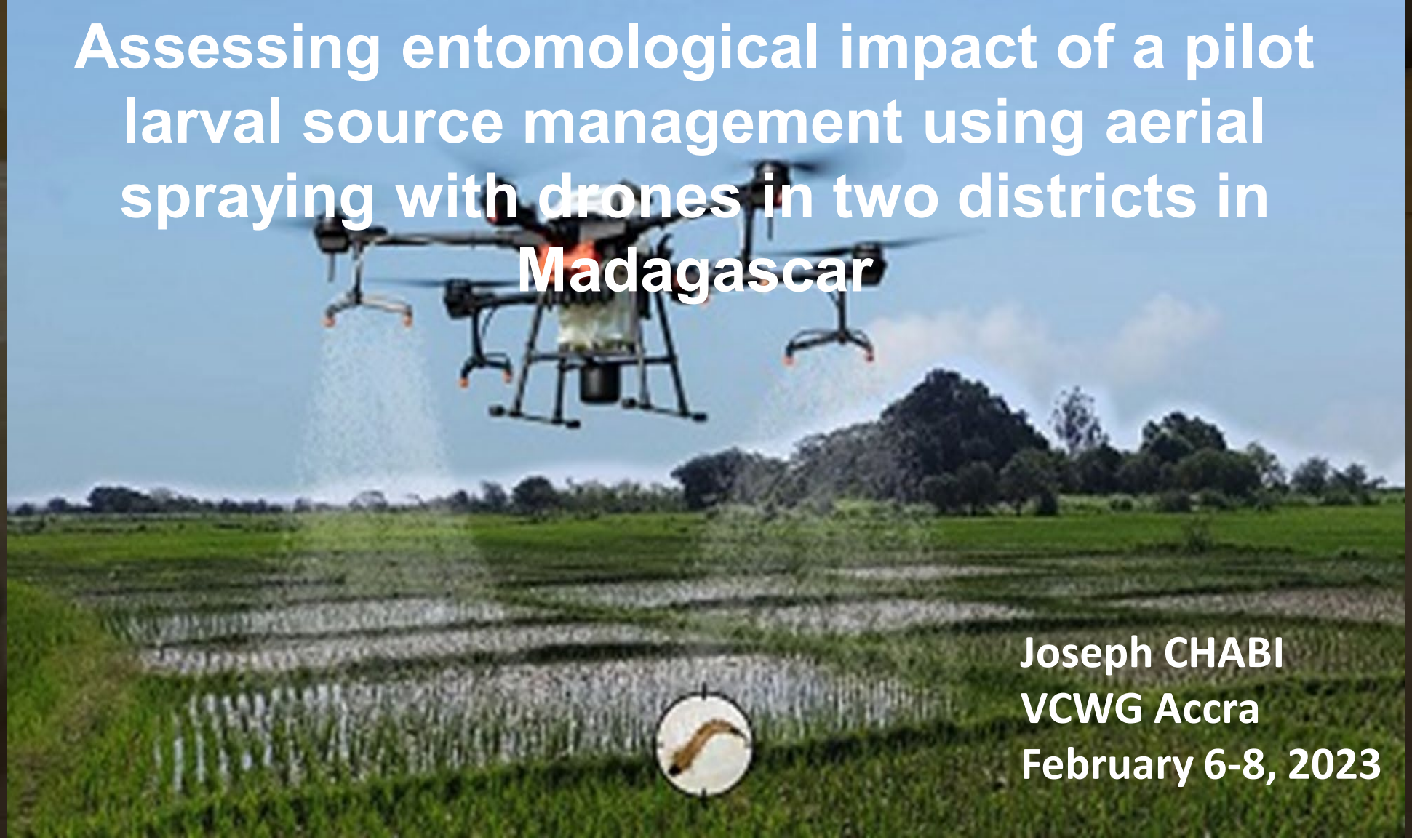
Assessing entomological impact of a pilot larval source management using aerial spraying with drones in two districts in Madagascar



