# Enhanced Survivorship and Fecundity of Malaria Vector Linked to Irrigation Scheme in Ethiopia

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# Presentation Outline

- Background
- Objectives
- Methods
- Results & Discussions
- Limitations
- Conclusions
- Recommendations
- Acknowledgements

# Background

- Water Resource Development (WRD) project  like irrigation schemes are key to ensure food security and promote economic growth in the developing world
- However, such land use change blamed to worsen VBDs burden like malaria through altering ecological settings in favor of parasites & its vector
- **Ethiopia** has been experiencing extensive irrigation schemes aimed to improve its crop production and promote economic growth
- However, the impact of such projects on malaria transmission risk has been poorly studied

(Awulachew et al., 2019; Haile, 2015Muriuki *et al*., 2016, Kibret *et al.,* 2017, Frake *et al*., 2020)

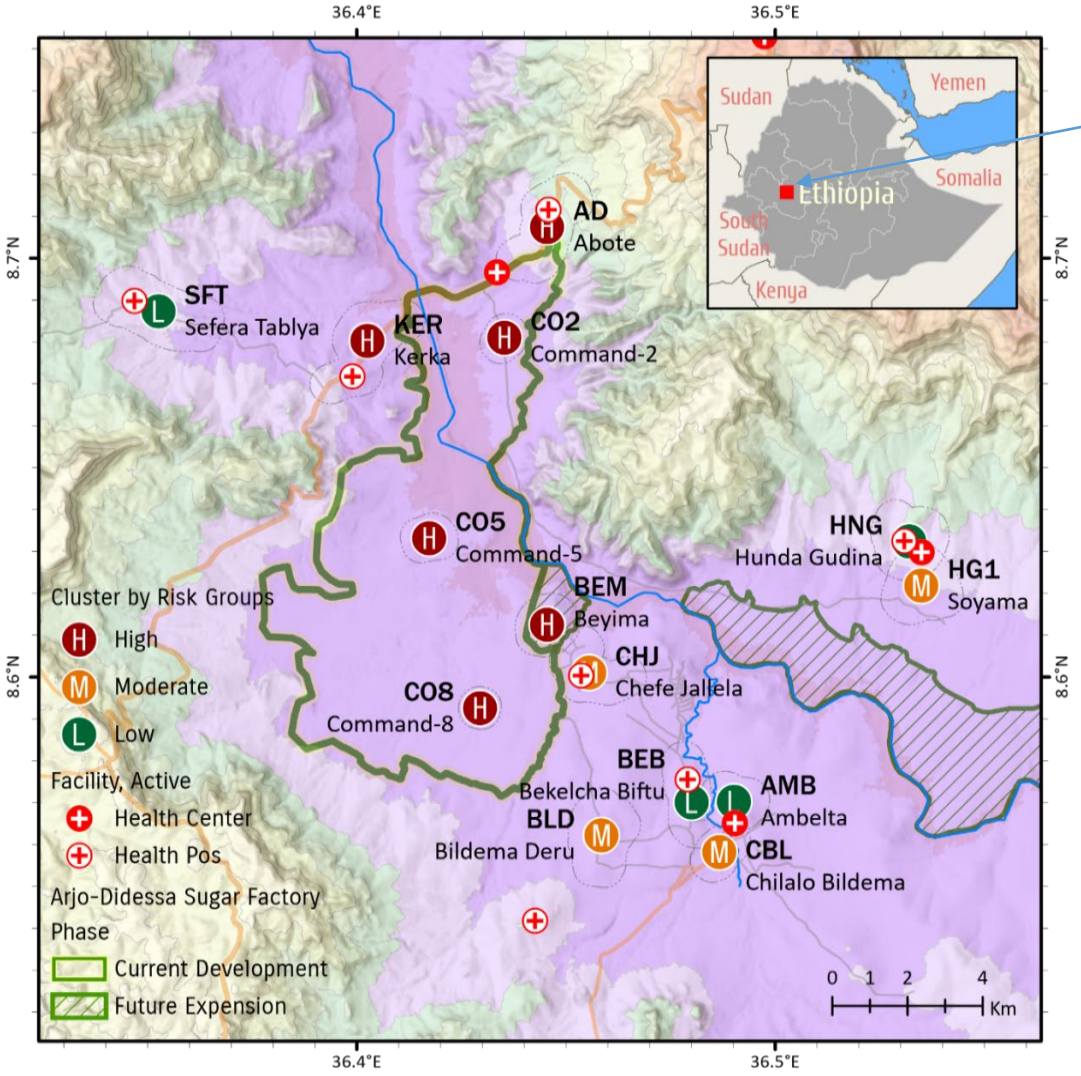
# Objectives

- To determine effects of environmental modification due to irrigation on the larval ecology of malaria vector in Ethiopia

- To determine effects of environmental modification due to irrigation on the survivorship and fecundity of malaria vector in Ethiopia

# Methods

## Study setting




- **Arjo-Dedessa sugarcane plantation development site**
- Irrigated sugarcane plantation: **Environmental modification**
- Irrigation source: **Dedessa River,** tributary of Blue Nile River Basin
- Historically, **malaria endemic area**
- Surrounding community: Practice non-irrigated farming (field crop cultivation and livestock rearing)

# Methods…

## I – *Anopheles* mosquito larval ecology study

### Study design & site selection

- A repeated cross-sectional study during both dry and wet seasons

