



Vector Control Working Group (RBM VCWG)
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Hosted Online via Zoom

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Session 4 – Work stream 2: Expanding the Vector Control Toolbox

Co-Leads: Allison Tatarsky & Sheila Ogoma

Welcome, Introduction and meeting objectives- Allison Tatarsky, University of California and Sheila Ogoma, CHAI

Sheila begins the session welcoming everyone and introducing the task teams. The themes of the three task teams are larval source management led by Jen Armistead and Prosper Chaki, human behaviour, human centred design in the context of vector control led by April Monroe and research updates on innovative vector control, led by Sheila Ogoma and Allison Tatarsky.

One activity within the work stream is to scope out whether there is a need for a consolidated information source on innovative vector control. To reach a decision, a survey was launched last week with the aim to collect information from our community about where and how people seek information on vector control products and evidence, what are the gaps remaining and if there is a need to consolidate updates and resources on innovative vector control to increase visibility around new tools. The preliminary analysis showed moderate accessibility of vector control products information. This information is mainly sourced through websites, conferences and webinars, while there were other sources as research papers, newsletters and social media. The majority of people entered the survey showed interest in LLINs (including PBO and dual LLINs), as well as IRS, gene control and topical repellents. The top choice sources for information about experimental vector control products among the survey participants were WHO technical webpages, WHO VCAg, IVCC, WHO PQ and PubMed. Some other sources included Malaria World website, ASTMH and VCWG meetings.

Larval source management: LSM task team updates- Jen Armistead, PMI and Prosper Chaki, PAMCA

Prosper briefly previews the priorities of the LSM task team for 2022. One is gathering and consolidating existing knowledge and gaps pertaining to LSM implementation, and within that the topics that we are looking at, include tools for habitat characterization and coverage and larviciding delivery, as well as product optimization, implementation and monitoring and evaluation of frameworks and tools. The second category is conducting a landscape analysis to reveal the importance and the potential of larval source management to make it one of the key interventions. Lastly, is creating a platform for LSM stakeholders, national programs and potential funders to promote knowledge exchange between countries and regional bodies.

Larval source management: MESA Alliance LSM landscaping - Beena Bhamani, MESA

MESA Track is a living database that captures all the ongoing and recently closed research projects in malaria. Usually contains projects from various institutional websites working in the field of malaria. Once the information is available the focal person of that Institute, or principal investigator is contacted to validate the available information and fill in the missing gaps and then the information is published. Currently, more than 1800 projects can be found in MESA Track, of which around 200 projects are still ongoing and active. The Deep Dives gather all the projects around a specific research question allowing the malaria community to glance at the research being done in a specific area. Deep Dives are created based on the needs at that particular time or at the request of an organization.

A Deep Dive on LSM was commenced in the start of 2021 and has altogether 31 projects in 16 different sites, mostly in endemic countries like Tanzania, Botswana, Uganda, Kenya, South Sudan. There is an overlap of projects in different research areas. The projects are categorized in community engagement, which are either training community workers to perform larviciding activities, or identifying and using different groups like agriculture or rice farmers for larviciding. Likewise, projects that are categorized in combining strategies like IRS, LLINs and ITNs in addition to larviciding are assessing the impact of integrated vector control strategies to reduce the burden of malaria in particular regions. Also, information is provided on which principal institutions are working in one field and what are the funding sources. MESA Track has also a feature to submit a project for anyone that wants to be a part of this living database. This will give a holistic view of LSM to malaria community, and it improves visibility of the work done as well.

In the future, Deep Dive will be updated. Information about ongoing LSM activities including products used by different countries is needed, so collaborating with countries will help in identifying the real case scenario. Also, is essential to capture the ongoing independent evaluation if there are any, and the study designs or evaluation methodologies that will assist in finding the impact of LSM.

Discussion:

It was commented in the chat the potential of crowdsourcing from VCWG members a landscape of those country programs and companies implementing LSM that may be 'routine' rather than higher level research projects captured by MESA.

Question:

Would MESA be open to receiving submissions from just direct implementation projects that may be happening, even if there is not really a monitoring and evaluation component to the activity that's being done?

Yes, definitely. We are really open to add on all the implementation projects and we would be working with the countries' malaria programs to see what they are using, how they are deciding on the products and what is the impact they are seeing in the region.

Apart from all the research, MESA Track is also an operational research implementation platform. So we also did a lot of work on the kind of products that have been used in LSM, but we could not get any information on what purpose it was used and what was its impact. Crowdsourcing information will be fantastic because we already have the tool in harnessing all the information that's out there and once that is there, then we can do a systematic analysis. But from the Deep Dive point of view, where you get to gather on information that is not specifically under the strict criteria for selection as the systematic review point of view.