Joseph CHABI

VCWG Accra

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Spraying Objectives and Procedure

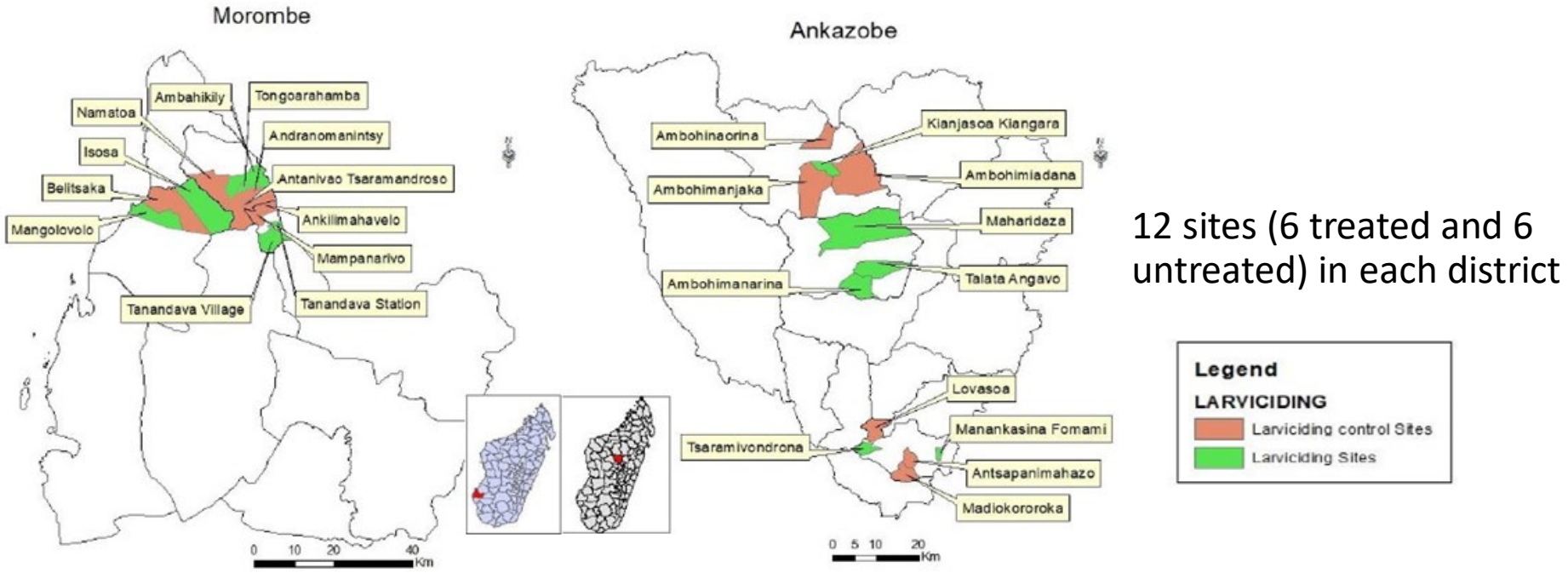
❖ **Objectives**:

- Assess the cost, logistics, cost-effectiveness and feasibility of larvicide application by drone in Madagascar
- Assess whether supplementary larviciding of aquatic/rice field habitats using **Bti (VectoBac® WDG)** at 30.2g/L (453.5g in 15L) in combination with pyrethroid-based ITNs (deltamethrin-based DawaPlus 2.0,Yahe LN and YorKool, and Alpha-cypermethrin based SafeNet) provides additional control of malaria vectors in Madagascar by reducing larval and adult densities, indoor and outdoor human bite rates, sporozoite rate, and entomological inoculation rate (EIR)
- Assess whether supplementary larviciding reduces malaria transmission, as measured by routine data and cross-sectional prevalence surveys (with RDTs) conducted by the Pasteur Institute of Madagascar at baseline in December-January and end in July