Irrigated areas → 6 Clusters → Surveyed for all accessible mosquito breeding habitats

Non-irrigated areas → 6 clusters → Surveyed for all accessible mosquito breeding habitats


- Standard larva survey technique (WHO 1975)

# Methods…

## I – *Anopheles* mosquito larval ecology study…

### Transporting, rearing and species identification at field insectary

- *Anopheles* larvae allowed to grow in the water collected from the field

- Adults were examined & identified to species complex level (Gillies M & Coetzee M. 1987)

# Methods…

## II – *Anopheles gambiae* s.l survivorship study

### Mosquito source:

Residence & animal shelter



Newly hatched 1st instars

**Experiment 1**

- Kept in cage provided with oviposition substrate to lay egg

# Methods...

## II – *Anopheles gambiae* s.l survivorship study…

**Experiment 1:** Immatures mosquitoes life-table setup

**Irrigated area**

- 8 R (microcosm –washbasins)
- 50 first instar larvae/washbasin
- Daily record of development rate and survival

**Non-irrigated area**

- 8 R (microcosm –washbasins)
- 50 first instar larvae/washbasin
- Daily record development rate and survival


Insect-proof Bug-Dorm tent (61 × 61 × 61 $cm^3$ ) – clear polyester netting material

# Methods…

## II – *Anopheles gambiae* s.l survivorship study…

**Experiment 2:** Adult mosquitoes life-table setup

**Irrigated area**

- 5 Replicates (Mosquito cages)
- 50 mosquitoes (25M + 25F)/R
- 10% sucrose solution provided
- Human arm for blood meal
- An oviposition substrate
- Daily count and record of the # eggs laid
- Daily recorded and removed of dead

**Non-irrigated area**

- 5 Replicates
- 50 mosquitoes (25M + 25F)/R
- 10% sucrose solution provided daily
- Human arm for blood meal
- An oviposition substrate
- Daily count and record of the # eggs laid
- Daily recorded and removed of dead