Presumably MESA Track will be updated in real time as you receive additional inputs on additional projects. Is there any report that you anticipate pulling together from this or is this information readily shareable with the sort of increased details and granularity for those that want to dig in deeper to look at individual projects that might be part of the Deep Dive?

We have been creating the report of what projects that we have and we will be coming up with all the dyes that we have. We will be doing it for LSM as well.

Madagascar LSM project- Saraha Rabeherisoa, National Malaria Control Program of Madagascar

The objectives of the project were to assess the feasibility of larval source management as complementary vector control to LLINs in Madagascar from 2021 to 2023. Also understand if complementary LSM of aquatic habitats / rice fields in combination with pyrethroid-only LLINs provide additional control of malaria vectors in Madagascar by reducing larval and adult densities and consequently if complementary LSM reduce transmission of malaria.

The process of implementing the project began with the approval of SIEE (Supplemental Initial Environmental Examination). Mapping was conducted through geospatial assessment of the presence of larval habitats and quantification of the area of larval habitats to ensure that the appropriate volume of larvicide is acquired by VectorLink and used to cover the entire water surface. The larviciding was done via drones in 2 districts with high malaria prevalence where irrigated rice fields are common larval habitats Morombe (6 fokontany) and Ankazobe (11 fokontany) using Bti twice per month. All breeding sites located within 1 km of the fokontany.

The intervention areas were located at the centre of the country where the climate is tropical and at the south west coast of the country where there is warm desert climate.

These areas were selected based on evaluation criteria through entomological and epidemiological monitoring, a qualitative study for the acceptability of LSM as well as cost, logistic and cost effectiveness evaluation. For the entomological monitoring the indicators looked at were the density of adult Anopheles indoors and outdoors using human landings captures (HLC) and CDC light traps, human biting rates, larval density and sporozoite rates. The epidemiological monitoring supported by Pasteur Institute looked into malaria case incidence based on the number of cases confirmed using rapid diagnostic tests (before and after the intervention).

Saraha presents photos showing the process of LSM from storage of the product used (VectoBAC WDG) to advocacy meetings to field usage.

Meetings have taken place where the local authorities were involved and informed about the interventions. The mobilization activities of the communities in Madagascar aimed at raising the acceptability of the method and to minimize the hesitation. The field testing was conducted by a team including experts from VectorLink, NMCP and other partners. The mapping was conducted using drones to identify the areas where the larvicide was going to be applied. Through this operation the technician could programme the field intervention gaining a lot of time. The preparation of the product was done by diluting the Bti in water of 20ltr volume right before the drone flight (drone's max volume capacity 30ltr). The inspection of the field was done by drones that allowed to modify the intervention when needed. The entomological activities included collection of larvae from the field during the intervention. However, there are always challenges to face, like bad weather that made moving and traveling difficult so the project was postponed. Also, the battery of the drones is limited and its autonomy is very short, 4 to 7 min.

Community- based LSM: Kenya- Lenson Kariuki, Kenya NMCP

Lenson presents briefly LSM in the context of Kenya, where malaria prevalence is at 6% with the Lake endemic zone at 19% and coast zone at 4%. The main malaria species are *P. falciparum* (76%) and *P. malariae* (4%) and the main malaria vectors are *An. arabiensis*, *An. gambiae* and *An. funestus*. The malaria vector control interventions implemented in the country are the distribution and use of LLINs in 27 counties, IRS in 2 high burden counties (Migori and Homabay) supported by PMI and LSM is supplementary intervention targeting 8 malaria counties community based approach. However, LLINs

and IRS are under threat of widespread insecticide resistance, especially to pyrethroids. One of the strategies of insecticide resistance management is community based LSM.

This strategy is implemented by the NMCP in collaboration with the Cuban government. A bilateral agreement has been signed to conduct a 2-year community based LSM in eight malaria endemic counties. The Cuban government will provide 8 vector control experts and biolarvicides, Bactivec (Bti) and Griselelf (*B. sphaericus*), which will be applied every 3 months, beginning during the dry season. The Cuban expert will train the community based workers and public health officers. The vehicles and the equipment for monitoring, entomological surveillance and spraying equipment are provided by the country's government. The social mobilization will be conducted in a county and sub county meeting level and a village level. Brigades will be selected for each village and they will be responsible for the mobilization of households, mapping of breeding sites, application of the biolarvicides and the monitoring. Training will also be conducted in two levels, training of trainers medical entomologists, public health officers and community coordinators at county level and training of community based workers at ward level.