❖ **Spraying – preparatory steps**

- Mapping of selected district all rice fields
- Selection of targeted spray areas and controls
- Determination of application frequency: twice per month
- Provision and preparation of logistics and resources

Entomological Monitoring Methods



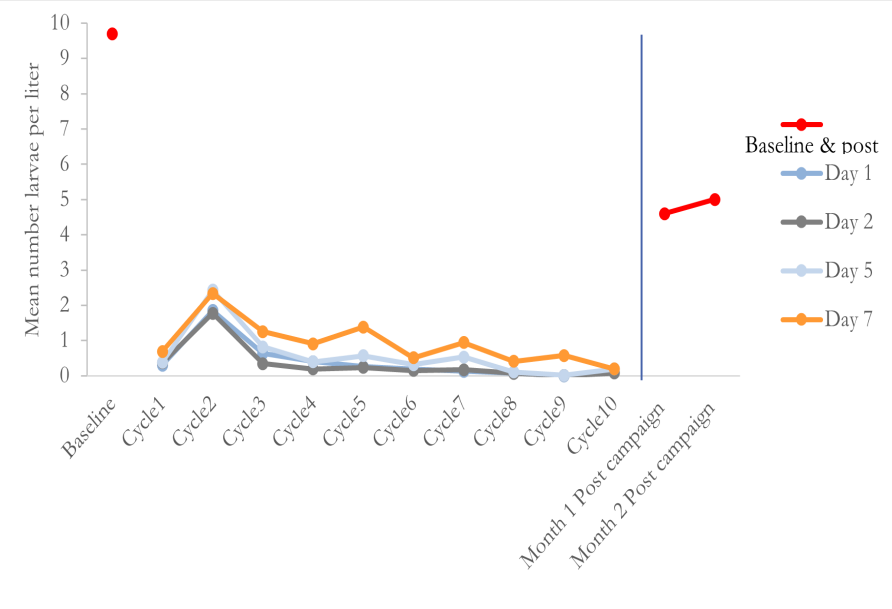
12 sites (6 treated and 6 untreated) in each district

- Larval surveys using dipping methods for presence/absence of larvae and density using 10 dips/ positive habitat
- Larval surveys done in one month baseline period and every 2 weeks after each Bti application, over 10 months
- Adult mosquito collections using indoor & outdoor human landing catches (HLCs), indoor resting prokopack, collection outdoor CDC light traps, outdoor prokopack and mouth aspiration
- Larval bioassays of Bti using serial dilution of sprayed solution and rice field water against wild *An. gambiae* L3 larvae

