecticides of IRS and following the same procedures.

Monitoring coverage and impact of LSM

Similar to IRS and LLINs monitoring and evaluation is integral part of LSM to ensure effectiveness of the intervention. Regular monitoring of quality of the larvicides and appropriateness of their application should be closely monitored. Trained vector control officers at district level should conduct impact assessment of all LSM interventions on the larval population of the treated breeding sites and presence and density of adult vector within the treated areas and their immediate surroundings. For LSM to be effective, potential breeding sites within the targeted area and immediate vicinity, which is a radius of about 0.5 km around the identified malaria case should be treated.

To facilitate monitoring and assessment of impact of LSM, baseline data on larval and adult populations should be collected for one transmission season. This allows major larval habitats and vector species to be identified and LSM to be well planned and targeted. It also facilitates evaluation of the impact of the interventions. Procedures on conducting larval surveys are described the WHO manual (AFRO 2015, WHO 2013).

Indicators for LSM

The indicators for the impact of larval control in malaria transmission are:

- The proportion of larval habitats positive for anopheles' larvae;
- The proportion of breeding sites treated by the appropriate LSM intervention within the mapped and targeted area (the target is 100%);
- Adult vector densities in surrounding houses compared to baseline.

In addition to the above indicators, impact of implementation of LSM on insecticide resistance should be monitored. To this effect, status of insecticide resistance in areas where LSM is implemented should be determined and documented at baseline. Results of subsequent resistance monitoring activities in the areas should be reviewed and compared with the situation at baseline to assess the impact of LSM on status of resistance of the vector against the insecticides in use in the country with a special attention to pyrethroids in view of their wide spread resistance.

Monitoring of susceptibility of anopheles larvae

Regular (yearly) monitoring of susceptibility of the anopheles larvae to the insecticide, in this case temephos (applying the WHO protocol) should be conducted in the sentinel sites designated for adult susceptibility monitoring. However, a few representative urban centres will be included for the larviciding monitoring purpose if most localities fall outside of the current sentinel sites.

Table 9: Types of breeding sites and preferred application methods of LSM

Type of intervention	Types of breeding sites	Possible interventions	Application	Responsible
	- drainage systems -ditches -Potholes and quarries created by development projects (construction, mining, etc.) -Dams	-Fixing drainage systems in urban & per-urban areas -Feeling ditches and pit holes created by construction and mining activities -Close open drainage system -Avoid overflow of dam water	-As the need arises, anytime of the year - One time and lasting intervention	-Municipalities -Construction authorities/ companies -Agriculture sector -Mining -Community, -Farmers -etc.
Habitat manipulation	-Irrigation system -Impoundments -Dams	- Intermittent irrigation - Canal flushing, -Good irrigation canal maintenance (e.g. clearance of vegetation so that water flows, or growing bushes over canals to provide shade); • Intermittent irrigation and periodical drying; -Draining of unavoidable impoundments - draining to eliminate pools	- Repetitive application mainly in transmission season -Anytime of the year in areas where temperature allows continuous breeding	-Communities/ HDA -Agriculture sector -Development project (sugar factories, etc.)
Larviciding	-Unavoidable permanent or semi-permanent breeding sites	-Application of temephos, if need be Bti	-Repetitive application -Not in big rains	-Trained community members/HDA - Mining -Agriculture sector -Municipalities -Irrigation systems

2.2 Vector control in the pre-elimination and elimination

2.2.1. Targeted LLINs in pre-elimination and elimination phases

LLINs can also be used in pre-elimination and elimination phases only if it is possible to ensure a high level of coverage (100%), as well as a high level of use (≥85%). In the control and optimization phases, such levels are achieved usually through mass distribution of LLINs in a wide area with at-risk populations. In malaria elimination, mass LLIN distribution for universal coverage can be scaled down to target populations in transmission foci and hotspots. However, scaling down of LLINs should be considered once the health system is strengthened to pick up and respond to resurgences particularly in highly receptive and vulnerable areas in a timely manner to avoid the risk of reestablishment and expansion of malaria transmission. Consequently, scaling down of universal coverage of LLINs to tLLINs is applied.

Even in presence of such system, the challenge in using LLINs in malaria elimination is in dealing with the gap usually observed between ownership and actual use, particularly in areas where malaria transmission is low and mosquito nuisance is negligible. As a result, in pre-elimination and elimination phases distributing LLINs in response to reports of localized malaria cases may not be the best vector control option. However, distribution of LLINs is less labour intensive than IRS and once distributed they are expected to be effective for much longer than IRS applications, which makes them useful in sustaining the low risk of transmission in areas where IRS is not recommended, such as in the prevention of re-introduction phase. The current strategies of LLINs distribution and management in control and optimization level should remain in place. This manual provides additional guiding procedures as it relates to the use of LLINs in the pre-elimination, elimination and prevention of re-introduction

Unlike in the optimization phase, in the pre-elimination – elimination phases LLINs will be targeted to certain groups of communities where the application of IRS is not feasible. These include urban areas, pastoralist communities, other vulnerable populations, for instance migrant workers, IDP, etc.

LLINs may also be distributed and utilized in selected malaria free areas with high receptivity and vulnerability particularly those adjacent to neighbouring countries where malaria burden and the risk of reintroduction of the transmission remain high.

The same monitoring and evaluation of coverage, quality, impact, application of indicators are applicable in the utilization of LLINs indicated above remain critical during the pre-elimination, elimination and prevention of re-introduction of transmission phases. The same indicators established for LLINs in the optimization phase should be applied in the pre-elimination and elimination phases.

2.2.2 Targeted IRS in pre-elimination and elimination phases

Once malaria transmission is reduced with universal coverage of vector control interventions, application of targeted IRS is a more feasible method to push malaria towards elimination.

Purpose

Targeted IRS will be conducted in transmission foci and hot spots in pre elimination/elimination phases to eliminate malaria transmission and to prevent re-introduction in cleared areas. The aim is to achieve 100% coverage of transmission foci and hot spots. Therefore, no foci or hot spot should be left unsprayed where locally acquired malaria case has been confirmed. Therefore, IRS operational indicators indictors in the pre-elimination and elimination phases are:

- *100% of foci and/or hotspots with local transmission targeted*

- ≥ *85% of targeted structures sprayed*
- ≥ *85% of targeted population protected*

Foci Investigation for action

Endemic foci and hot spots: Before additional interventions are conducted in foci and hot spots, monitoring and evaluation of current interventions, parasitological, entomological and social investigation should be done, as this will help to identify the reasons why malaria transmission is persistent despite implementation of interventions. Foci investigations should be done on vector susceptibility to insecticides in use, quality of IRS (or LLINs if in use), confidence of community for IRS as shown by re-plastering and outdoor resting and biting of the vector.

New active and residual active foci: In new active and residual active foci, IRS should be conducted and intensified to interrupt malaria transmission. After 2-3 consecutive years with no reported confirmed malaria case, the foci will be considered malaria free but being vigilant to ensure that interventions are in place to prevent re-introduction of malaria.

Epidemic response in tIRS

Effective planning and a good level of preparedness are key to the success of IRS. This is because each identified local case, particularly in elimination phases is considered an epidemic and is given an immediate and appropriate response.

Monitoring and evaluation for tIRS aspects to consider

The key requirements for monitoring and evaluating progress in tIRS include:

- Accurate and quality record keeping, including well organised surveillance and information on case management
- Complete and regular reporting
- Regular data audits on IRS to ensure completeness and timeliness of information
- Timely feedback to all staff and partners involved in IRS at all levels.
- Geographical reconnaissance and mapping of structures / households.
- Monitoring / tracking, management of insecticide resistance.
- Surveillance of vectors and their bionomics.

Larval Source Management (LSM) in pre-elimination and elimination phases

LSM plays an important supportive or even leading role in malaria elimination where the target mosquito breeding sites are limited in number and are found around an identified focus. When malaria transmission is reduced to very low levels, complete interruption of transmission will become a challenge, as outdoor transmission will continue, particularly in areas where *An. arabiensis* is an important vector. The species tends to feed and rest outdoors as much as indoors when and where blood meal sources and suitable resting sites are available. The outdoor resting segment of the population can continue transmitting the disease unless the breeding sites are eliminated or treated with effective larvicides. With very high coverage, which might be attainable in malaria elimination owing to the limited size of the target area, it is anticipated that LSM can contribute significantly to the reduction of the risk of malaria transmission. However, in persistent foci and hotspots the main intervention should remain IRS, but it can be supplemented with LSM to minimize the impact of outdoor-resting vector populations if needed.

General management of LSM in Pre-elimination and elimination is similar to that is described for the optimization phase.

2.3 Vector control for prevention of reintroduction of malaria

When malaria is eliminated sub-nationally or from the country, it is not the end of the game. Rather it is the beginning of a phase that is intensively focused on sustaining the malaria free status.