# Methods…

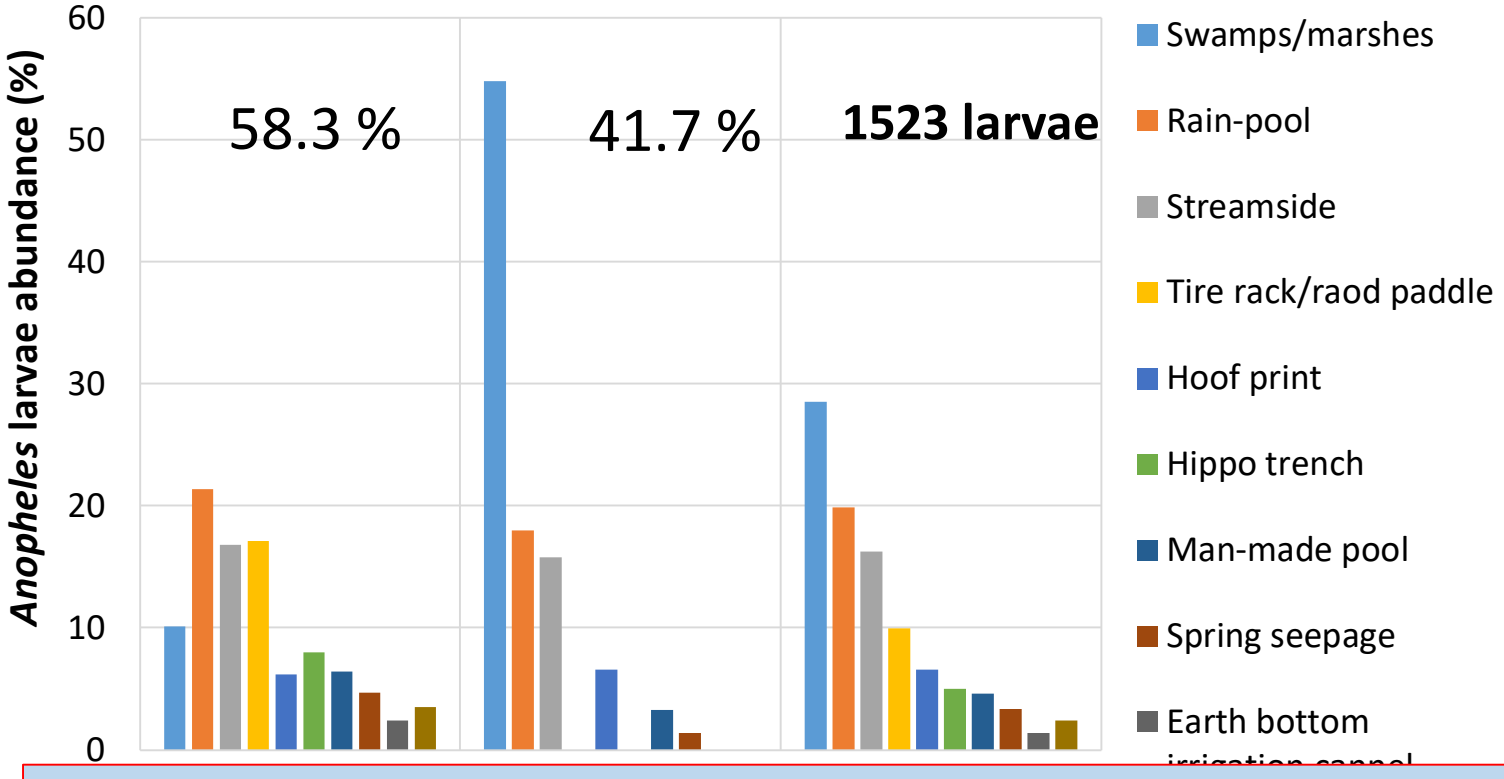
## II – *Anopheles gambiae* s.l survivorship study…