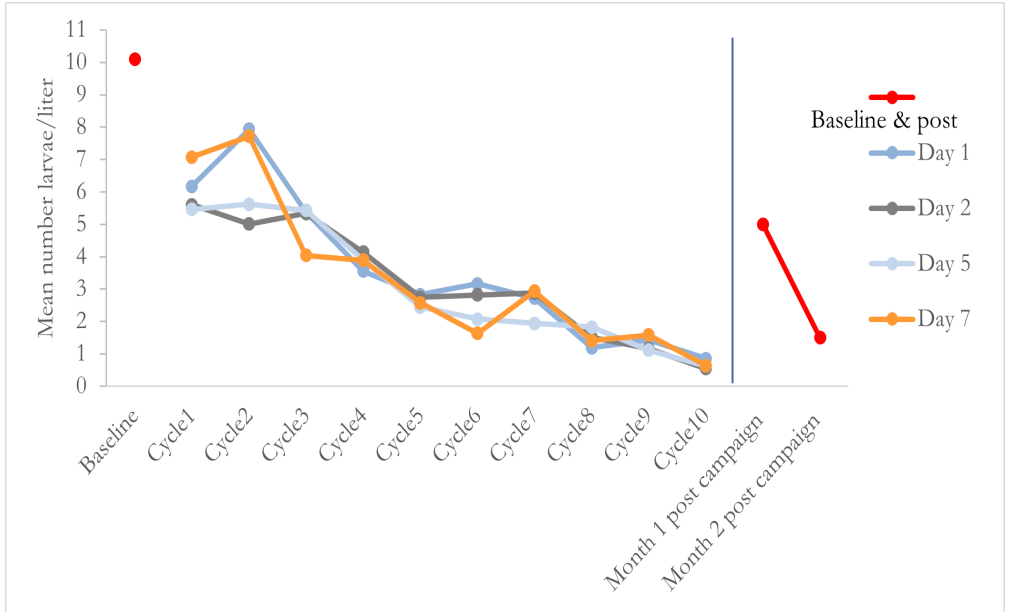
Results

Larval survey in Morombe

Larval Density in the Sprayed Sites of Morombe



Larval Density in the Control Sites of Morombe

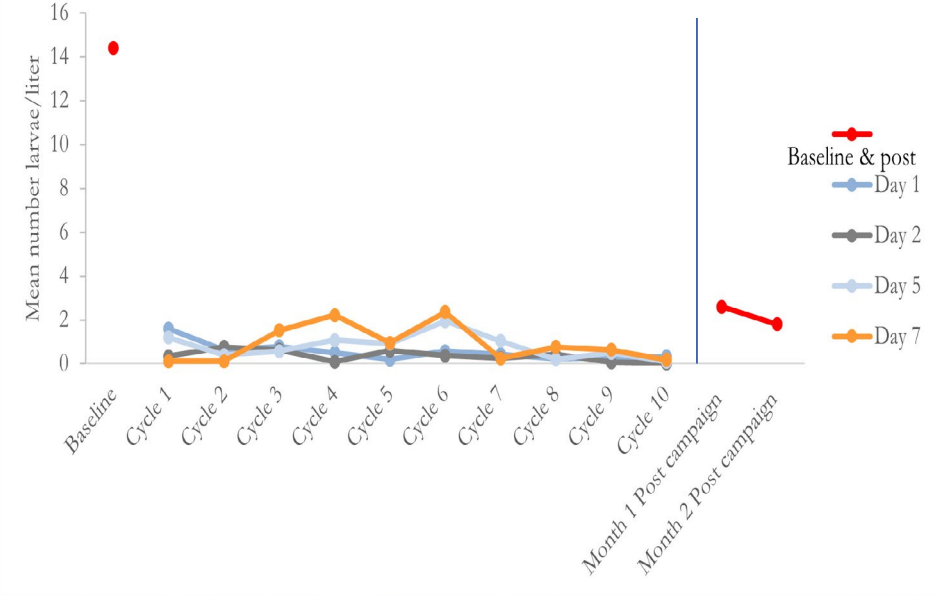


- Mean of 9.7 larvae/L at baseline in sprayed sites and 10.1 larvae/L in control sites
- Decrease larval density from day 1 to day 5
- Increase in density from day 7
- Mean larval density reduction of 94.3% over 7 days
- Significant decrease of larval density over spray cycles and lower than control sites
- Decrease of larval density in control sites
- Increase of larval density after spraying was stopped