2.3.1 Understanding the risk of reintroduction of malaria

When complete interruption of local transmission of malaria has been achieved at either sub-national or nation level, vector control activities will be directed at preventing the reintroduction or re-establishment of malaria in the areas covered by the elimination programme. It should be noted that environmental conditions and socioeconomic factors in the country would continue to favour vector breeding and human-vector contact, so the areas from where malaria has been eliminated will remain receptive, and if the human parasite carrier becomes available, the risk of epidemics will be real. Therefore, it is important for the districts that have eliminated malaria transmission to continue vector surveillance and monitoring until the whole nation is free of malaria and the frontiers for prevention of re-introduction become borders with neighbouring countries rather than districts. This is a long-term battle until countries in the Region, particularly those with which Ethiopia shares borders, become free of the disease.

The challenge in sustaining the malaria-free status is in continuously minimizing outbreak risk factors, which are the potential for malaria transmission in the elimination areas and the likelihood that an imported case will give rise to others that in turn could generate still more cases, causing a local outbreak. The systematic and focused implementation of IRS, LLIN and LSM interventions and probably personal protection measures will have greatly reduced the outbreak risk by the time elimination is achieved at the district or national level. Sustained effort, taking the appropriate vector control actions, particularly in highly vulnerable foci, is required to maintain the low risk. The choice of vector control interventions to be used, the consistency of their application and the level of their coverage will be dictated by the level of the risk of malaria reintroduction. Up-to-date information on the existence and distribution of breeding sites and prevalence of vector larvae is extremely important, particularly for areas with a high risk of reintroduction and re-establishment of transmission. This requires a well-organized vector surveillance system. Moreover, maintaining the malaria-free status will require the awareness and contribution of all groups in the population to ensure a deliberate checking of the risk factors for transmission.

The main risks for reintroduction of malaria are related to population movement between districts in the elimination phase and those where malaria is still endemic and are in the optimization phase. The same is true about risk of cross border introduction, where the challenge is the movement of populations between countries that have eliminated malaria and those where the diseases is still endemic.

2.3.2 Sustained actions to reduce the risk of reintroduction

Continuously updating geographic reconnaissance (GR) data is vital so that the appropriate actions for sustaining the malaria-free status are taken when required. Vector surveillance should be conducted particularly in potentially receptive areas, including monitoring of breeding sites for larvae, surveying both indoors and outdoors for the presence of adult mosquitoes. Follow-up actions and analysis of major changes in environmental parameters, especially meteorological features that may favour malaria transmission such as rainfall and temperature and environmental changes due to infrastructural modifications such as construction of dams, roads, irrigation schemes, new settlements and so on should continue after malaria elimination. This will allow appropriate mitigation actions to be taken to reduce the risk of malaria reintroduction and re-establishment of local transmission from imported human cases or infective vectors.

2.3.3 *Post-elimination critical vector control capacity*

Maintaining entomological capacity at the appropriate administrative level as per the national malaria elimination programme (NMEP) policy, taking into consideration the country's specific situation, is critical. It is preferable to have a health management team or teams with entomological capacity at the district level in highly vulnerable areas to eliminate the costs of long distance travel from the central level and to ensure timely response to malaria threats when needed.

Adequate technical capacity, supplies, and equipment such as those required for IRS also should be maintained and kept in operating order to enable the system to respond to reported epidemics or obvious risks of epidemics. In addition to the NMEP vector control team, capacity can be created at the community level and in municipalities in urban areas to participate in vector monitoring, particularly in searching for mosquito larvae and adults.

3. Cross cutting issues

The following cross cutting actions should be implemented to intensify effective vector control to reduce the malaria burden in the coming five years and eliminate the disease from the country by 2030.

3.1 Capacity building

Intensification of the vector control program for impact in the optimization phase and the targeted implementation of interventions to interrupt localized transmission to eliminate malaria requires building of the human and material capacity of the health system at all levels and that of the stakeholders.

Training

Capacity building for planning, implementation, supervision, monitoring and evaluation of IRS, LLINs and LSM should be conducted as part of reorientation and preparation of the Ethiopian malaria control program for intensified actions for elimination. Entomologists and vector control officers at national and regional levels should be trained in proper management of vector control including implementation, monitoring, evaluation and vector surveillance.

Following the national and regional staff training cascade training should be organized at district level. The trained entomologists and vector control officers should train district staff, HEWs and HDAs to ensure good quality management of the interventions.

With regards to the capacity building pertinent to LSM relevant staff in stakeholder institutions such as Ministry of Agriculture, Municipalities, Mining, Construction authorities and companies, other development projects, etc. would focus on enabling them to adequately play their expected role in the countries effort to eliminate the disease.

Training on management of IRS should focus on:

- ✓ Preparation and conducting GR for implementation of IRS and LSM, and interpretations and utilization of the information including estimation of target population size and number of structures or size or sprayable surfaces
- ✓ Determination of requirements:
    - Amount of insecticide
    - Amount of logistics
    - Number of spray days
    - Number of spray teams and spray operators
    - Financial needs
    - etc.
- ✓ Preparation of macro plan (national/regional level)
- ✓ Preparation detailed micro plan (district level)
- ✓ Implementation of IRS operation (preparation of insecticide solution, application, etc.)
- ✓ Supervision
- ✓ Monitoring quality implementation (e.g. cone bio-assay test)

- ✓ Monitoring operational (population) coverage
- ✓ Compilation and analysis of IRS data and reporting, etc.
- ✓ Training on management of LLINs should focus on:
- ✓ Preparation and conducting GR for mass distribution including estimation of target population size
- ✓ Determination of requirements:
  - Number of LLINs
  - Number of distribution points
  - Number of individuals for distribution
  - Financial needs, etc.
- ✓ Preparation of macro plan (national/regional level)
- ✓ Preparation detailed micro plan (district level)
- ✓ Post distribution assessment of implementation
- ✓ Monitoring coverage and actual use of LLINs
- ✓ Monitoring bio-efficacy and physical integrity of LLINs at community level
- ✓ Compilation and analysis of data and reporting for action, etc.
- ✓ Training on management of LSM should focus on
- ✓ Preparation and conducting geographic reconnaissance for implementation for LSM,
- ✓ Identifying (determine) areas for LSM
- ✓ Mapping and accurate description of larval habitat (characterizing)
- ✓ Preparation of macro plan (national/regional level)
- ✓ Preparation detailed micro plan (district level)
- ✓ Determination of requirements:
  - Amount of insecticide
  - Amount of logistics
  - Number of spray days
  - Number of spray teams and spray operators
  - Financial needs
- ✓ Application of the LSM method of choice in the area
- ✓ Supervision
- ✓ Monitoring quality and coverage of ISM application
- ✓ Assessing the impact of the LSM and in the interpretation of the data, etc.

Training in vector surveillance

Training in vector surveillance should be organized as standalone session. Entomologists and vector control officers at national and regional levels should be trained in vector surveillance techniques. As indicated above, the national capacity should be cascaded to district staff in the required areas of surveillance at that level. The following will be the focus of the vector surveillance.

- ✓ Conducting insecticide susceptibility testing for adult mosquitoes
- ✓ Conduct insecticide susceptibility test for mosquito larvae
- ✓ Monitoring tests and interpretation of the data
- ✓ Adult vector collection techniques
- ✓ Distinguishing anopheline eggs, larvae, and pupae from that of culicines and aedes species
- ✓ Distinguish adult anopheline from culicines and aedes species
- ✓ Rearing larvae and pupae in the lab for various tests
- ✓ External anatomy of adult Anopheles used for identification
- ✓ External anatomy of Anopheles larva used for identification

- ✓ Bio assay test for insecticide deposits on wall surfaces
- ✓ Bioassay test for insecticide treated mosquito net surfaces
- ✓ Laboratory mosquito processing techniques (dissection for ovary, glands, etc.)
- ✓ Rearing mosquito colonies in the laboratory
- ✓ Analysis and interpretation of entomological data, etc.

In order to facilitate hands on training at the field level pertaining to IRS, LLINs, LSM and vector surveillance trainings should be organized during transmission season and if possible as part of baseline data collection for LSM and adult vector surveillance.

Existing modules are applied for the above listed trainings. Modules should be revised and/or developed by adapting the global and regional WHO documents (AFRO 2015) if need be.

3.2 Vector surveillance

Vector surveillance is a regular and systematic collection, analysis and interpretation of entomological data for planning, implementation, monitoring and evaluation of vector control interventions.

3.2.1 Purpose of vector surveillance

The aim of vector surveillance is to:

- ✓ gather entomological information that guides appropriate selection and planning of malaria vector control interventions;
- ✓ determine temporal and spatial changes in the distribution, composition, density and bionomics of malaria vectors including insecticide resistance in relation to malaria vector control interventions and environmental changes;
- ✓ assess the impact of malaria vector control interventions and facilitate timely and appropriate decision-making for their implementation;
- ✓ contribute to the investigation of problem areas where control measures prove unsuccessful;
- ✓ provide evidence for advocacy and resource mobilization;
- ✓ provide entomological data that will help in risk assessment and emergency preparedness for malaria outbreaks, etc.