The baseline survey will include epidemiological and entomological data and it will be conducted by Community Based Workers. They will map larval habitats and the larval density within their villages under supervision of Ward-PHOs and adult collections will be conducted in selected sentinel houses close to the mapped habitats by use of CDC Light traps and aspiration. Malaria incidence data will be obtained in catchment health facilities within the Ward level at the same time and will act as baseline data.

The larvicides will be applied during the dry season and reapplied depending on monitoring data every 2-3 months. Regarding monitoring and evaluation, larvae will be sampled in selected sites and density established while mosquito adult catches will be sampled from selected sentinel houses on monthly basis to establish adult density and other entomological indicators. Malaria incidence data will be obtained from selected catchment HF within the Wards and the quality of biolarvicides will be checked before application in collaboration with KEMRI. Finally, an evaluation report will be generated after the end of each stage. This project is funded entirely by the Kenyan government.

Questions:

Why are you not implementing larviciding in the rainy season but are you expecting a significant impact as malaria cases usually are the highest levels in the rainy season?

We are viewing it in terms of fixed and few sites after the rains or before the rains. During the rainy season the habitats are not fixed and many which will have a cost implication.

Bti residual effect is a few days, so will you have a population build up before next application 2-3 months later?

We will be doing weekly monitoring after application and the data will guide us on frequency of application. That is why I indicated that we will mainly rely on monitoring data

Will you use routine data for monitoring epidemiological impact?

We will use routine data from H/facilities within the catchment area. However we are trying to engage research and academic institutions for cross-sectional/prevalence data.

With bulky stocking of biolarvicides you have plans to monitor their efficacy over time taking note that the shelf life may actually be affected by the high temperature fluctuations?

That is true. Indeed we have set two sites where we will be running controlled efficacy trials through KEMRI.

What are some of the main challenges when working with the community?

First, packaging of information and community perception that LSM might be the solution to their malaria problem hence they think other interventions that are more personal driven such as use of nets are not necessary. Second, 'Lower level community political interference'- who will be engaged in the project

Community based in Tanzania- Denis Kailembo, Swiss TPH

In mainland Tanzania, the implementation of ITNs and IRS has been the mainstay and this has contributed a lot in reducing the malaria prevalence from 18.1% in 2008 to 7.5%, in 2017, which the last malaria indicator survey. However, in further enhancing malaria control the country is planning to deploy larva source management. So, the NMCP with support from the TEMT project (financial and technical) has planned to implement LSM in councils. Currently, the intervention has started in three councils in Tonga region.

The selection of the councils was also based on the budget of the program, but it was considering the representation of all the malaria risk strata. In Tanzania the councils are classified into different malaria risk levels from very low, low, moderate high. It was also considering the councils that have ongoing malaria vector entomological surveillance. And the counties that are also implementing other interventions, LLINs, IRS, MDA, IPTi. Councils with high heterogeneity and with bimodal and unimodal rainfall patterns were considered as well as the logistics in-terms of biolarvicide distribution & supervision. The 15 councils are strategically chosen from five regions, they are covering all areas across the country, also covering all the different malaria risk strata.

LSM is conducted through a community-based approach, whereby volunteers are used at the community level implementing LSM who will be supervised by officers from the current government structure that is already in place at the village or street level, ward level and council level.

The project uses two biolarvicide products, which are manufactured locally in Tanzania, BACTIVEC *Bacillus thuringiensis var. israelensis* (Bti) and GRISELESF *Bacillus sphaericus* (Bs). These products are highly selective and target only larvae stages of mosquitoes. Biolarvicides are also safe to humans, animals and the environment.

The frequency of application upon further consultation with the program and other partners, was based on the rainfall pattern. There are councils that have a bimodal pattern, as well as others that have a unique ordering pattern. Each spray period or spray application lasts for about two months where spraying is done for almost approximately eight weeks. The application will be either before the rainy season or after the rainy season trying to curtail the peak of infection or the peak of transmission that happens after the rainy season. Most of the activities started mid last year, including

development of guidelines and SOPs. Six SOPs are covering from advocacy to mapping logistical setup, implementation, monitoring and evaluation as well as environmental management.

Advocacy to all the three councils and the region and training of the trainers the national, regional and council levels was also done back in August of 2021. All the necessary equipment required including the bio lab setting, the pumps and other necessary equipment were procured. The training at the sub council level was done. Baseline data was collected for a duration of one month. The application of the biolarvicides was delayed and it is expected to start middle of this month together with ongoing supervision and M&E.

The baseline data that has been collected during the dry season showed that the number of breeding habitats in the Handeni council is around 2000 higher than the rest of the councils.

Some of the challenges that have already been noted its difficulties in reaching all the areas within the villages, as well as difficulty in identifying breeding habitats, especially in rural settings, and especially after a rainy season. This is something to consider following up closely during supervision and monitoring and evaluation.