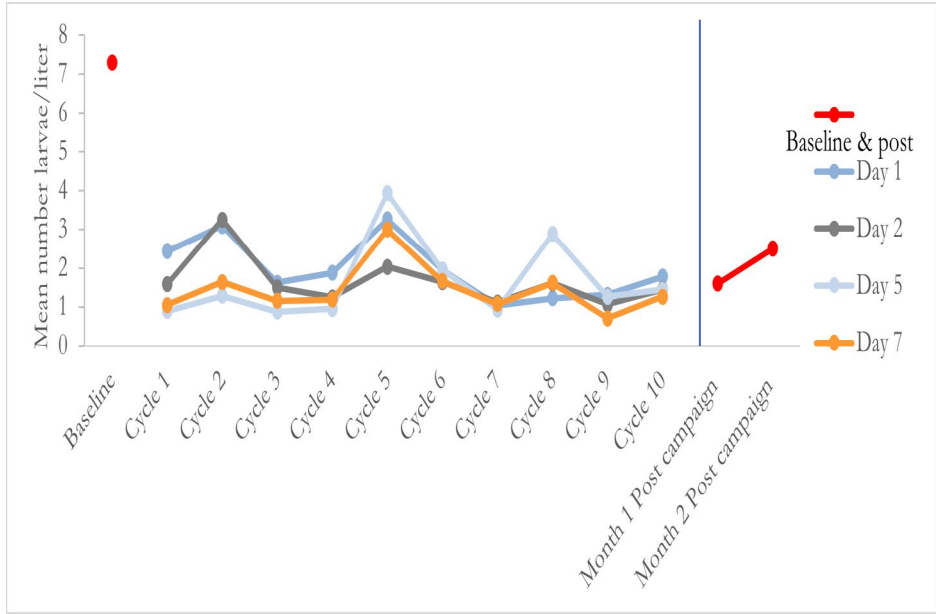
Results (Cont..)

Larval survey in Ankazobe

Larval Density in the Sprayed Sites of Ankazobe



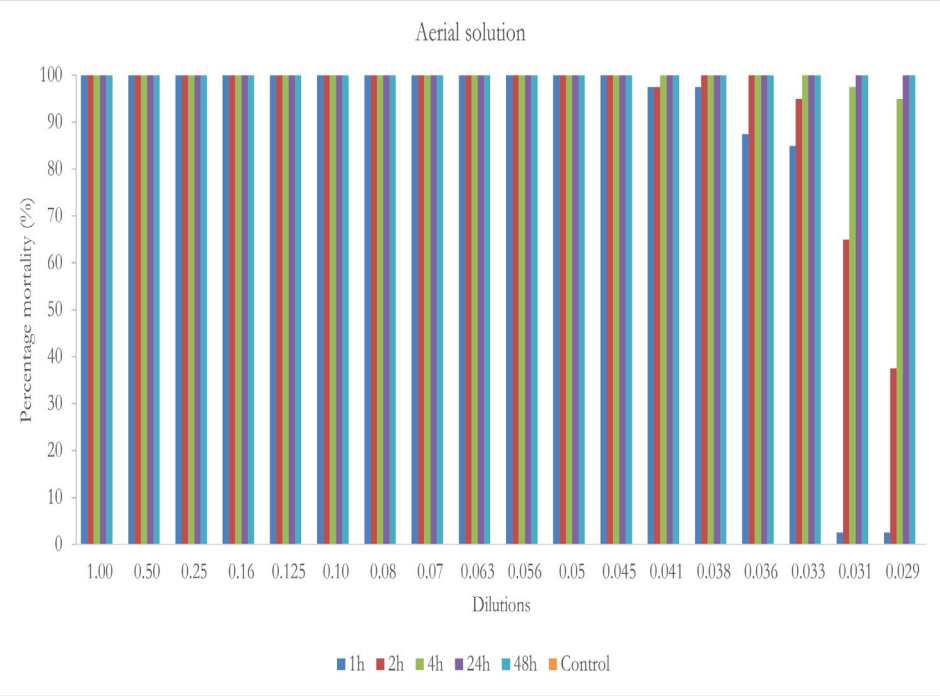
Larval Density in the Control Sites of Ankazobe