Malaria vector control in the optimization and pre-elimination-elimination phases should be guided by data generated through vector surveillance as part of the overall malaria surveillance. Temporal and spatial changes in the distribution, composition, density and bionomics of malaria vectors including status of susceptibility to insecticides should be monitored regularly to ensure quality vector control implementation and impact on transmission. The impact of malaria vector control interventions need to be assessed regularly. The WHO operational manual on vector surveillance will be adapted and applied for implementation of vector surveillance in Ethiopia.

3.2.2 Sentinel sites for vector surveillance

Vector surveillance is conducted in representative sentinel sites. Assessment of existing sentinel sites should be carried out in the optimization phase to determine the needs for making them fully functional for routine vector surveillance. This includes availability of field insectaries equipped with basic entomological equipment and supplies such as aspirators, paper cups, cages, bioassay cones etc.; and availability of trained staff. Based on the outcome of the assessment the sentinel sites should be strengthened and prepared to accommodate entomological activities required to guide vector control interventions at that level.

3.2.3 National entomological reference centres

Some activities of vector surveillance require well-equipped laboratories. For instance, determination of the type (mechanism) of insecticide resistance in a vector population is critical for the choice and implementation of insecticide management strategies. However, determination of insecticide resistance mechanism and some other activities of vector surveillance should be conducted in advanced laboratories equipped with the required machineries and a trained human power in the required techniques. Existing entomology laboratories at the EPHI and at other stakeholder institutions such as universities should be strengthened.

3.3 Geographical reconnaissance

GR is critical for planning and implementation of vector control interventions for optimal impact on high transmission foci and hot spots, both in the optimization and pre-elimination and elimination phases. GR is the activity that identifies the target areas, including the spatial distribution and number of structures to be sprayed, the households to receive LLINs and the breeding sites for LSM. Furthermore, GR provides information on the distribution of breeding sites in relation to confirmed malaria cases and other relevant operational data.

GR is conducted using hand-held global positioning system (GPS) devices, geographic information systems (GIS) and computerized mapping. GR will be undertaken regularly to generate precise information for implementation of vector control interventions to accommodate the changing epidemiological and physical environment as the program progress from optimization to pre-elimination in all malarious areas of the country.

3.4 Advocacy, community engagement and partnership for vector control

Effective advocacy, partnership and resource mobilization facilitate implementation of planned vector control activities. Community engagement fosters ownership for increased uptake of vector control and other interventions. It is also vital to have advocacy for leaders to build awareness and knowledge with the aim of maximizing their support. Table 9 summarizes key items on advocacy, community engagement, partnership and resource mobilization needed to enhance effective delivery of vector interventions.

Table 10: Advocacy, community engagement and partnership for vector control

Cross cutting item	Contribution to vector control intervention
Advocacy and community engagement	• Advocacy for leaders to increase awareness, knowledge and solicit support. • Community social mobilization to boost community involvement and increase uptake and use of vector control interventions.
Partnership and resource mobilisation	• Partnership to maximize comparative advantages of each partner to enable effective mobilisation of resources (financial, technical, and material) for effective implementation • Enhanced evidence based decision-making processes in vector control interventions • Partnerships and intersectoral collaboration and consultations within health and non-health sectors, including **cross-border activities** to enable effective integrated vector control (IVM).

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Annexes

Annex 1: IRS Supervision Inspection Checklist 1

Pre-spray storeroom and soak pit inspection

Date of inspection: ..... /..... /.....

Country: ..... Region: .....

Districts: ..... Village/Kebele: .....

GPS coordinates: .....

Inspectors: .....

Security at central warehouse and district storage facility

	MITIGATION ACTIONS	FINDINGS		COMMENTS/ RECOMMENDED ACTIONS	COMPLETION DATE (IF APPLICABLE)
1	Is the storage facility located at an adequate distance from schools, homes and water bodies/flood plains?	Yes	No	Facility located at least 100 m away from residential housing?	
2	Is the storage facility secured including double locks on pesticide storage containers, all windows barred and doors secure?	Yes	No	Strong front door with double locks? Windows secured? (mark with a tick or X where appropriate)	
3	Is the facility guarded 24 hrs/ day with adequate lighting?	Yes	No		
4	Are guards equipped appropriately: boots, whistles, flashlights, phones?	Yes	No		
5	Is the storeroom well ventilated?	Yes	No		
6	If the storeroom is to be used to keep insecticides for longer duration, does it have adequate ventilation and/or exhaust fans working?	Yes	No		
7	Is there adequate lighting inside the store?	Yes	No		
8	Are danger signs and appropriate hazard labels prominently displayed?	Yes	No		
9	Do the compression pumps meet WHO specifications for use in IRS?	Yes	No	Pumps fitted with 8002E nozzle? Fitted with 1.5 bar CFV?	
10	Are technicians available to service compression pumps and fix dysfunctional pumps?	Yes	No		

	MITIGATION ACTIONS	FINDINGS		COMMENTS/ RECOMMENDED ACTIONS	COMPLETION DATE (IF APPLICABLE)
11	Are the pumps kept dry and properly stored?	Yes	No		
12	Are the spray pumps properly maintained and is a stock of spare parts available?	Yes	No	1) Pumps serviced once a year 2) Pumps and nozzles (8002E) calibrated prior to spray cycle	
		Yes	No	3) Nozzles cleaned and tested regularly 4) Spare 8002E nozzles available	
13	Is personal protective equipment (PPE) properly maintained?	Yes	No	1) Overall in good condition, cleaned and properly stacked 2) Head gear and boots in good condition, cleaned and properly stacked 3) Are PPEs kept separately and away from equipment and insecticides?	
14	Is the store clear and free of rodents? (Rodents can damage sprayers by chewing hoses)	Yes	No	Rodent traps set in the store?	

Stock review

	MITIGATION ACTIONS	FINDINGS		COMMENTS/ RECOMMENDED ACTIONS	COMPLETION DATE (IF APPLICABLE)
1	Is there a system for recording stock, and are stock cards up to date?	Yes	No		
2	Are the available stock cards properly filled to enable tracking of stock?	Yes	No	Using stock cards, can warehouse supervisor indicate: a) Quantity and age of remaining stock?....., b) Quantity of stock that has been used to-date?.....	
3	Are stock items shelved in an orderly fashion on pallets, according to their type or expiry date?	Yes	No		
4	Does the storeroom have a leak-proof floor and a sump at the entrance to contain major leakage?	Yes	No	*The leak-proof floor should drain into a sump so that if the floor is washed, liquid can be collected for appropriate disposal.*	

	MITIGATION ACTIONS	FINDINGS		COMMENTS/ RECOMMENDED ACTIONS	COMPLETION DATE (IF APPLICABLE)
5	If flood risk is unavoidable, what precautions are in place to mitigate the consequences?	Yes	No	1) Raised storage area..... 2) Proper drainage in place.....	
6	Does the storeroom have a leak-free roof?	Yes	No		
7	Is storage capacity sufficient to store the total stock of insecticides at any time?	Yes	No		
8	Are insecticide containers (boxes, drums etc.) stored on pallets and stacked in a manner that allows for inspection?	Yes	No		
9	Is the maximum storage height (2 m) for insecticide stacks maintained?	Yes	No	*If no, then containers must be* *restacked to bring them in line with the maximum storage height*	
10	Are all insecticide containers checked to ensure none are leaking?	Yes	No		
11	Is there a recording thermometer in the pesticide storeroom?	Yes	No	Logbook with regular record of temperature available?	
12	Are functional in-date fire extinguishers or fire-fighting equipment (e.g. bucket of sand) available?	Yes	No	Outside / inside the storeroom , pesticide room , and transport vehicles?	
13	Is there a system for fire extinguishers to be tested and replaced before their expiry dates?	Yes	No	Are all fire extinguishers functional?	
14	Are pesticide labels securely fixed and legible?	Yes	No		
15	Are samples of pesticides taken for quality (QA/QC)[a] analysis?	Yes	No	If no, is there evidence to show the quality of	
16	Are any insecticides that are past their expiry date separated from operational stocks?	Yes	No	Expiry date of pesticides in inventory / /	
17	Is there any evidence of pesticide leakage or spill (sign of dust or granules)?	Yes	No		