The next steps are to conduct the first round oof larvicide application and reapplication as per identified schedule. Finally, close monitoring and evaluation of the of the implementation, to ensure that it is done as per the SOP or as per the guidelines, to do thorough entomological evaluation, larvae and adult mosquito monitoring, epidemiological monitoring, cost effectiveness analysis and lastly to look at impact analysis of the intervention.

Questions:

How do you make the selection of biolarvicide, Bti or Bs? Anopheles vs Culex species?

We are using both products, they will be alternated within the rounds.

What are some of the main challenges when working with the community?

It is important to provide necessary information on LSM both to the councils and the community. It especially helps using the current local government structure. This assists the acceptability of the intervention within the community.

Human Behaviour and Human- Centered Design Task Team- April Monroe, Johns Hopkins Center for Communication Programs

We know that there are gaps in protection or interventions provided and that there are specific times places and groups that remain at risk. We also know there are exciting options to expand our Vector Control Toolbox. But for any of these new and complementary tools and interventions to be successful, they really need to be appropriate to the context, and they need to be accepted by communities that are affected by malaria. Social and behavioural research and approaches like human centered design can really play an important role in ensuring that the tools processes and programs that we are developing are actually meeting people's needs. Additionally, people closest to the problems that we are trying to solve have a say in the development of those solutions

The Task Team emerged in response to increasing recognition in our field of the importance of human behaviour to the success of vector control interventions, as well as growing interest from this group from VCWG members. We are increasingly seeing social science research being meaningfully included in evaluation of vector control tools and we are also seeing really increasing interest in applying approaches like human centered design. Through this task team, we hope to provide opportunities for engagement and exchange among groups that are working on this topic, and also include an also improved coordination between VCWG and the RBM SPC working group. We also want to document lessons learned the best practices and information gaps for considering human behaviour in vector control. And to support opportunities to expand understanding and application of human-centered approaches among professionals and organizations working in the vector control field.

The agenda for this task team includes the Highlights from HCD workshops, Integrating social science research with epidemiological trials, Advancing Evidence for Global Implementation of Spatial Repellents (AEGIS) project, Broad One Health Endectocide-based Malaria Intervention in Africa (BOHEMIA) project and African conversations for gene drive.

Discussion:

What is one piece of advice you would give to colleagues who want to consider end-users and affected communities more intentionally in their work? What are you most excited about for the future of this type of work?

Answers:

- Center empathy: By rooting problem-solving in empathy, we make room for truly collaborative and creative novel solutions to the complex problems of malaria control and prevention.
- Reflect on how you influence what people tell you and what you hear. In qualitative research the researcher is the 'tool'.
- I'm excited about novel solutions that can be designed alongside communities as the true experts of their needs and the needs of their communities. As new threats and new innovations emerge, like *An.stephensi* and the RTS,S vaccine, HCD has the power to bring groups together to create solutions that work - solutions that resonate with users and are truly sustainable
- One thing I learned with engagement of the public for GM technologies is that if you are not the first to provide information, then they will get information from either the web or anti-GM groups. If this information is negative, then it is extremely hard to change their minds. So you have to think carefully about engaging the public early in any engagement activities.
- With active community engagement: Begin planning for it as soon as you begin conceptualising the project. It requires well thought out investments in resources (e.g. plan, talent, time, funds, etc.) and works well when carefully thought through.

Workshop Overview: Introduction to human-centred design, Ashley Riley, JHU CCP

The workshop was hosted by the Social and Behavior Change and Vector Control Working Groups. The objectives of the workshop were to explain the importance of a human-centered mindset to malaria control, to define key concepts related to HCD and the design thinking process and to identify potential applications of HCD in malaria control. The workshops had an interactive format and was held 3 times, each time lasting 3.5 hours of learning sessions and group work.

In each workshop the participants worked in groups to complete activities that are aligned with the steps of human centered design approach. The steps were empathize, define, ideate, prototype and finally test. The design challenge of the workshop was to reimagine RBM SBC WG or VCWG to promote broad-based engagement. At the end the participants shared their reflections and potential applications.

If interested in learning more about the workshop contact April Monroe (amonro10@jhu.edu) or Ashley Riley (ashley.riley@jhu.edu).

AEGIS Kenya Social Science: rationale, methods, interim results and implications – Prisca Oria, Kenya Medical Research Institute

AEGIS project's research objectives are to investigate behavioural, market, and practical factors affecting potential of household spatial repellent use and complimentary to a randomized-controlled trial testing the efficacy of a spatial repellent intervention class for malaria control.