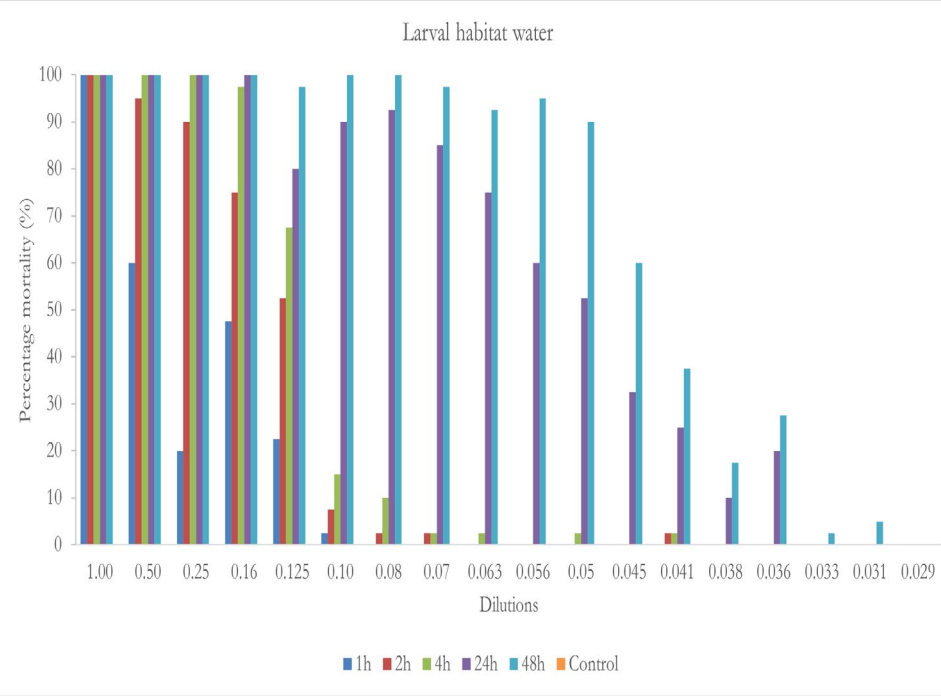
- Mean of 14.4 larvae/L at baseline in sprayed sites and 7.3 larvae/L in control sites
- Decrease larval density from day1 to day5 of each spray cycle
- Increase in density from day7
- Percentage mean larval density reduction of more than 95%
- Higher larval density in control sites than treated sites with increase over the spray cycles
- Increase of larval density after spraying stopped

Larval bioassays in Morombe

Mortality using solution of Bti from the drone tank



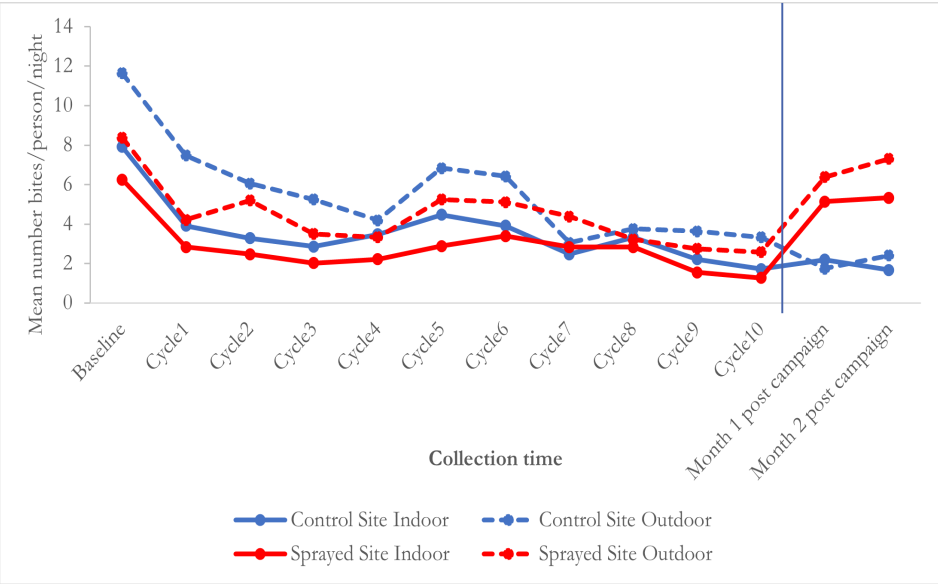
Mortality using post Bti sprayed larval habitat water