	MITIGATION ACTIONS	FINDINGS		COMMENTS/ RECOMMENDED ACTIONS	COMPLETION DATE (IF APPLICABLE)
18	Are barrels or containers for waste available and are these clearly labelled?	Yes	No		
19	Are used sachets or bottles counted and stored neatly in boxed containers or barrels?	Yes	No		
20	Is soap and water available for hand washing after handling insecticides?	Yes	No		
21	Are antidotes to specific pesticides available nearby? (*Note: Not all pesticides have an antidote*)	Yes	No	Is there a plan for emergency evacuation to health facility in case of accidental poisoning?.....	
22	Do storeroom supervisors know the signs of poisoning specific to the pesticides being used, as well as the location of the nearest treatment facility?	Yes	No	Distance to nearest pesticide poison	
23	Are pregnancy test strips in stock for female staff and have preparations been made for tests to be conducted at a nearby clinic or by a nurse?	Yes	No	Pregnant or	
24	Is there an adequate number of supervisor checklists, inventory and monitoring and evaluation forms available?	Yes	No		

• QA – Quality assurance: QC – Quality control

Health and safety issues

Sr. No.	MITIGATION ACTIONS	FINDINGS		COMMENTS/ RECOMMENDED ACTIONS	COMPLETION DATE (IF APPLICABLE)
1	Are pesticide Material Safety Data Sheets (MSDS) readily available?	Yes	No		
2	Are there extra MSDS available for labelling transport vehicles and are drivers trained in the event of an accident?	Yes	No		
3	Is there a plan for maintenance of PPE?	Yes	No		
4	Are instructions provided for the correct use of PPE?	Yes	No		
5	Is there adequate PPE in the inventory for the number of operators expected? (Three pairs of overalls, one set of gloves, boots, headcover and mouth/nose mask per spray operator)	Yes	No	Number of operators to work out of this centre....., number of full sets of PPE available	
		Yes	No	Number of available overalls ....., hand gloves....., mouth/ nose masks....., boots (insert numbers)	
6	Are first-aid kits for the storeroom and for transport vehicles stocked with pain killers (e.g. aspirin, panadol), dressings (e.g. plasters, gauze, tape, bandages) and eye wash?	Yes	No	Number of transport vehicles expected to be used..... Number of fully stocked first-aid kits.....	
7	Is the emergency response procedure posted in the stockroom (including phone numbers) and on the notice board at the warehouse?	Yes	No		
8	Is the spill response procedure posted?	Yes	No		
9	Are emergency spill kits in place for the storeroom and for vehicles (sand bucket, long-handled brush with stiff bristles, shovel) with instructions included?	Yes	No	Number of vehicles to work out of this operations center Number of spill kits included in inventory	
10	Is there more than one spray season of accumulated solid waste?	Yes	No	If yes, is there a plan in place for its disposal? When will disposal take place?	
11	If present, are foods, medicines and other products stored separately from pesticides (to prevent contamination)?	Yes	No		
12	Is there someone trained in first aid, specifically in treating pesticide exposure?	Yes	No	If no, is there a plan to provide training?.....	

Soak pit and washing area

	MITIGATION ACTIONS	FINDINGS		COMMENTS/ RECOMMENDED ACTIONS	COMPLETION DATE (IF APPLICABLE)
1	Is the soak pit located away from water bodies, steep slopes or flood prone areas?	Yes	No		
2	Are the soak pit and surroundings cleared of vegetation and cleaned?	Yes	No		
3	Is the gravel on soak pit adequate, well placed and able to act as a filter?	Yes	No		
4	Are the washing areas properly sloped to drain to the soak pit, with no leaks or cracks?	Yes	No		
5	Are clothes lines present and are they sufficiently strong?	Yes	No		
6	Are the clothes lines located above the soak pit or wash area?	Yes	No		
7	Are danger signs and appropriate hazard labels posted on all exposed sides of the soak pit?	Yes	No		
8	Is the soak pit sufficiently well-built and is it correctly fenced, gated and locked?	Yes	No	Well-built and fenced? Gated? Locked?	
9	Are showers and toilets with adequate privacy and drainage present at the site?	Yes	No	Separate male / female facilities?	
10	Is there adequate clean water available for rinse management?	Yes	No	Adequate water available for progressive rinsing, washing PPEs and cleaning of operators?	
11	Is there a storage space for clean non-working clothes and are changing areas available to put on work clothes?	Yes	No		

Evaporation tanks (non-biodegradable chemical waste)

	MITIGATION ACTIONS	FINDINGS		COMMENTS/ RECOMMENDED ACTIONS	TIMELINE FOR ACTIONS (IF APPLICABLE)
1	Is the evaporation tank for DDT liquid waste well built, is it located away from water bodies and is the tank covered with wire mesh?	Yes	No NA	Located downward side of rinse area? Constructed of concrete? Sunk into the ground with sides raised 20–30 cm high? Covered with mesh wire?	
2	Is there any cover available in the event of rain?	Yes	No NA	Could be permanent shelter or temporary tarpaulins	
3	Are the washing areas properly sloped to drain to evaporation tank, with no leaks or cracks?	Yes	No NA	No leaks No cracks	

Annex 2: IRS Supervision Inspection Checklist 2

Spraying activities inspection

Date of inspection: ..... /..... /.....

Country: ..... Region: .....

Districts: ..... Village: .....

GPS coordinates: .....

Inspectors: .....

Field site office / district storage facility

	MITIGATION ACTIONS	FINDINGS		COMMENTS/ RECOMMENDED ACTIONS	TIMELINE FOR ACTIONS (IF APPLICABLE)
1	Are first aid kits for the storeroom and for transport vehicles stocked with pain killers (e.g. aspirin, Panadol), dressings (e.g. plasters, gauze, tape, bandages) and eye wash?	Yes	No	Number of transport vehicles expected to be used Number of fully stocked first aid kits	
2	Is there someone trained in first aid, specifically in treating pesticide exposure?	Yes	No		
3	Are the store keeper, spray operators and wash persons properly instructed to wear PPE and do they wear appropriate PPE?	Yes	No	Instructed or trained to wear PPE? Do they wear appropriate PPE?	
4	Do spray teams have clean and complete PPE at the start of each work day?	Yes	No		
5	Are overalls washed daily at site and are they dried over the soak pit?	Yes	No		
6	When conveying equipment to the field, are all spray operators comfortably seated in vehicles with pumps well placed between their legs?	Yes	No		
7	Are the spray operators given a meal at the beginning of their workday?	Yes	No	Meal should be provided if the spray operation is expected to last longer than 8 hours a day	
8	Do any of the female spray operators appear to be pregnant or breast feeding?	Yes	No	Records for pregnancy test results observed on site? Plans to do pregnancy test midway during spray season? Pregnant or breastfeeding female spray operators should be assigned tasks other than spraying	

	MITIGATION ACTIONS	FINDINGS		COMMENTS/ RECOMMENDED ACTIONS	TIMELINE FOR ACTIONS (IF APPLICABLE)
9	Is the "first in – first out" principle of insecticide use applied?	Yes	No	Oldest inventory pesticides should be used first before reaching expiry date	
10	Is the store well-arranged (including the height of arranged items, allowance for free movement, proper stacking of items, appropriate ventilation)?	Yes	No		
11	Are warning signs and appropriate hazard labels correctly displayed (danger signs, insecticide safety notices)?	Yes	No		
12	Is a functional in-date fire extinguisher and other firefighting equipment available?	Yes	No		
13	Is there a thermometer to measure daily temperature in the store?	Yes	No		
14	Is the floor impermeable?	Yes	No		
15	If flood risk is unavoidable, what precautions have been taken to mitigate this fact?	Yes	No	Raised storage area Proper drainage in place	
16	Is the roof leak-proof?	Yes	No		
17	Are lighting and ventilation adequate?	Yes	No	Is there visibility in the store day and night? Are there windows that can be easily opened? Are ventilators [e.g. fans, air conditioners] available to allow air circulation?	
18	Are the surroundings of the store and soak pit clear of IRS solid wastes (empty sachets, masks, gloves)?	Yes	No		
19	Is the spray team deployed with an adequate number of pumps, including spare nozzles?	Yes	No		
20	Are all pumps fitted with a CFV?	Yes	No	If no, any plans to procure CFV?	