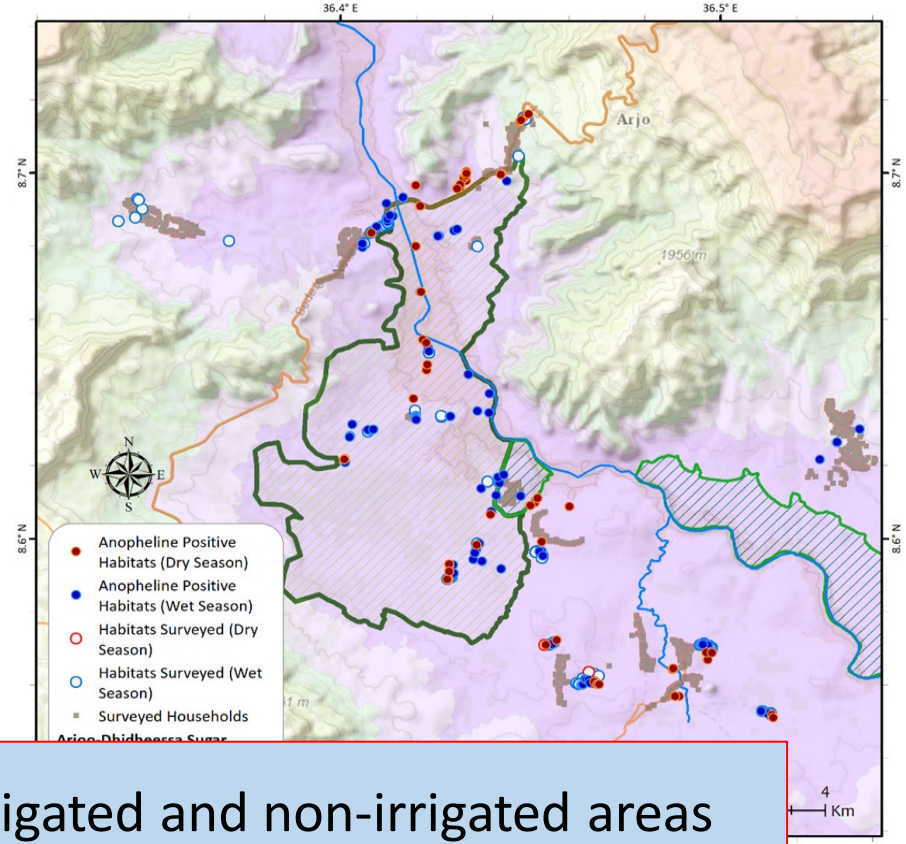
### Adult mosquitoes life-table experiment setup

- At field, a roof structure was constructed to protect mosquito cage from rain
- Paper cages suspended from the ceiling

# Results and Discussions

## *Anopheles* larval habitat diversity & larvae abundance




The difference in *Anopheles* larval occurrence between the irrigated and non-irrigated areas could partly be due to difference in microclimate between the two settings.

**Figure 1** *Anopheles* mosquito breeding habitats diversity and larval abundance across seasons in irrigated and non-irrigated areas, southwest Ethiopia (2019 – 2020).