The rationale behind the project was that no strategy will be successful if the affected population does not perceive benefit, believe in it and adopt it. The methods used were retail audit to identify malaria prevention tools available in the local market, free-listing and ranking of mosquito control products, observations of night time activities and sleeping patterns, trials of improved practices (TIPs) to better understand participant experiences with and perceptions of SRs and in-depth interviews and key informant interviews (KIIs).

The interim results from the retail audit and the free listing, showed that retail outlets commonly stocked mosquito coils (73.0%), topical repellents (38.1%), aerosol insecticide sprays (23.8%) and ITNs (14.3%), while others included insecticide incense sticks, electric mosquito strikers, insecticide soaps, electrically heated insecticide mats, and electric insecticide emanators. In the free lists were elicited 317 tools, coded into 47 categories. Participants often mentioned ITNs, mosquito coils, draining stagnant water, creating smoke and clearing the compound and others included spraying insecticide and closing doors/windows early, applying mosquito repellent and clearing the compound of garbage. Baseline results from HLC and night-time observations showed that *Anopheles gambiae* s.l. species complex and *An. funestus* comprised the majority of anophelines collected. Indoor biting rates were 59% and 71%, respectively. However, when accounting for overlaid indoor and outdoor resident location, an estimated 97% of bites occurred indoors. Using an ITN while sleeping was estimated to prevent 80% of bites for *An. gambiae* s.l. and 83% of bites for *An. funestus*. Results from TIPs R1 (1 week) & R2 (2 months) showed that in 1 week most participants mentioned a perception that the product was effective, reporting fewer mosquitos. As a result, some households reported stopping use of other mosquito control tools. At 2 months some reported mosquitoes had started to return. Participants had positive views of the intervention generally, benefits of protection outside of sleeping hours when nets provide protection, and not requiring daily action. Most liked the product appearance, but some suggested using a long lasting active ingredient.

Some of the implications seen during the project were the wide range of tools within the study area suggests the need and demand for tools, in addition to ITNs, that are affordable, easy to use and effective. Also, the differences between unadjusted anopheline vector collection rates and human behaviour-adjusted indicators highlight the importance of integrating entomological and human

behavioural data for a comprehensive understanding of malaria risk. This research will provide important data for comparing perceptions of SR product feasibility, effectiveness, and acceptability following trial unblinding. The results of the project will be considered for designing and large-scale distribution of the spatial repellent.

Questions:

After R1 which products were some households not using anymore/as much? Presumably coils etc rather than nets?

Both. But we were more concerned about ITNs and reinforced the key message of continued ITN use and the fact that the SRs are still under research and even if they proved significantly effective, they would be an additional strategy to ITNs.

Can you describe the results of the overlay of human and mosquito behaviours. Does this mean that much of the time that HLCs were recording outdoor landings, there was no one else outdoors (other than the mosquito collectors)?

There were HLC collectors indoors and outdoors and household members went about their lives normally (or at least as close to normal as possible). For the observations of human activity, we also observed and recorded hourly. We were therefore able to overlay the hourly mosquito data and the hourly behaviour data for analysis

BOHEMIA- Broad One Health Endectocide-based Malaria Intervention in Africa -Caroline Jones, KEMRI and Felisbela Materrula, CISM & Caroline Jones, KEMRI

The aim of the study is to understand the acceptability of iMDA as a strategy for malaria control in the context of the BOHEMIA clinical trial in Mozambique and Kenya & identify the factors likely to enhance or constrain the uptake of iMDA as a strategy for malaria control. The objectives of the Community Acceptability Study (Task A) look into the contribution to the development of MDA delivery approaches and community engagement strategies that are responsive to local needs and to identify the local norms and daily realities that drive adherence or non-adherence to ivermectin MDA. The County & sub-county stakeholders (Task B) aims to identify the system level enablers and challenges to intervention delivery.

The Study Design Task A is a longitudinal qualitative exploratory study using an ethnographic approach divided in three phases. The first phase is a formative Study prior to trial that includes a rapid ethnographic assessment and informs about key community stakeholders and influencers. The second phase is the implementation of the study, where the investigators collect data during iMDA. Lastly, the third phase takes place 1-3 months after iMDA and is a cross sectional qualitative study that offers data on the perceptions & experiences of iMDA, the effects of intervention, the advantages and concerns and the factors affecting adherence/non-adherence.

The value of ethnographic approach is highlighted by the development of trust between researcher and researched as it helps in the development of appropriate community engagement strategies and messaging. For instance, many stated that they would feel more safe if leaders and influencers are accepting the medications. Also, during trial helps identify and resolve rumours against antimalarials

quickly. Researchers observe and hear things that are often hidden in one of interviews and FGDs, like the misuse of nets.