Spray can preparation

	MITIGATION ACTIONS	FINDINGS		COMMENTS/ RECOMMENDED ACTIONS	TIMELINE FOR ACTIONS (IF APPLICABLE)
1	Are the pumps filled using water from the previous day's progressive rinse?	Yes	No		
2	When the contents are mixed in the tank, is the tank shaken before being pressurized?	Yes	No		
3	Is the pump pressurized to 4 bar (58 psi)?	Yes	No		

Information dissemination and household preparation before spraying commences

	MITIGATION ACTIONS	FINDINGS		COMMENTS/ RECOMMENDED ACTIONS	TIMELINE FOR ACTIONS (IF APPLICABLE)
1	Have the residents been instructed on what to do during and after the spraying operation?	Yes	No	Instructed to exclude animals from the house, to keep the house locked up for a specified duration post-spray....., the importance of ventilation after the lock up period....., proper disposal of dead insects.....,etc.	
2	Have all residents been informed that if they have any reaction such as skin irritation, they should wash the affected area with soap and clean water and seek medical attention if the symptoms persist?	Yes	No		
3	Have all personal belongings, animals, sick persons, food/ water items and eating utensils been removed from the house?	Yes	No		
4	Have all immovable items been properly covered with polythene sheets?	Yes	No		

Observation of spray operators and adequacy of supervision in the field

	MITIGATION ACTIONS	FINDINGS		COMMENTS/ RECOMMENDED ACTIONS	TIMELINE FOR ACTIONS (IF APPLICABLE)
1	Do spray operators correctly record household details?	Yes	No		
2	Are spray operators in full PPE (hat/ helmet, face shield, overalls, boots, gloves and nose mask)?	Yes	No	If some spray operators are not in full PPE, what are the missing items? Is there a plan to replace missing items?	
3	Is the mixing of the insecticide witnessed by household residents?	Yes	No	Residents should witness mixing as a way to confirm that the insecticide is being used for spraying	
4	When liquid insecticide is used, are spray operators rinsing (x3) the bottle and adding rinse to the pump?	Yes	No NA		
5	Are spray operators spraying only the recommended surfaces?	Yes	No		
6	Do spray operators correctly apply spraying techniques?	Yes	No	Operator should maintain the nozzle tip 45 cm from the wall, use vertical swaths, ensure a swath overlap of 5 cm, shake the pump can and observe the pressure gauge	

	MITIGATION ACTIONS	FINDINGS		COMMENTS/ RECOMMENDED ACTIONS	TIMELINE FOR ACTIONS (IF APPLICABLE)
7	Are any spray operators observed eating/ drinking/ smoking while at work?	Yes	No		
8	If spray operations last longer than 6 hours, is there a plan for spray operators to wash and drink water during a break?	Yes	No		
9	Is there adequate supervision during the operation?	Yes	No	Are supervisors alongside spray operators to monitor spray progress? Is proper use of PPE observed? Are supervisors cross checking spray operators data forms?	

Spray operators after spraying operations

	MITIGATION ACTIONS	FINDINGS		COMMENTS/ RECOMMENDED ACTIONS	TIMELINE FOR ACTIONS (IF APPLICABLE)
1	At the end of the shift are both full and empty sachets/ bottles returned, counted and recorded?	Yes	No		
2	Are empty sachets/bottles and used masks stored in separate designated and labelled containers in the store?	Yes	No		
3	Are 7 barrels for triple rinsing placed and arranged on impermeable ground or on a polythene sheet (in the case of permeable ground) along the wash bay?	Yes	No		
4	Do barrels #2, 4 and 6 contain enough water for triple rinsing?	Yes	No		
5	Are pump leftovers emptied into barrel #1 and stored properly for the next day's use?	Yes	No		
6	Do spray operators correctly conduct triple rinsing of pumps while wearing PPE?	Yes	No		
7	Are all used hand gloves, nose masks and empty sachets/bottles separated and consolidated in a waste storage room at the end of the day's work?	Yes	No		
8	Are all overalls, face towels and other cloth PPE handed over to the store keeper for washing?	Yes	No		
9	Are washed pumps arranged in the store in an orderly fashion?	Yes	No		

	MITIGATION ACTIONS	FINDINGS		COMMENTS/ RECOMMENDED ACTIONS	TIMELINE FOR ACTIONS (IF APPLICABLE)
10	Do spray teams have access to end-of-day washing facilities (including soap and water)?	Yes	No	Is there adequate clean water available for washing? ; Is soap available for washing?	
11	Do spray operators complete daily report forms (structures sprayed, stock received, used and returned)?	Yes	No	Are supervisors cross-checking data forms filled in by spray operators?.....	
12	Is the insecticide usage rate and average number of houses sprayed per spray operator within acceptable limits? (At least 4–8 sachets and 10 houses/spray operator/day)	Yes	No		

Annex 3: IRS Supervision Inspection Checklist 3

Post-spraying activities, wash up and waste disposal

Date of inspection: ..... /..... /.....

Country: ..... District: .....

County: ..... Village: .....

GPS coordinates: .....

Inspectors: .....

Observations on spray operation on arriving at field station ash-up facility / progressive rinse

	MITIGATION ACTIONS	FINDINGS		COMMENTS/ RECOMMENDED ACTIONS	TIMELINE FOR ACTIONS (IF APPLICABLE)
1	Is the wash site located near the field station/district storage facility?	Yes	No		
2	Are all spray operators wearing PPE when they return from spraying?	Yes	No		
3	Are all persons conducting the progressive rinse in full PPE?	Yes	No		
4	Are all wash persons wearing appropriate PPE?	Yes	No		
5	Are any spray operators eating, drinking or smoking?	Yes	No		
6	Are the #2, 4 and 6 wash tanks filled with water?	Yes	No		

	MITIGATION ACTIONS	FINDINGS		COMMENTS/ RECOMMENDED ACTIONS	TIMELINE FOR ACTIONS (IF APPLICABLE)
7	Are spray pumps triple rinsed using the progressive rinse method?	Yes	No	Is the insecticide poured into tank #1 used for spraying the following day? If rinse in other drums is kept clean, is the water used to reconstitute insecticides? Note: Pesticides poured into tank #1 can be used for spraying the Following day. If rinse in other drums is kept clean, then the water can be used to reconstitute insecticide	
8	Are the outsides of the tanks rinsed off in the soak pit?	Yes	No		
9	Are the helmets and face shields rinsed off in the soak pit?	Yes	No		
10	Are PPEs washed and then hung to dry over the soak pit or soak away?	Yes	No		
11	Are soak pits or evaporation tanks used to dispose of all contaminated water?	Yes	No		
12	Are the pump nozzles, filters and strainers cleaned with a soft (tooth) brush and water to remove particulates?	Yes	No		
13	Are the spray pumps hung upside down to dry?	Yes	No	Spray pumps should be hung upside down after being washed	

Solid waste

	MITIGATION ACTIONS	FINDINGS		COMMENTS/ RECOMMENDED ACTIONS	TIMELINE FOR ACTIONS (IF APPLICABLE)
1	Are empty sachets/ bottles inventoried and documented?	Yes	No		
2	Are all contaminated empty sachets/ bottles (leaked and damaged containers) repacked and labelled appropriately, and put in storage?	Yes	No	Not thrown on the ground, or buried or burned in an open pit	
3	Are contaminated mouth/ nose masks stored with empty sachets?	Yes	No	Are chemical waste stored in a separate room?	
4	Are any other contaminated materials (e.g. cardboard, materials for cleaning spills) placed in a container?	Yes	No	If no, is there a plan in place? NA	
5	Have worn out and contaminated PPE that cannot be reused been cleaned and disposed of together with other waste materials?	Yes	No	If no, is there a plan in place? NA	
6	Have DDT sachets been incinerated at a certified facility?	Yes	No NA	If no, has such a facility been Identified?	

Effluent waste soak pit (biodegradable insecticides, e.g. pyrethroid)

	MITIGATION ACTIONS	FINDINGS		COMMENTS/ RECOMMENDED ACTIONS	TIMELINE FOR ACTIONS (IF APPLICABLE)
1	Is the soak pit located away from bodies of water or from flood prone areas?	Yes	No	Is the soak pit at least 100 m from water body?	
2	If located on a slope, is there a berm to prohibit run-off from entering on the uphill side, and one on the downhill side to contain effluent runoff?	Yes	No		
3	Is the soak pit absorbing all the effluent waste?	Yes	No		
4	Is a puddle and/or run-off being created?	Yes	No		
5	Is there adequate gravel to act as a filter?	Yes	No	Is the soak pit surface clear of soil and vegetation?	
6	Is the soak pit area fenced and gated?	Yes	No	Fence needed to keep children and animals out	
7	Is there a danger sign and appropriate hazard labelling at the soak pit to keep out unauthorized persons?	Yes	No	If no, has there been adequate Communication with the community so they understand not to enter the wash areas?	

Effluent wastes evaporation tanks (non-biodegradable chemicals)

	MITIGATION ACTIONS	FINDINGS		COMMENTS/ RECOMMENDED ACTIONS	TIMELINE FOR ACTIONS (IF APPLICABLE)
1	Are evaporation tanks located away from bodies of water or flood prone areas?	Yes	No	Evaporation tank should be at least 100 m from water body	
2	If located on a slope, is there a berm to prohibit run-off from entering on the uphill side, and one on the downhill side to contain effluent runoff?	Yes	No		
3	Are there cracks visible in the concrete?	Yes	No	If yes, is there a plan to seal the cracks to avoid seepage into the soil?	
4	Are there signs of evaporation?	Yes	No	Are traces of dried residual on the side of the tank above water visible?	
5	If not, do you see effluent contained safely elsewhere? (e.g. in polythene tanks)	Yes	No		
6	Is there any cover available in the event of rain?	Yes	No	Could be permanent shelter or temporary tarpaulins	
7	Is the evaporation tank fenced off and gated?	Yes	No	To keep out children and animals	
8	Is there a danger sign and appropriate hazard labelling at the evaporation pit to keep out unauthorized persons?	Yes	No	If no, has there been	

Effluent waste wash area

	MITIGATION ACTIONS	FINDINGS		COMMENTS/ RECOMMENDED ACTIONS	TIMELINE FOR ACTIONS (IF APPLICABLE)
1	Is there a concrete catchment area or tarpaulin spread out on the ground to catch all effluent?	Yes	No		
2	Can all effluent be easily drained into a soak pit or evaporation tank?	Yes	No		
3	Are the overalls hung out to dry on clothes lines over the wash area?	Yes	No		
4	Is the wash area fenced off and gated?	Yes	No	To keep out children and animals	
5	Is there a danger sign and hazard labelling at the evaporation pit to keep out unauthorized persons?	Yes	No	If no, has there been Communication with community so they understand dangers and that they must not enter wash areas?.....	