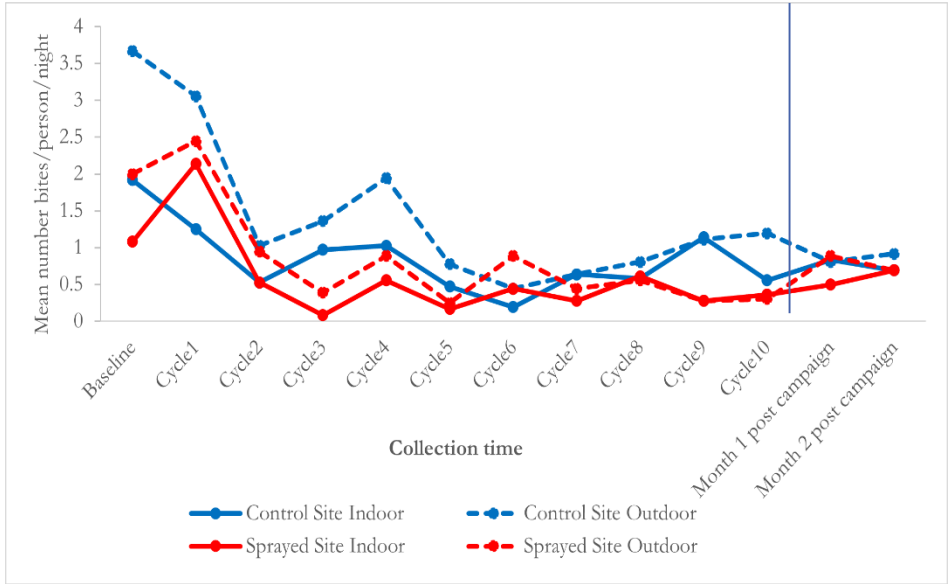
- 100% mortality after 48h for all dilutions [S_0 (stock solution at 30.2g/L) to $S_{1/34}$ (0.9g/L)] of the drone tank mixed solution
- 100% mortality after 1h from S_0 to $S_{1/24}$ (0.045g/L)
- More than 90% mortality after 48h of the sprayed larval habitat water from S_0 to $S_{1/20}$ (0.05)
- Decrease mortality after $S_{1/2}$ at 1h with the larval habitat water

Vector surveillance

Mean Indoor and Outdoor Human Biting Rates of *An. gambiae*s.l. in Sprayed and Control Sites of Morombe



Mean Indoor and Outdoor Human Biting Rates of *An. gambiae*s.l. in Sprayed and Control Sites of Ankazobe



- 156,345 mosquitoes collected from all the 24 sentinel sites in 10 months using all methods
- 61,830 (39.5%) *Anopheles* mosquitoes including 10 different species
- Reduction in human biting rates both indoor and outdoors in the sprayed sites compared to controls
- Higher outdoor biting than indoor in all settings
- Increased vector population after completion of spraying cycles

DISCUSSION AND CONCLUSIONS

- The bioassays conducted with both Bti stock solution and water from the sprayed sites showed high me larval bioassays mortality at least between 24h and 48h for the larval habitat water at higher concentrations, while the solution of Bti was overall effective after a dilution of 1/34 times.
- This implies that the mosquito larvae could be killed after 24h post ingestion of the larvicide. In addition, in the situation of rainfall or irrigation after treatment, the product could still be effective at about 20 times of dilution of the larval habitats meaning that there is limited impact of the level of irrigation or rainfall on the effectiveness of the Bti
- Decrease of larval density observed from the first day post spray (D1) to at least day 5 in the sprayed sites compared to the baseline and throughout the spray cycles showing good efficacy of Bti within the week1 after which the larval habitats could be recolonized
- Increase in larval density in the remaining habitats after the spraying ended implying continuous follow up to maintain effectiveness