Moreover this approach allows researcher to develop understanding of what is 'normal' in a community and can identify unusual behaviours and 'silent refusals' during the trial. It helps unpick which experiences and perspectives are related to the trial effects and which to the intervention itself and provides in-depth understanding of context that helps inform effective 'probes' in FGDs and interviews.

The key messages are that understanding the acceptability of an intervention is central to understanding its efficacy. However, trials of interventions come with huge inputs that are never replicated under routine conditions. In gauging acceptability, disentangling trial and intervention effects is very challenging. The way forward would be cross sectional social science research that is more likely to provide insight into the acceptability of the trial than the intervention itself. But, longitudinal qualitative research using an ethnographic approach can help disentangle the experiences and perceptions of an intervention from the experiences and views on trial participation. When data from acceptability studies conducted alongside a trial should always reflect on potential trial effects.

African conversations about gene drive for malaria elimination- Lina Finda, Ifakara Health Institute & UCSD Herbert Wertheim School of Public Health

This project aimed to facilitate conversations on gene drives for malaria control and elimination. Gene drive technologies have demonstrated high potential for control of various vector borne diseases like malaria, but there are ongoing debates on its benefits and risks. The primary objective of the project was to elicit opinion and recommendations of African key stakeholders regarding gene drive technologies and their application to vector control. This will inform the development of product profiles of gene drive mosquito products.

The conversation included 5 stakeholder groups, media, regulatory agencies, academic and research institutions and government ministries. The process followed 4 steps. Firstly, selection of countries and participants, which represent the malaria-situation in Africa, then use mixed method approach to investigate baseline awareness and perceptions. Thirdly bridge the knowledge gap and finally dissemination & monitor the educational material.

Twenty five countries were selected from all over the continent, within which 367 people were contacted, 192 were surveyed and 18 were interviewed. The stakeholders were mostly from academic and research institutions and less from regulatory agencies and the government. Most participants were male working in the research field. The reported knowledge of the GMMs was relatively high and the awareness for gene drive was equally high, while knowledge on how gene drive works was low. About three quarters of the participants deemed gene drive technologies beneficial, more than half believed that they are effective in malaria control, while one third believe that it is affordable, sustainable and safe for humans and the environment. Two thirds of the participants had concerns over gene drive. They were concerned about acceptability by the communities, affordability, safety and the top concern was inadequate local technical expertise.

From the in-depth conversations some recommendations came up from stakeholders. They were divided in evidence of safety needed, such as control for mutations, control for invasiveness, ecosystem safety, prevention of re-infection and in ethics and regulations it was recommended to explain risk assessment and management strategies, build and improve capacity of regulators and local scientists, addressed cross-border issues, build up on existing regulations of GM crops and public health-based regulations needed. Other recommendations were on effectiveness and usefulness', like evidence on feasibility of implementation demonstrated and the variations in dominant vector species. Also, it was recommended to consider tailor-made gene drives and invest resources in vector surveillance. Finally, regarding stakeholder engagement, a top-down approach was recommended, as well as active involvement of NMCPs, recognition of community members' expertise, public engagement and transparency in communicating risks and benefits of the technology. The 95% of the respondents supported the adaptation of scaling up of gene drive technologies. The next steps are going to be a better look into specific recommendations according to each country's profile.

Discussion:

I think acceptability is the main challenge. Not sure if the modified population is made locally to reassure the communities. But the current issues is the fact that the project may be importing mosquito population for release. Not sure if African communities are well informed to accept at the current stage. It is easy to have spread of fake news than good news nowadays.

- It is true that there are a lot of concerns over importing and releasing foreign mosquitoes, but what we have found out is that there isn't lack of acceptance, rather a lot of concerns and questions that need to be answered. Depending on the answers to the questions, then that will determine acceptance or lack thereof. Right now there are just a lot of questions that need to be responded to, and I think that is where a lot of efforts should be; to improve awareness and knowledge, explore concerns in different settings and addressing those before asking people to make decisions.

One thing I learned with engagement of the public for GM technologies is that if you are not the first to provide information, then they will get information from either the web or anti-GM groups. If this information is negative, then it is extremely hard to change their minds. So you have to think carefully about engaging the public early in any engagement activities.

- Yes, we are definitely thinking about that. We developed a series of animation-educational videos to respond to some of the knowledge gaps, but yes, a lot of thoughts and efforts are needed on what are the best strategies to improve knowledge of these. There are also no local terms to differentiate between different types of GMM technologies, or even gene drive approaches, so for the lay audience it really is difficult. The problem with engaging early is that there are still a lot of unanswered questions still, and going to the public without all the answers has been discouraged, as this could also validate anti-GM's concerns.