Annex 4: Larval inspection form

LARVAL INSPECTION FORM

INSPECTOR NAME			HABITAT DETAILS				SAMPLING RESULTS								% VEGETATION COVER & TYPE
DATE							LARVAL STAGES PRESENT (YES/NO)					DIP COUNT (add # pupae)			
ZONE															
TIME	SOURCE NUMBER	LOCATION DESCRIPTION	LAT	LON	HABITAT TYPE	SQUARE METERS	L1	L2	L3	L4	PUPAE	# DIPS	# An	# Cx	
							An	Cx	An	Cx	An	Cx	An	Cx	

Annex 5: Standard Operating Procedures (SOP) in conducting a house spray

1. Objective

To conduct quality IRS and gain community acceptance in order to reduce, and ultimately interrupt, malaria transmission.

2. Acronyms

CFV	Control flow valve
HEW	Health Extension Worker
IRS	Indoor Residual Spraying
KPa	Kilopascal
Psi	Pound force per square inch
SO	Spray operator

3. Role and responsibilities spray operation teams

Refer Vector control operational manual for malaria elimination in Ethiopia.

4. Conducting a house spray

Once the necessary planning, procurement and training has been completed in preparation for IRS, actual house spraying can begin. This phase of the IRS operations involves informing the community so that they may be ready for the spray teams when they arrive (moving household items, making water for mixing available); preparing insecticides; spraying target structures; and recording which structures are sprayed and which are not. Adequate supervision is important to ensure each step is performed efficiently and to the highest standards.

4.1 Communicating with the villages and households

Prior to spraying, team leaders must contact community leaders to inform them of the planned spray operations and of the fact that IRS team members will be visiting the villages to provide more detailed information and to conduct the spray. The day before the actual spraying (or as near to the planned spraying date as possible), a member of the IRS team, known as the 'warner' or 'sensitizer', travels to the target location and informs community leaders and householders of the purpose of spraying, the details of the spraying schedule, and what residents are expected to do in preparation. In this way, members of the community understand what they need to do to facilitate the operations and can prepare their homes and other structures in advance of the spraying. The information provided must be as simple as possible and the use of technical words must be minimized.

On the day of spraying itself, it is important that the spray operators reinforce to householders the objectives of the IRS program and outline to them the benefits, safety precautions and potential post-spraying side-effects. The residents should be given information on how long the insecticide is expected to remain effective on their walls, and about the importance of not re-plastering, painting or washing the walls during that period, and should be instructed to continue using treated mosquito nets if these are available. They should also be reminded of the importance of waiting outside after spraying is complete, until the insecticide is dry, to reduce the risk of skin and eye irritations. This usually takes about 1 hour. In some circumstances where there is high humidity, drying may be delayed and householders may be requested to remain outside longer, up to 2 hours.

The spray operators should also reassure the occupants of the effectiveness and safety of the insecticide being used and tell them where to seek advice and assistance if they experience any problems with side-effects; reassure residents and community leaders that the insecticides applied will not damage walls, ceilings and furniture; and reassure householders that operators will not spray places used for storage of foods.

Specifically, spray operators should ensure that householders willingly agree to:

- Allow spray teams to enter their households;
- Collect and make available at least 10 liters of clean water for mixing of insecticides in the sprayer and for any other use;
- Notify the spray team if there are sick residents, newborn infants, or any cultural issues that would prevent a room or house from being sprayed;
- Prepare houses for spraying by covering or moving portable items outside (e.g. foodstuffs and other consumables, cooking utensils, light furniture, bedding and clothing);
- Move those items that cannot be taken out of the dwelling to the center of the room and cover them with a plastic sheet;
- Move themselves and their families outside and remain outside for an hour or more while the insecticide dries;
- Sweep out any household pests (e.g. cockroaches, beetles) that are killed in the house by the spraying and bury, burn, or dispose of these in a pit latrine;

- Prevent chickens and other domestic birds from eating the dead insects; and
- Advice from re-plastering, painting or washing the sprayed surfaces for at least 6 months. This is important in order to allow the residual effect of the insecticide to continue killing mosquitoes.

4.2 Preparing rooms and households

To prepare for spraying, householders must remove as many of their household contents as possible, especially water containers, food, cooking utensils and toys. All pictures, wall hangings and posters should be removed. Items that cannot be removed should be completely covered with plastic sheeting and placed in the center of the room to allow easy access to the walls. Caged or leashed pets and domestic animals should be relocated away from the house until sprayed surfaces have dried and dead insects have been swept up and removed from the floor.

4.3 Preparing the spray charge

Just as there are a series of steps for the householder to prepare the structures for spraying, there is a standard series of procedures for the spray operator to prepare the insecticide mixture (the "charge") to spray. The following nine steps should be followed to ensure safe and proper application.

Step 1: Wearing protective clothing and gear

The first step is for the spray operator to put on protective clothing and gear. Spray operators must be aware that they are at occupational risk when using insecticides. It is their responsibility to ensure they use the following protective clothing:

- Broad rim hat or plastic helmet (to protect head, face and neck from spray droplets);
- Full face shield or goggles (to protect eyes against spray fall-out and splashes);
- Face mask/respirator (to protect nose and mouth from airborne particles of the spray fall-out and to avoid inhalation);
- Long-sleeved overalls;
- Mutton cloth or light cloaks (to protect the neck)
- Rubber gloves (to protect the hands);
- Boots (to protect the feet); and
- Raincoat (to protect spray operator when it is raining; not to be used during spraying).

The spray operator should also check other support items including:

- Notebook and records
- Bag/haversack for carrying charges
- Muslin cloth or metal strainer (funnel) for filtering dirty water
- Plastic sheeting.

Step 2: Checking the sprayer

Before starting a spray operation, the equipment must be checked. Faulty sprayers may result in poor application, over or under-application, and personal or environmental contamination. Examine the sprayer to ensure that all component parts are present, assembled correctly and in good condition.

a. Sprayer tank
b. Shoulder strap
c. Inner seal lid
d. Pump (handle)
e. Pressure gauge
f. Lance
g. In-line strainer (is the strainer inside the valve handle clean?)
h. Hose
i. Nozzle assembly with a CFV fitted to the nozzle tip
j. Trigger on/off valve (cut-off valve)
k. Footrest
l. Trigger assembly
m. Shut-off valve (open)

Step 3: Mixing the insecticide

Spray operators must follow the instructions on the product label to ensure safe and correct mixing, handling and application of insecticides. The insecticides should be mixed outdoors or in a well-ventilated area.

While in the field, keep the insecticide sachets or containers in the sachet holders or in drums or cartons free from moisture, heat and direct sunlight.

In order to mix the product, the following items are required:

- Product pre-measured and factory-packed in sachets or plastic bottles (one chemical charge for filling one spray pump);
- Functioning sprayer;
- Appropriate protective clothing; and
- Bucket with clean water.

If the standard spraying procedure is adopted, the spray liquid will be applied at a rate of 40ml /30ml per m^2 or 1 liter per $25m^2/33.3m^2$ depending the presence or absence of CFV. This amount of suspension normally stays on the surface without run-off. In general, insecticides now come in pre-measured sachets for ease of use.

Step 4: Preparing the sprayer

- **To close tank:** insert the cover vertically into the tank, lift it and fit it into the tank opening; turn the handle across the width of the opening.
- **To open tank:** push down the air-release valve by turning the handle on the cover; the cover will become loose once the air pressure is released and the tank reaches atmospheric pressure.

Step 5: Filling the spray tank

For sprayers without a 1.5 bar CFV

Spray operators should identify a suitable flat, level and hard surface on which to place the sprayer and half-fill the tank with clean water. A sachet or bottle of IRS formulation enough to spray an area of 200 m_2 will require 8 liter tank mix for a compression sprayer ***not fitted*** with 1.5 bar CFV discharging at rate between 760 and 790 ml per minute. The pre-packed insecticide from sachets or plastic containers should be added directly into the spray tank, the sprayer lid should be closed tightly and the contents mixed by agitating the sprayer. The tank must then be filled with the required total amount of water. The tank usually has a mark indicating the total water level and for most standard sprayers this is 8 liters.