- Reduced vector density with decrease of human biting rates in sprayed sites compared to controls
- Higher outdoor biting than indoor in both sites calling for awareness and community education
- Cumulative decrease over spray time showing the added value of continuous spraying
- Rebound of vector density after stopping the treatment, which is in line with the larval density trends

❖Overall, LSM has shown efficacy and should be consider as appropriate complementary strategy in the country. Though effort should be made to preserve the gain by continue the treatment as there is vector population recolonization after weeks

Acknowledgement

Thanks to the PMI VectorLink country team, Home office backstops and PMI/CDC team

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Madagascar

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Additional slide

Larval survey in Morombe

	Mean # larvae per liter during the baseline and post spray (days)					Post spray reduction (%)			
		Day 1	Day 2	Day 5	Day 7	Day 1	Day 2	Day 5	Day 7
Baseline	9.7								
Cyde1		0.3	0.4	0.4	0.7	96.9%	96.3%	96.0%	92.9%
Cyde2		1.9	1.8	2.4	2.3	80.9%	81.7%	75.0%	75.9%
Cyde3		0.6	0.3	0.8	1.3	93.5%	96.4%	91.5%	87.1%
Cyde4		0.4	0.2	0.4	0.9	95.9%	98.0%	95.9%	90.7%
Cyde5		0.3	0.2	0.6	1.4	97.3%	97.6%	94.2%	85.7%
Cyde6		0.2	0.2	0.3	0.5	98.0%	98.5%	96.8%	94.7%
Cyde7		0.1	0.2	0.5	0.9	98.7%	98.2%	94.5%	90.3%
Cyde8		0.1	0.1	0.1	0.4	99.2%	99.3%	98.9%	95.8%
Cyde9		0.0	0.0	0.0	0.6	100.0%	99.9%	99.8%	94.1%
Cyde10		0.1	0.1	0.2	0.2	98.8%	99.2%	98.0%	98.0%
Average		**0.4**	**0.3**	**0.6**	**0.9**	**95.9%**	**96.5%**	**94.1%**	**90.5%**
Post campaign 1 (Aug-2022)	4.6								
Post campaign 2 (Sep-2022)	5								

Larval survey in Ankazobe

	Mean # larvae per liter during the baseline and post treatment (days)					Post treatment reduction (%)			
		Day 1	Day 2	Day 5	Day 7	Day 1	Day 2	Day 5	Day 7
Baseline	14.4								
Cycle 1		1.6	0.4	1.2	0.1	88.9%	97.6%	91.7%	99.2%
Cycle 2		0.6	0.8	0.4	0.1	95.6%	94.7%	97.2%	99.2%
Cycle 3		0.8	0.6	0.6	1.5	94.5%	95.6%	96.0%	89.4%
Cycle 4		0.5	0.1	1.1	2.2	96.4%	99.4%	92.4%	84.5%
Cycle 5		0.2	0.6	0.9	1.0	98.6%	95.9%	93.6%	93.4%
Cycle 6		0.6	0.4	1.9	2.4	96.0%	97.4%	86.5%	83.6%
Cycle 7		0.4	0.3	1.0	0.3	97.0%	98.2%	92.8%	98.3%
Cycle 8		0.2	0.4	0.2	0.8	98.3%	97.1%	98.5%	94.7%
Cycle 9		0.3	0.1	0.5	0.6	98.0%	99.5%	96.5%	95.5%
Cycle 10		0.3	0.0	0.1	0.2	97.7%	99.8%	99.4%	98.7%
Average		**0.6**	**0.4**	**0.8**	**0.9**	**96.1%**	**97.5%**	**94.5%**	**93.6%**
Post campaign 1 (Aug-2022)	2.6								
Post campaign 2 (Sep-2022)	1.8								