# Results and Discussions…

## *Anopheles* mosquito species composition

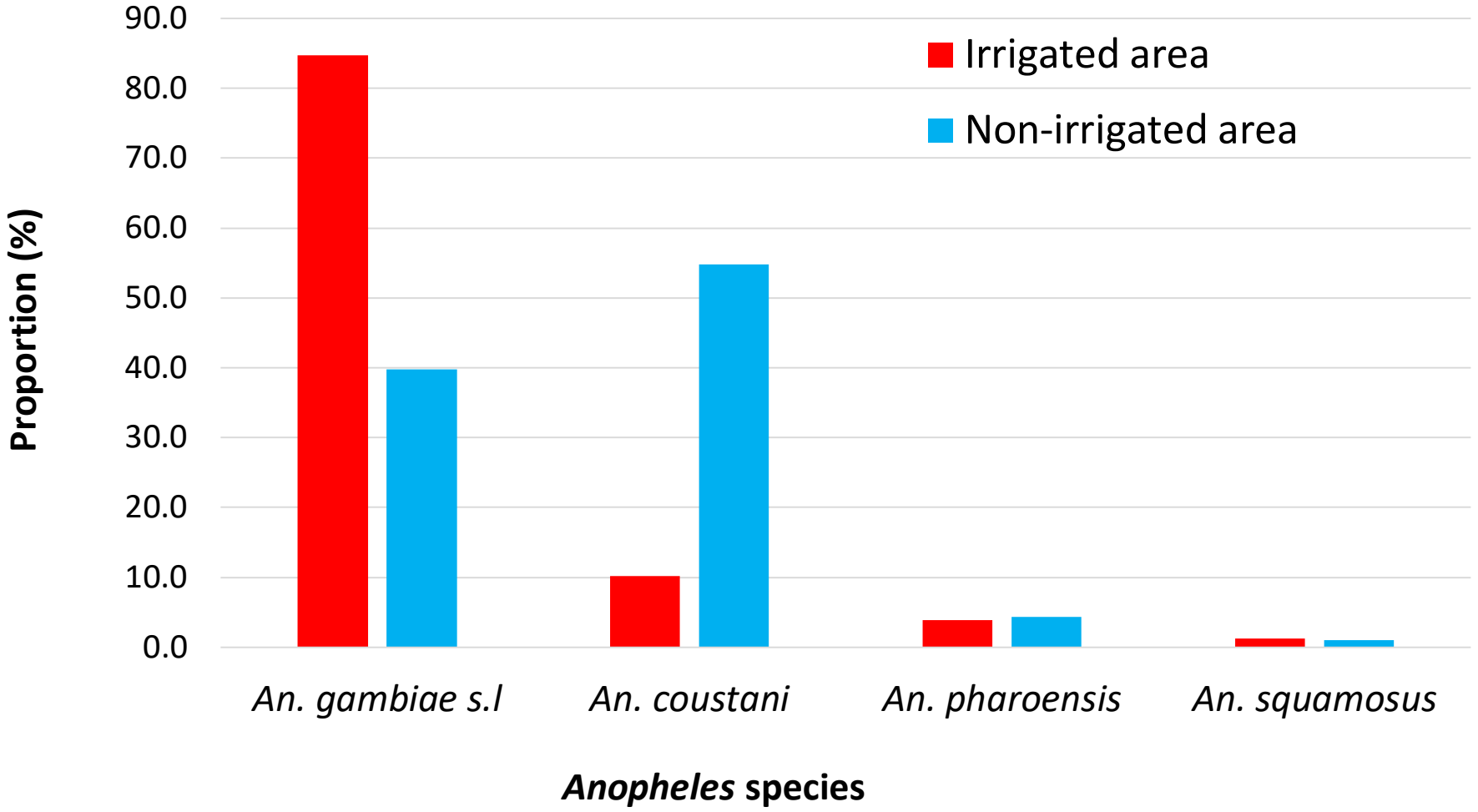
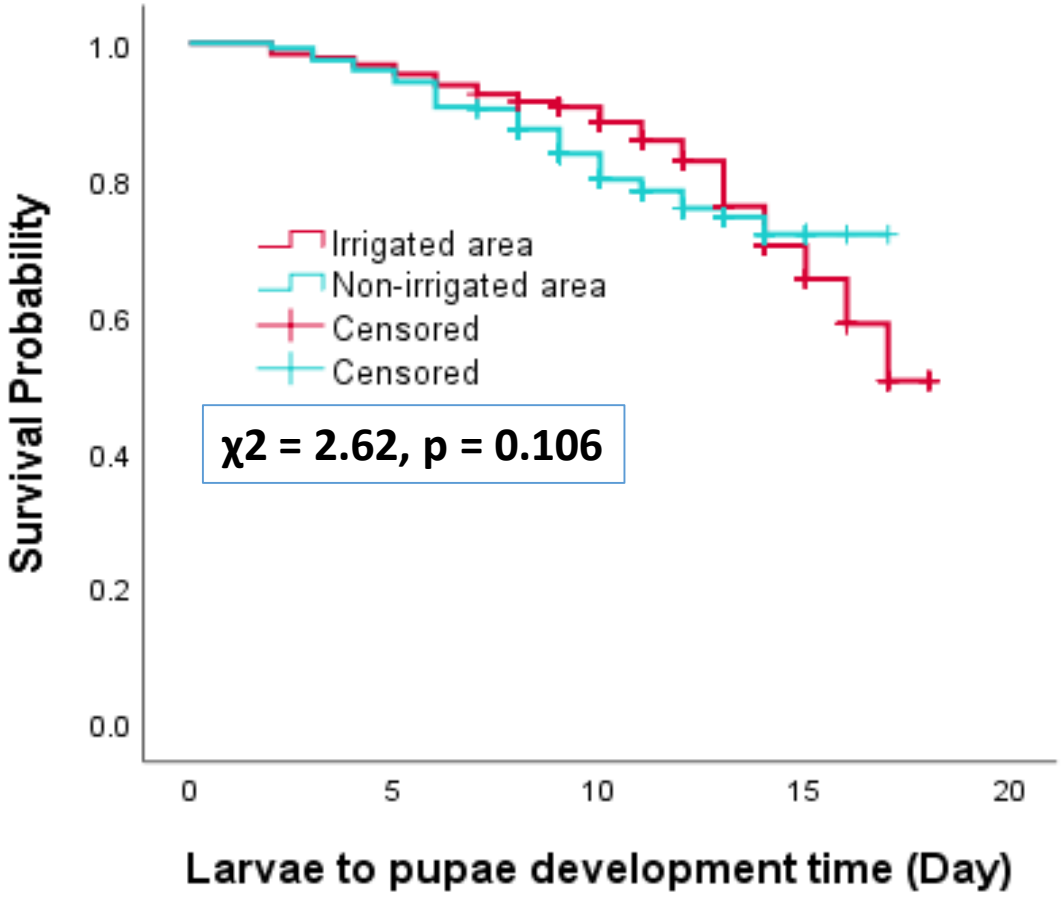