For sprayers with a 1.5 bar CFV

A sachet or bottle of IRS formulation enough to spray an area of 250 m_2 will require a 7.5 liter tank mix for a compression sprayer fitted with a 1.5 bar CFV discharging at a rate of 550 ml per minute. When using a 1.5 bar pressure (1.5 bar CFV), measure 7.5 liters of water. The first 4 liters of this water should be added to the tank and the contents of the sachet should be added to this. The remaining 3.5 liters of water should then be added to the mixture. The lid should then be replaced and the tank slightly pressurized. The tank can then be shaken to mix the insecticide well, following which the sprayer can be fully pressurized to 4 bar to commence spraying.

Step 6: Shaking the spray tank

The suspension needs to be well mixed by shaking the tank before beginning to spray and by shaking again at regular intervals during spraying. Shaking is done by grasping the sprayer by the pump shaft and the bottom end of the tank. The tank should not be held by the strap, nor should it be swung forwards and backwards while on the shoulder. Formulations that meet WHOPES specifications should remain in suspension with minimum shaking.

Step 7: Pressurizing the tank

Sprayer without a 1.5 bar CFV

Spray operators in programs still using pumps not fitted with a 1.5 bar CFV should take the following steps to pressurize the tank:

- Use the pressure gauge (manometer) to monitor the pressure in the compression sprayer;
- Put one foot on the footrest and unlock the pump plunger. Pull the plunger all the way up with both hands and then push it downwards using full, even strokes;
- Pump strokes should be even and regular from

top to bottom (short irregular strokes make more work and less pressure input per stroke);

- Keep pumping the sprayer until it registers a pressure of about 4 bar, which is 58 psi. The upper and lower operating pressure limits are 400 kPa (58 psi) and 172 kPa (25 psi), giving an average pressure during spraying of about 276 kPa (40 psi);
- While some sprayers have not yet been fitted with CFVs, it is important that operators of these sprayers re-pressurize to keep the pressure between 25 and 58 psi throughout the entire charge. As the water level decreases in the sprayer, more strokes will be required to return it to its required pressure;
- If the pressure is too high, the flow rate will be too high and cause run-off from the wall, which may increase spray bounce off and contribute to early damage of the nozzle aperture;
- If the pressure is too low, the spray angle will be to small and the operator may try to compensate by reducing the distance of the nozzle from the wall thereby altering swath width and the spray deposit on the wall;
- Check the pressure by looking at the pressure gauge (manometer), which usually shows the 'operational pressure range' by a color band. Pressure should not be checked by:
    - *The amount of fluid discharged*
    - *The appearance or width of fan shaped spray*
    - *The time of last pumping;*
- Always release pressure when sprayer is not in use, for example:
    - *When the operator stops for long breaks (e.g. for lunch)*
    - *When the sprayer is being transported.*

It will usually be necessary to re-pressurize and re-shake the sprayer once or twice before it is empty.

Sprayer with 1.5 bar CFV

For sprayers operating at 1.5 bar: when the tank pressure has decreased to below 1.5 bar, the CFV will close and the tank should be re-pressurized to use the remaining spray. Note, it may not be necessary to pump to 4 bar (58 psi) if there is a small amount of spray left in the tank. Note also that to spray 7.5 liters at 550 ml/min usually takes 13.6 minutes.

Step 8: Checking the nozzle

Spray operators should inspect the nozzle daily for blockages or signs of wear. Blockages can be removed by cleaning with water or by using a soft probe such as a brush or grass stalk. Sharp instruments should be avoided and operators should NEVER put the nozzle between the lips and blow.

Step 9: Carrying and handling the sprayer

- *Carrying position when not spraying:* the sprayer should be placed on the back of the left shoulder in an upright position with the strap in front and the hose collected under the sprayer lid handle.
- *Carrying position when spraying:* the sprayer should be placed on the front, hanging under the left shoulder with the upper part of the sprayer forward. The sprayer is held with the left hand on top. The pressure gauge does not need to be monitored regularly because a pump fitted with a 1.5 bar CFV will continue to operate and only stop when pressure falls below 1.5 bar. This position allows for:
    - *Quick unloading for placing on the ground for re-pressurizing*
    - *Easy handling in narrow passages and rooms.*

Spray operators should always check and adjust the strap for comfortable carrying and handling.

4.4 Applying insecticide

The insecticide suspension has to be sprayed evenly and at the recommended application rate over all sprayable surfaces. The amount of insecticide that is sprayed on a surface is determined by a number of different factors.

Factors that are influenced by the spray operator during the spraying, and that need to be highlighted during training are:

- Distance from the nozzle tip to the surface being sprayed (should be kept at 45cm);
- Speed of movement of the nozzle over the surface; and

- Air pressure in the sprayer (should be maintained at 172–380kPa (25–55psi) or (1.7–3.8 bar) for a sprayer without a 1.5 bar CFV.
- Air pressure in the sprayer with a 1.5 bar CFV should initially be 4 bar. When the spray stops and tank pressure has fallen to 1.5 bar, the air pressure should be increased by further pumping until the tank pressure rises to above 2 bar (29 psi) while spraying. With a 1.5 bar CFV, spray is applied at a constant flow rate at 1.5 bar pressure at the nozzle.

Factors that are not directly influenced by the spray operator, but that require attention during preparation for actual spraying are:

- The concentration of insecticide in the suspension
- The nozzle tip aperture size.

4.5 Insecticide spray procedure

The quality of spraying affects the residual effectiveness of the insecticides.

General: In households with multiple rooms, spraying should commence in the innermost rooms and work outwards.

Total coverage: Spray teams and spray operators (SO) must find and spray every single sprayable structure in the target area.

Complete spraying: All sprayable surfaces within a structure must be sprayed and no sprayable areas should be left out, missed or forgotten. Sprayable structures include all buildings, large or small, in which people may sleep or gather at night.

Sprayable structures: These include houses, kitchens, health centers (with overnight patients), hospitals, hotels and rest houses, huts in the field etc. Animal shelters (cattle sheds) with roofs can be sprayed but open pens and corrals should not be sprayed.

Schools, shop houses, churches, health centers and other buildings should not be sprayed unless people regularly sleep in them overnight. Latrines are generally not sprayed. The underside of tin/metal roofing should not be sprayed as these can reach high temperatures during the day, which may significantly reduce the duration of effectiveness of the insecticide. However, the undersides of thatch roofing may be sprayed.

Sprayable surfaces: These are all inside walls, the insides of roofs and under eaves, under exposed doors, verandas, rafters and beams. Sprayable surfaces also include the undersides of beds, tables, chairs, shelves, and the backs of cupboards and wardrobes.

Correct dosage: The right amount of insecticide should be deposited on the targeted spray surfaces. The following 10 steps should be followed by spray operators to ensure good practice during spraying:

Step 1: Inspecting the room

To inspect the room:

- On arrival, greet the householders and explain the purpose of the visit;
- Request permission to enter the rooms, being led by a member of the family;
- Enter the room and conduct a general inspection;
- Ensure that the room has been cleared or heavy furniture has been moved to the center of the room and covered with plastic sheeting;
- Check that wall hangings and other items on walls have been removed;
- If the structure has more than one room, make sure that there is no one in the other rooms; and
- Check that all food and water containers have been removed.

Step 2: Carrying the sprayer correctly

Once the inspection is finished:

- Lift sprayer using the shoulder strap;
- Position strap on the shoulder and tank under the armpit so that the pressure gauge is visible;
- Adjust shoulder strap to appropriate length;
- Support the hose and lance in one hand; and
- Enter the room to be sprayed and face the door.

Step 3: Maintaining correct distance and angle for spray pattern or swath

Keeping the correct distance and angle of spraying is critical in depositing the correct concentration of insecticide on the sprayed surfaces. Spray operators should:

- Stand in front of the spray surface area;
- Maintain a body position of an average of 1 m from the surface to be sprayed;
- Maintain a distance of 45cm between the spray nozzle and surface to be sprayed. This provides a spray pattern of swath which covers 75 cm;
- Be aware that due to reduced deposit at the edges of the spray pattern, a 5cm overlap needs to be maintained in order to achieve an even coverage of adjacent spray patterns of swaths;
- Always begin spraying at the top of the swath, moving down and then up and from the left hand side towards the right hand side of the area to be sprayed;
- Maintain a smooth comfortable action with the hand and elbow. The arm should be extended
- Fully at the top and bottom with elbow bent in the middle to maintain a 45 cm distance from the nozzle to wall; and
- Ensure that:
    - *In the upper position the spray pump lance moves vertically upwards;*
    - *In the middle position the spray lance remains horizontal; and*
    - *In the lower position the spray lance moves downwards vertically through the middle position.*

The first swath is from top to bottom. After the first swath, the spray operator should take a step sideways to get to the middle of the next swath and cover the second swath from bottom to top. The correct footwork should be maintained together with the hand spray speed to generate the correct rhythm.