Research updates on innovative vector control

Updates from the first release of GM males in Burkina Faso as part of Target Malaria – Franck Adama Yao, Institut de Recherche en Sciences de la Sante, Burkina Faso

Every year, malaria kills in Sub-Saharan Africa, much children under the age of five years. Many countries, progress in malaria control has been threatened by the rapid spread of resistance to antimalarial drugs and insecticides. Target Malaria, is a research consortium that aims to develop and

share new genetic mosquito control tools for integrated malaria control strategies. In this context in July 2019, the consortium proceeded with the first release of a genetically modified (GM) strain of *Anopheles coluzzii* in Burkina Faso (BF).

The study was conducted in July 2019 in three phases, the marking phase, where the mosquitoes were coloured the release phase, where the WT and the DSM mosquitoes were released at the field and the recapture experiment. The study site was the village of Bana. The number of marked male mosquitos collected using swarm collection was 465, while with pesticide spray catches was 62.

The results showed that the majority of marked males (97.7%) were caught during the first ten days after the release, while the temporal distribution of recaptures and Euclidian dispersal distance showed that GM males were recaptured 50.8 - 497m and siblings 50.8 – 1,678m from the release point. As expected, the GM males were significantly less mobile than their wild type siblings.

These results provide information about the fitness and behaviour of GM males released at the start of the rainy season. In general, GMs are less robust than their non-transgenic (Wild type) sibling because they have a lower mobility and daily survival rate than their wild type sibling. Also they recognize and participate in swarming.

This first release is a first milestone towards future releases of more effective strains targeting the sibling species of the *An. gambiae* complex. This first experience will allow us to obtain easily the different approvals for the future releases, to train staff and prepare for engagement activities for future work. It also provided a good understanding of the regulatory environment and how to navigate through the system and it made clear the need of a very good team coordination to make sure that all the different sections of the project are well prepared and are working timely towards the final goal. The Anti GMOs groups are being identified and still figuring out how to manage these groups. This first effort gave some insight on how to avoid future mistakes.

This project is divided in 3 phases. The first phase that has been completed was the no gen drive sterile male phase, the one that follows is the no gene drive male bias where live eggs of no gene drive male bias mosquitos are going to be imported. The final phase is the self-sustainable gene drive mosquitoes.

Updates on ATSB- Michal Gez, Westham

ATSB is a new vector control product class developed to control outdoor malaria transmission in a peri domestic environment. Product development started a decade ago and include as a method, application, deployment and overall operation. Proof of concept field studies were conducted in Mali, which demonstrated a significant impact on mosquito density and survival. Goal to be ready for deployment right after WHO-PQ approval.

The ATBS method exploits the sugar feeding behaviour of the newly emerged mosquitoes that seek and forage on sugar for their immediate energy needs before seeking a blood meal. The ATSB is a 2dimensional bait station that hangs on walls and is a two components system, the formula which includes attractants, feeding stimulants and insecticide and the bait stations which protects the bait from abiotic conditions and nontarget insects while providing access to mosquitoes.

One of the main capabilities of this method is that it targets exophilic mosquitos with limited exposures to core methods (IRS,LLINs) and its prolonged use (6 months). Moreover, different insecticides with different modes of action can be used in a way that facilitates insecticide resistance management. In addition, the mode of delivery of the insecticides through mosquito sugar feeding is different from the usual contact mode of action to which resistance is evolving towards most public health insecticides.

Initiated and supported by IVCC, we conducted a successful proof-of-concept in Mali during 2016-2017. Since then, Westham has optimized the product design and manufacturing. An assembly line for 3,000 stations/day operated at our site over 350,000 stations produced and shipped to Mali, Zambia and Kenya for product evaluation. Entomological trials, supported by IVCC, were completed and IVCC already started epidemiological trials in Mali, Zambia and Kenya. WHO-PQ regulatory and policy process is on track as we are waiting for public health value demonstration which will result from the Epi trial.

Studies were conducted in Zambia, Kenya and Mali using ASBs without the active ingredient to determine level of feeding on baits by wild anophelines in the different locations and they showed daily feeding rate exceeds the 2.5% threshold that corresponds to 30% reduction in malaria incidence. The epi study in Zambia started 2021 and the deployment was conducted in 70 clusters (35 per arm). The cohort study involved approximately 2,500 children in a period of 2 years, with a first year interim analysis. In parallel entomological monitoring is conducted in 20 out of the 70 clusters.

In order to be ready for deployment the next steps will include NMCP engagement to establish local requirements, understanding WHO policy, PQ listing and national regulatory requirements, collaborative engagement with international donors, broad stakeholder engagement to anticipate potential challenges and define deployment strategy and finally production & scale up.