**Figure 2** Composition of adult female *Anopheles* mosquito species in irrigated and non-irrigated areas, southwest Ethiopia (2019–2020).

# Results and Discussions…

## Survivorship of *An. gambiae* s.l larvae

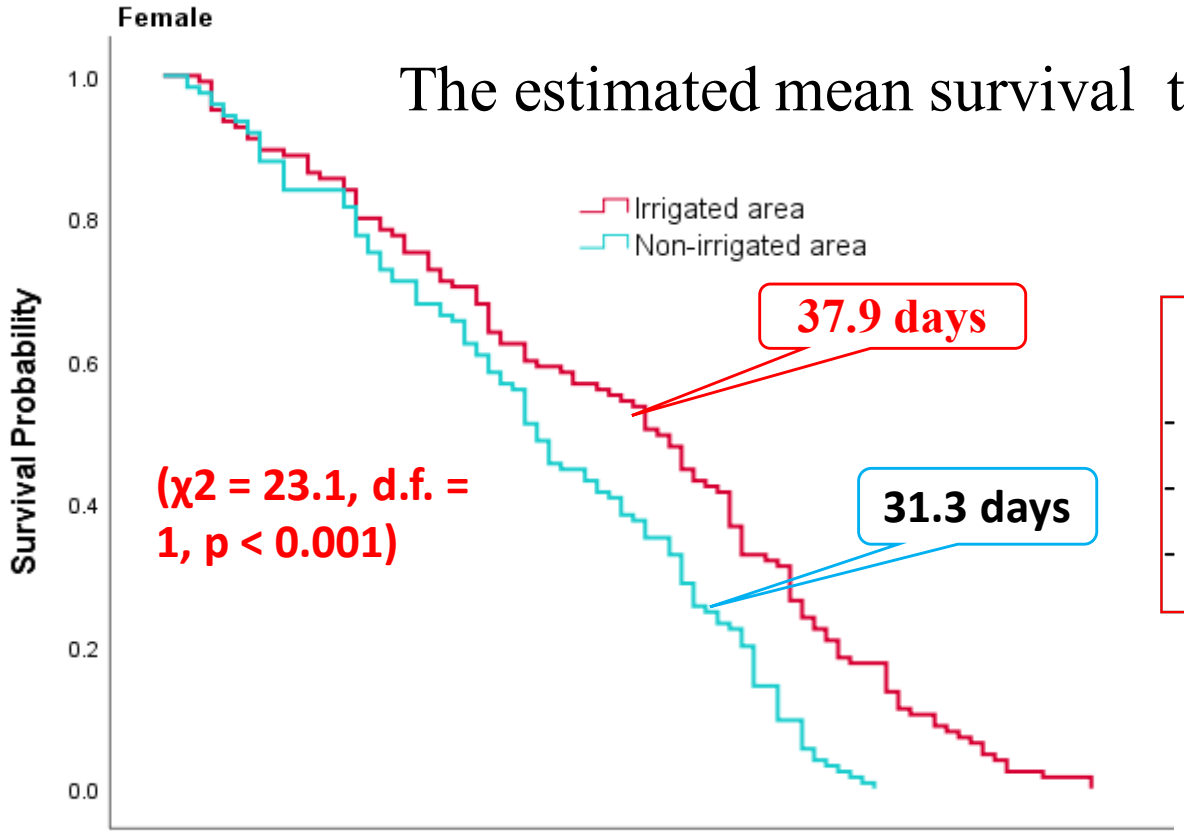



- The study showed no significant difference in survivorship, development, and pupation rate
- Indicating both areas are supporting immatures mosquito development & survival

**Figure 3** Survivorship of *An. gambiae* s.l larvae in irrigated and non-irrigated areas, southwest Ethiopia, 2020.

# Results and Discussions…

## Adult *An. gambiae* s.l survivorship and fecundity




The estimated mean survival time

Total egg laid throughout the experiment period = 7,737

**Irrigated area**
- 5,125 (66.2%)
- Mean eggs/day : 80
- Mean eggs/mosquito: 41±11.63

**Non-irrigated area**
- 2,612 (33.8%)
- Mean eggs/day : 33
- Mean eggs/mosquito: 21±5.61

**Fecundity was 96.2%** higher in irrigated area than non-irrigated area (T-test = 2.83, P = 0.002)

- In Kenya reported median survival time of 29 days (Gary and Forster 2001)
- The longer survival & higher fecundity in the irrigated area indicates that *An. gambiae* s.l is well adapted to the environmental conditions – vectorial capacity – malaria transmission intensity

# Limitations of study

- ***Anopheles*** **aquatic ecology study:**
  - Many small mosquito breeding water bodies might be overlooked
  - Lacks chemical & biological characterization of habitats
  - Lacks climate data
- **Survivorship study:**
  - Only wet season data was analyzed
  - Possible overestimated survival rates due to confined experiment

# Conclusions

- Environmental modification due to irrigation scheme significantly enhanced the malaria vectors:
  - ✓Breeding habitat diversity, positivity, and larval abundance
  - ✓Adult *An. gambiae* s.l survivorship and fecundity

## Recommendations

- Local-specific vector monitoring and surveillance systems should be design in WRD project areas
- Targeting major *Anopheles* breeding habitats might enable more efficient use of available resources to control malaria through LSM
- Supplementary interventions should be implemented in WRD areas
- Further research work
  - ✓Survivorship in different seasons, climate data, biological & chemical characteristics of larval habitat

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## Co-authors

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2. Prof. Delenasaw Yewhalaw
3. Dr. Solomon Kibret
4. Dr. Ming-Chieh Lee
5. Mr. Assalif Demissew

# Thank you!

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