The correct timing for spraying a 2m swath is 5 seconds (i.e. each linear meter covered should take 2.2 seconds). Timing may be aided by mentally counting "one thousand and one, one thousand and two, one thousand and three", etc. Adjust the mental counting procedure according to the local language.

To maintain the proper distance between the nozzle and the sprayed surface while spraying vertically (i.e. a wall or the back surface of large furniture), it is necessary to slowly bend the elbow towards the waist as the nozzle approaches the midpoint. At this point, the elbow should be bent at a 90° angle. The arms must be extended as the spraying progresses. This process must be followed throughout the entire spraying process.

A uniform speed of spraying is required to provide the correct target dosage.

If the arm moves too quickly, less spray will be applied, with the result that the amount of insecticide deposited will be lower than the recommended concentration. This will reduce insecticidal activity and greatly impact on the efficacy of the operation. It might also contribute to the emergence of vector resistance if inadequate concentrations are repeatedly applied. On the other hand, if the spray speed is too slow there will be an overdose of insecticide, resulting in wastage and unnecessary extra costs

Step 4: Spraying doors and windows

Total coverage cannot be achieved without spraying the sides of all doors and windows of the targeted structures. In particular:

- When doors and windows open inwards, both sides need to be sprayed;
- When doors open outwards, only the interior surface needs to be sprayed;
- The doorframe must be sprayed, beginning from the left or right bottom corner;
- The portion of the wall covered by the door (behind the door) must be sprayed; and
- Once sprayed, the door should be opened to allow adequate lighting into the room for the rest of the spray operation.

Step 5: Spraying the wall (vertical spraying)

Starting from the edge of the doorframe, spray operators should spray the walls moving in a clockwise direction. Spray operators must:

- Make sure the overall swath is 75 cm if the nozzle is 45 cm from the wall;
- Maintain an overlap of 5 cm for successive swaths;
- Maintain the rhythm of no more than 5 seconds for every 2 vertical meters;
- Agitate the sprayer at regular intervals while checking the pressure gauge; and
- Ensure that pressure does not drop below 25 psi (172kPa) for sprayers without a 1.5 bar CFV (re-pressurization will be required below this level). One pump stroke generally adds 1 psi to the tank pressure.

Step 6: Spraying the ceiling

Spraying of inner roof and ceilings requires horizontal spraying. Spray operators should:

- Spray the ceiling or underside of the roof after the walls have been sprayed;
- For distance and timing of spraying, follow the method outlined above for spraying of walls;
- Use a lance extension tube where necessary;
- Ensure pressure is at 58psi or 4bar before spraying the roof (for those programs still using compression sprayers without CFVs) or above 2 bar when using a sprayer fitted with 1.5 bar CFV;
- Wear a hat when spraying the roof or ceiling, and use an extended lance if needed;
- Stay in front of the spray swath (in front of the nozzle) to minimize exposure to insecticide that may drift down, each time maintaining a distance of 45cm from the surface;
- Spray horizontally from the furthest point inside the room until arriving back at the start point;
- Move up to the next swath and spray round the room;
- ***Avoid exposure to spray fall-out*** by directing the lance at an angle from the body so that the spray not deposited on the roof does not fall on the operator and by walking backwards to the door;
- On completion, exit room and close the door; and
- Spray door from outside.

In houses without a ceiling, the inside of the roof may be too high to spray with the standard lance provided with the sprayer. Such houses should be visited by two spray operators, one who is equipped with the standard lance and is responsible for spraying the walls, while the other has a sprayer on which the lance is fitted with an additional lance. The nozzle and CFV are unscrewed from the lance, the extra straight lance is screwed onto the lance and the nozzle and CFV screwed back onto the end of the lengthened lance. This allows spray to be applied with the nozzle at a greater height, so that the inside of a roof can be treated. A different type of nozzle should not be fitted.

Step 7: Spraying eaves and openings

The house eaves and areas around openings such as doors and windows need special attention. Spray operators should:

- Start spraying the inside of the eaves, beginning from above the door from the outside
- Move around the house spraying the outside eaves, taking care to avoid insecticide fall-out
- Make sure that there is an overlap between the wall and the roof
- Upon completion of the eaves, spray around the window openings and air vents.

Step 8: Spraying difficult-to-reach surfaces and other structures

It is important that insecticide coverage reaches all potential mosquito resting sites. Obstacles such as chairs, tables and cupboards against walls can impede progress and cause interruption of spray timing and pattern. It may be necessary for the spray operator to adopt different postures while maintaining basic distance and speed (e.g. bending knees to reach under beds).

The underside of floorboards of houses that are elevated or raised above the ground on stilts or

posts provide ideal resting sites for many *Anopheles* vectors. These areas must also be sprayed; an extension lance may be necessary for tall houses. In the Asia-Pacific region, flexible swan neck extensions are necessary for spraying the underside of floorboards. These can be used to spray the edges. The swan neck can also be used in situations where it is difficult to spray (e.g. under the bed and where there are cupboards, furniture, floorboards).

After completing the spraying of the rooms, operators must spray the internal walls of other outside structures such as poultry runs and animal sheds. Poultry and animals should be taken out and secured outside for one day. The inside of storerooms or any rooms where agricultural products are stored should NOT be sprayed.

Step 9: Post-spraying communication

Spray operators should give the following post-spraying information and education to householders:

- Advise residents to stay outside until the sprayed walls and other surfaces have dried, which usually takes about 1 hour;
- Advise residents that there is likely to be residual odor but this should not be cause for alarm;
- Instruct residents to sweep the floor before allowing in children or pets, and to dispose of dead insects and other material immediately by burying or burning; and
- Inform residents of any future spray plans involving their neighborhood.

Step 10: House spray record keeping if available

Houses visited by spray teams and which have been totally sprayed can be marked with paint or chalk with the team number and date on the front wall. House spray cards (if available) can also be updated by writing the house number, spray operator number, team number and date. Locked houses, rooms and households whose residents have refused IRS should be marked appropriate.

Information such as locked rooms, refusals and the number of spray charge(s) used should also be recorded in the daily spray operator record form or book.

Houses and structures that have not been sprayed can be followed up with mop-up spraying if they are identified and recorded at the time of the initial attempt.

4.6 Spray data recording and reporting

The spray operator should ensure that household information is filled in accurately before leaving the site. This information must be presented to the team leader at the end of each working day using the daily reporting form. It is the responsibility of the team leader to summarize this information at the end of each working day. The information is necessary for program management and supervision and it will be cross-checked with the information provided by district supervisors.

Malaria house spray cards

An IRS household record card is kept accessible in each household. The house spray card acts as a census record of the number of people and rooms or structures per household or dwelling and provides a record of insecticide spraying for each numbered house.

Routine reporting forms

Spray operators, spray team leaders and IRS district malaria officers should use standard reporting forms to report, supervise and monitor IRS implementation. A daily reporting form is completed by the spray operator for each house and submitted at the end of the day to the spray team leader who records and checks the performance of the individual spray operators. A weekly reporting form should be maintained by IRS district supervisors and districts IRS malaria officer. Each malaria officer tracks up to 10 spray teams and measures the weekly progress in relation to the total planned target for the spray round. A monthly reporting form is used by IRS district malaria officer to monitor progress on IRS

spraying coverage for the spray round in the district in relation to the total planned target.

4.7 Post-spraying procedures

When spraying has finished for the day, and before removing any protective clothing, the following procedures should be followed:

- All the empty chemical containers/sachets should be returned and counted, and unused chemicals should be returned to the supervisor;
- The day's spray report should be submitted to the supervisor;
- Any final surplus spray solution from the final cleaning through the progressive rinse method should not be thrown away but be kept and reused the next day;
- Sprayers ***must*** be cleaned daily inside and out using the progressive rinse method of saving and recycling water used for cleaning the sprayers and reusing it the next day. The spray mixture should not be left in sprayers overnight as suspension will start caking and block the filters and hose. The chemicals may also damage the components of the sprayer and reduce their lifespan (e.g. seals or valves will stick and disintegrate);
- Sprayers should be checked for any faults that may have developed and these should be reported to the team leader;
- All cleaning and washing of the sprayer should be done away from water sources;
- Cleaned sprayers should be put in an inverted position to drain off any water; and
- Sprayers should be returned to storage making sure they are kept dry. If possible, they should be stored in an inverted position with the cover assembly loose.

After doing all the above, spray operators should:

- Remove protective clothing and gear;
- Wash their whole body thoroughly using soap, paying particular attention to exposed areas such as hands and face;
- Wash used protective clothing in detergent (separately from household washing); and
- Dispose of washing water and rinse water safely, using a toilet or bathroom with a soak pit or soak way.