Portable Mosquito-Proof housing for itinerant rice farmers in Rural Tanzania

Kyeba Swai, BSc.

Environmental Health and Ecological Sciences Thematic Group, Ifakara Health Institute
• Malaria infections and parasitemia ranged from about 50-86% in 2-9 year old children

• Malaria was the principal cause of death in <5 year old children

Tanner et al 1991
ITN’s, case treatment and diagnostic tools
Nearly 1 million lives saved in Africa since 2000, due to enhanced malaria vector control, but there remains residual malaria transmission mediated by resilient and resistant sub-populations of vectors.

Getting to zero will require effective new tools for surveillance and control of the residual vector species.

Impact of improved living standards and urbanization

Impact of malaria interventions (LLINs, IRS, Diagnostics, Treatment and Chemoprophylaxis) and improved living standards

>90% transmission mediated by vectors that predominantly bite humans indoors and rest indoors

30-50% transmission mediated by resilient vectors that bite humans outdoors, rest outdoors, and readily bite non-human hosts

Approximated force of malaria transmission (no. infectious bites per person per year), based on observations in a rural Tanzanian village.

Okumu et al 2014
Housing and Mosquito indoor densities

A longitudinal survey done in two villages of the Kilombero region by Lwetoijera et al from 2008 - 2011

- Showed that even at high ITNs coverage levels there was still a limitation in reducing the entry of mosquitoes into the house
- Poor house characteristics like unscreened open eaves, lack of screening and ceiling, holes in the walls etc were associated with increased indoor vector abundance
- These findings emphasize not only on the insufficiency of LLINs to control indoor vector densities but also improving house design to prevent indoor vector abundance"
Lessons From the past

• Celli’s work with railway workers that resulted in 92% of control group infected while only 4% of the treatment group got infected

  Ferroni et al 2012

• Manson’s work in a malaria endemic region in England where a wooden hut with net screened windows doors and bed nets that resulted in none of the research team members falling ill of fever

  Manson et al 1900
Rice Farming in Kilombero

- Subsistence rice farmers in rural south east Tanzania are mostly itinerant, sometime spending up to 6 months in distant river valley rice fields.

- Despite, high risk to mosquito bites and mosquito borne illnesses, common vector control methods are not always applicable.
Develop a portable and low-cost mosquito-proof hut design that can protect itinerant rice farmers from infectious mosquito bites and mosquito-borne illnesses, during the period when they are at their rice fields.
Quantifying biting exposure in main houses and *Shamba* houses

1. Listed of all households from HDSS
2. Randomly selected 20 Main houses
3. Identified 20 *Shamba* houses adjacent
4. CDC light trap for indoor collections
   M-trap for Outdoor
5. Species ID by PCR and parasite detection by ELISA

**Key:**
- Δ - Main house
- ▲ - Shamba house
- --- - Rice paddies
CDC light trap for indoor mosquito collection

M-trap for outdoor mosquito collection
Average Number of mosquitoes caught indoors
by CDC light traps (95% C.I.)

- **Anopheles arabiensis**
- **Anopheles funestus**
- **Culex spp**
- **Mansoninae spp**

- **Main house**
- **Shamba house**
Design and construction of prototypes that are low-cost, portable and exposure-free hut.
Desirable characteristics

To be effective, these new farm houses must be:

• Easy to transport and assemble,
• Fitting other vector control tools
• Durable (lasting at least 3 years)
• Accommodate an average itinerant family size
• Well ventilated and comfortable
• Manufactured locally
• Fire-proof
• Affordable
Foldable High density plastic roofing

Wide-screen viewing windows

Aluminium main frame

Double-panel door to prevent insect entry during use

Oily-water moat to prevent crawling insects

Roll-up canvas wall, for privacy and wind-shielding

All weather wooden bars to support the roof

U-V resistant netting wall sprayed with fire-retardant to withstand heat and allow indoor cooking

Raised rock/wooden pedestal to prevent runoff and wildlife
First Portable mosquito proof prototype hut for itinerant rice communities
i) Semi field tests
Volunteers using intact nets

Average number of mosquitoes caught indoors (95% C.I.)

- CDC unfed
- CDC Fed
- Resting catch unfed
- Resting catch Fed
- Floor Unfed
- Floor Fed
- Bednet Unfed
- Bednet Fed

Legend:
- Prototype
- Shamba house
Volunteers using torn nets

Average number of mosquitoes caught indoors (95% C.I.)

- CDC unfed
- CDC Fed
- Resting catch unfed
- Resting catch Fed
- Floor Unfed
- Floor Fed
- Bednet Unfed
- Bednet Fed

Prototype
Shamba house
Outcome measures: 1) No. mosquitoes of different species entering each hut type, 2) % blood-fed, 3) microclimate measurements and 4) *Plasmodium* infection rates
Assessed views, experiences and behaviors of itinerant farmers and their views on the prototype

**Phase I: Semi-structured interviews**
- Participant identification and consent seeking
- Conduct the interviews
- Transcription and translation

**Phase II: Participant observations**
- Literacy checks, participant identification and consent seeking
- Training of participating member
- Perform 3 observations (2 trials and 1 real)
- Compilation of data. Comparison with SSI data

**Phase III: Focus group discussion**
- Participant identification and consent seeking
- Conduct focus groups discussions
- Transcription and translation
Responses from itinerant rice farmers from qualitative study

Views from farmers:

On current *Shamba* houses

❖ “There is no protection without sleeping inside the bed net, mosquitoes easily enter inside and bite us.”
- female interviewee from Lupiro

On the mosquito proof prototype

❖ “I am ready to use it. Even the day after tomorrow, I will go to the farm and prepare a place to put that good house.”
- male interviewee from Minepa
What’s next

• To ascertain the protective efficacy when in actual use

• Commercialization of the prototypes into products

• Identify means of reducing the costs of the final product

• Nomadic communities