Rice cultivation practices and malaria vector ecology: the need for cross-sector collaboration

Harrison Hardy – PhD student
Natural Resources Institute
University of Greenwich

Contact:
harrison.lambert@greenwich.ac.uk
@HardyMedEnto
The link between rice and malaria

• Rice agroecosystems provide habitats conducive to malaria vector breeding
  - Higher vector densities and biting rates in associated communities
  - Increased malaria incidence in communities adjacent to rice cultivation

• Africa is increasing its rice production capacity
What is SRI?

• System of Rice Intensification.

• A “set of interdependent agronomic practices that modify current plant, soil, water, and nutrient management” \(^4\).

• A climate-adapted methodology that aims to increase rice yields whilst reducing agricultural inputs.
What is SRI?

**SRI Rice**
- Seedlings raised in a nursery
- Planting of single seedlings per hill
- Wide grid spacing of plants
- Alternate wet and dry irrigation
- Regular hand/tool weeding
- Promotion of organic fertilisers

**Non-SRI Rice**
- Broadcast sowing of seeds
- Rainfed/irrigated flooded fields
- Multiple seedlings per hill
- Water controlled weeds/no weeding
- Non-uniform plant distribution
- Use of industrial fertilisers
The SRI agroecosystem is a fundamentally **different** environment
Mkindo irrigation scheme, Tanzania - Morogoro

- Four SRI and four non-SRI fields.
- Each field divided into four transects, with four sample points along each.
- Sampling commenced two weeks prior to rice planting and finished two weeks after harvest (Jan – May 2022).
- Three consecutive sampling days per week via larval dipping and emergence trapping.

SRI rice

Mkindo irrigation scheme, Morogoro, Tanzania

Non-SRI rice
Vector bionomics: Larval and adult density

Preliminary data and analysis

- SRI is associated with higher vector densities and productivity.
Vector bionomics: Species composition

Preliminary data and analysis.

SRI

- An. gambiae s.l.: 83.80%
- An. pharoensis: 13.20%
- An. funestus s.l.: 3%

Non-SRI

- An. gambiae s.l.: 54.80%
- An. pharoensis: 16.10%
- An. funestus s.l.: 19.40%
- An. coustani: 9.70%
SRI and malaria transmission

- The SRI agroecosystem appears to be a more productive habitat for malaria vectors.
  - Increased vector densities = enhanced biting rates and malaria transmission.

- Rice cultivation practice can affect vector populations and therefore malaria transmission.

\[ V = \frac{ma^2 b p^N}{-\log_e(p)} \]

Vectorial capacity
Medical entomologists and rice agronomists working together

• Rice production contributes to the malaria problem, and alternative practices can modulate this relationship.

• Currently, there is limited interaction between public health/entomology and the rice production sector.

• How can we move forward together?
Cross sector collaboration

• Rice fields can act as a *mosquito reservoir* that undermines malaria elimination and control efforts.

• Collaboration between those seeking to intensify rice production and those working towards malaria elimination is required.

• Rice farmers must be part of the conversation.
Routine vector population monitoring

• A need for cost effective, simple, and time-efficient methods with targeted control, if needed.

- Larval sampling creates difficulties with specimen transport and species identification.

- Emergence traps may provide a reliable alternative for regular monitoring.
Mosquito emergence trap

Hardy, H., et al. (2022)

Floating emergence trap

Fillinger, U., et al. (2009)

Aquatic emergence trap - NHBS

https://www.nhbs.com/aquatic-emergence-trap
Integrative control methods

• The promotion of mosquito control strategies that do not impinge on rice productivity.

  - Bti application in tandem with fertilisers.

  - Application of organic fertilisers with larvicidal qualities such as chicken manure.

  - AWD schedules sufficient to reduce mosquito populations.
• Bti mixed with fertiliser significantly reduced *An. gambiae s.l.* abundance.

• Rice yields were not affected.

• Greatest reduction was found when following normal fertiliser schedule.

Organic fertilisers – Chicken dung

- Chicken dung exposure significantly reduces *An. gambiae s.l.* adult production.
- Chicken dung is an effective fertiliser for rice.
- Promotes predators of mosquitoes and rice pests.

Mosquitocidal AWD schedules

- Where AWD is applied, irrigation schedules are highly variable.
- Up to five dry days may be required to kill 100% of larvae.
- Effects on crop yield should be considered, but SRI research suggests AWD is beneficial.

Key messages

• Rice cultivation increases malaria transmission and cultivation practices can modulate this relationship.

• Involvement of the rice production sector is critical for reducing malaria vector populations and mosquito control.

• Rice agronomists, medical entomologists, and policy makers must work together.

• Available mosquito control interventions should be applied, but they must not impinge on rice production.
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harrison.lambert@greenwich.ac.uk
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