Some of the most commonly asked questions have to do with health safety for children and pets, as well as the risk for the environment. The active ingredient presents very low risk for human and pets and the environment and pollinators are not attracted to the bait. It is important to note that this method aims at community protection rather than personal.

Some take home messages are:

ATSB® is the first in Class Vector Control Intervention for outdoor use and is expected to address the gaps of existing indoor interventions

- Modelling suggests that even a modest daily feeding/kill rate of 2-3% would translate in a substantial decrease in transmission of malaria burden
- We are in the process of engaging with NMCPs to be ready for access and scale up in 2025
- We are looking for broad stakeholder engagement to anticipate potential challenges and define deployment strategy for optimal impact
- We are still in the process of learning about the challenges and the potential of this new intervention

Updates on Project BITE to evaluate new bite prevention tools in the Asia Pacific- David McIver, University of California San Francisco

BITE stands for Bite Interruption Towards Elimination and is a project focused on elimination of malaria species in Cambodia with additional work outside Cambodia. The NMCP in Cambodia is targeting elimination of all species of malaria by 2025 by pursuing an accelerated last mile strategy and more focalized approaches. The people more at risk are those living and/or working in the forest. One of the initiative in Cambodia to push towards elimination are the “Forest packs” with LLINs, LLHNS, and topical repellents, among other practical items for forest goers.

There are gaps in protection from mosquito biting and BITE is interested in 3 different groups at risk, the individuals who live in the forest, individuals who travel to the forest frequently and the forest rangers who patrol the forest. In order to protect these groups a package of intervention is put in place. This package includes volatile passive pyrethroid, treated clothing and repellent. Project BITE is raised in a phased approach. The first phase includes semi field studies that took place in Thailand, the second includes formative assessment and user acceptability studies with targeted populations, next is an entomological field study, followed by a baseline prevalence survey and epidemiological field trial and a feasibility study. As the data is coming in transmission modelling it is used to understand how the product contributes to the elimination of malaria in Cambodia.

The Thailand semi field systems to look at endpoints beyond mosquito landing. They look at mortality, disarming and repellence. All these are used for personal protection, but it is investigated how it contributes to community protection. The entomological study was conducted in Cambodia using a 7x7 Latin square design, with 6 different variations of the products and a combination of all their products.

The topline results to date from semi-field and field studies showed 9 of 11 products and product combinations reduced Anopheles landing. Also, all products and product combinations (n=6) reduced risk of mosquitoes landing by at least 50% and the passive volatile pyrethroid (I1) and the combination of all three products (I7) reduced risk by nearly 95%. Results of other outcomes indicate tools go beyond personal protection to impact community protection if used. The results from the acceptability studies showed high acceptability of passive VP due to ease of use and perceived protection from mosquitoes, but there were concern expressed about exposure to rain. High acceptability of active VP, but users noted fast depletion of product. Moderate acceptability with Etofenprox treated clothing due to mild skin irritation and smell. Experience with product improved after 1-2 washes to remove some smell and dermal irritation from the product.

Wrap up and close- Allison Tatarsky, University of California San Francisco and Sheila Ogoma, CHAI
Allison thanks all the attendees for the participation the speakers and facilitators.

List of acronyms

AEGIS Advancing Evidence for the Global Implementation of Spatial Repellents
ASTMH American Society of Tropical Medicine and Hygiene
ATSB Attractive Targeted Sugar Bait
Bti *Bacillus thuringiensis israelensis*
CDC Centers for Disease Control
DCs Discrimination Concentrations
DD Deep Dive

GM	Genetically Modified
GMO	Genetically Modified Organism
GMP	Global Malaria Programme
GVH	Global Vector Hub
HCD	Human Centred Design
HLC	Human landing Catches
iMDA	ivermectin Mass Drug Administration
IRS	Indoor residual spraying
ITN	insecticide-treated net
IVCC	Innovative Vector Control Consortium
IVM	Integrated Vector Management
LLIN	long-lasting insecticidal net
LSM	larval source management
NMCP	National Malaria Control Programme
NTD	Neglected Tropical Disease
PATH	Program for Appropriate Technology in Health
PBO	Piperonyl butoxide
PHO	Public Health Officer
PI	Principal Investigator
PMI	President's Malaria Initiative
PQ	Prequalification Programme
RBM	Roll Back Malaria
SOP	Standard Operation Practice
TOR	Terms of Reference
TDR	Special Programme for Research and Training in Tropical Diseases
TGF	The Global Fund
VBD	vector borne disease
VCWG	Vector Control Working Group
WHO	World Health Organization
WG	Working Group