Climate-adapted cultivation techniques can increase malaria vector production from rice fields

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The link between rice and malaria

- **Rice agroecosystems provide habitats conducive to malaria vector breeding[1]**

  - Higher vector densities and biting rates in associated communities[2]

  - Increased malaria incidence in communities adjacent to rice cultivation[3]

- **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?

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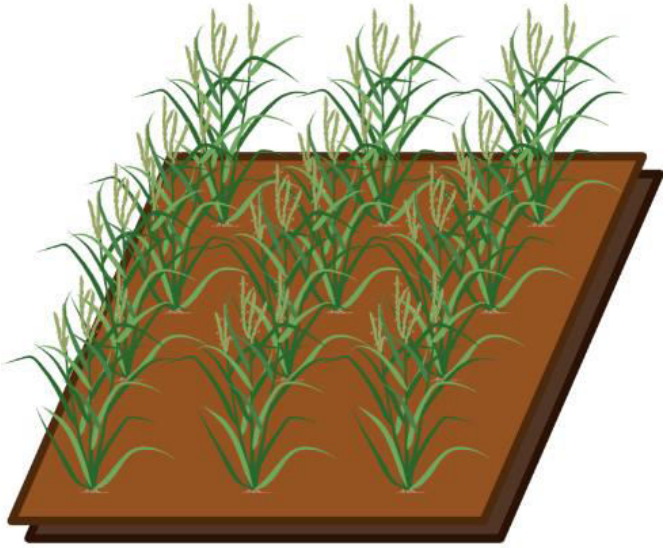
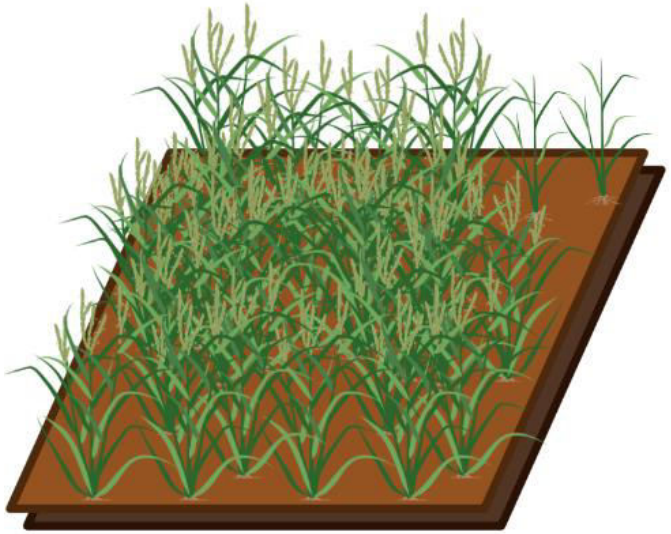
SRI Rice



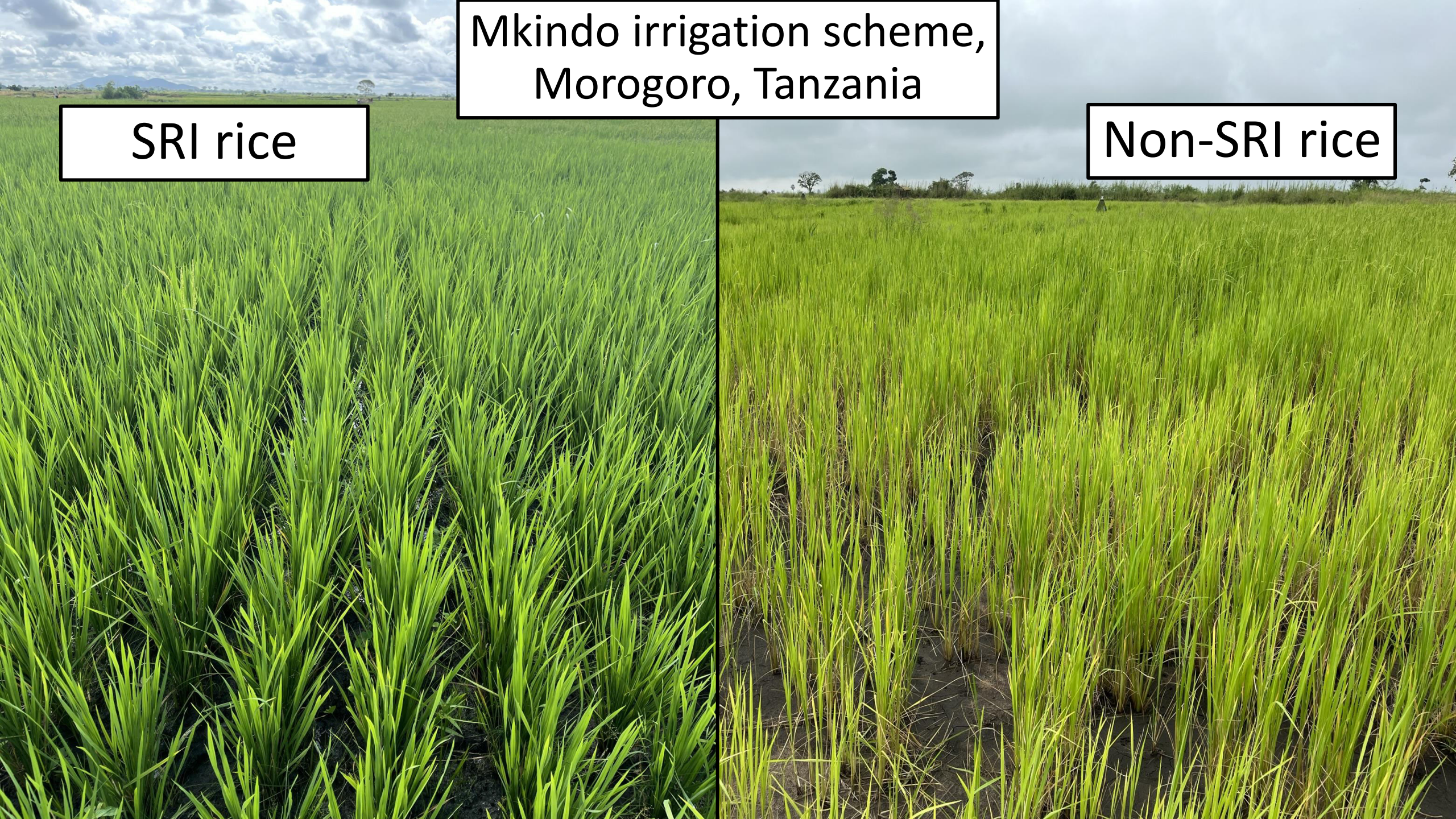
- Seedlings raised in a nursery
- Alternate wet and dry irrigation
- Planting of single seedlings per hill
- Regular hand/tool weeding
- Wide grid spacing of plants
- Promotion of organic fertilisers

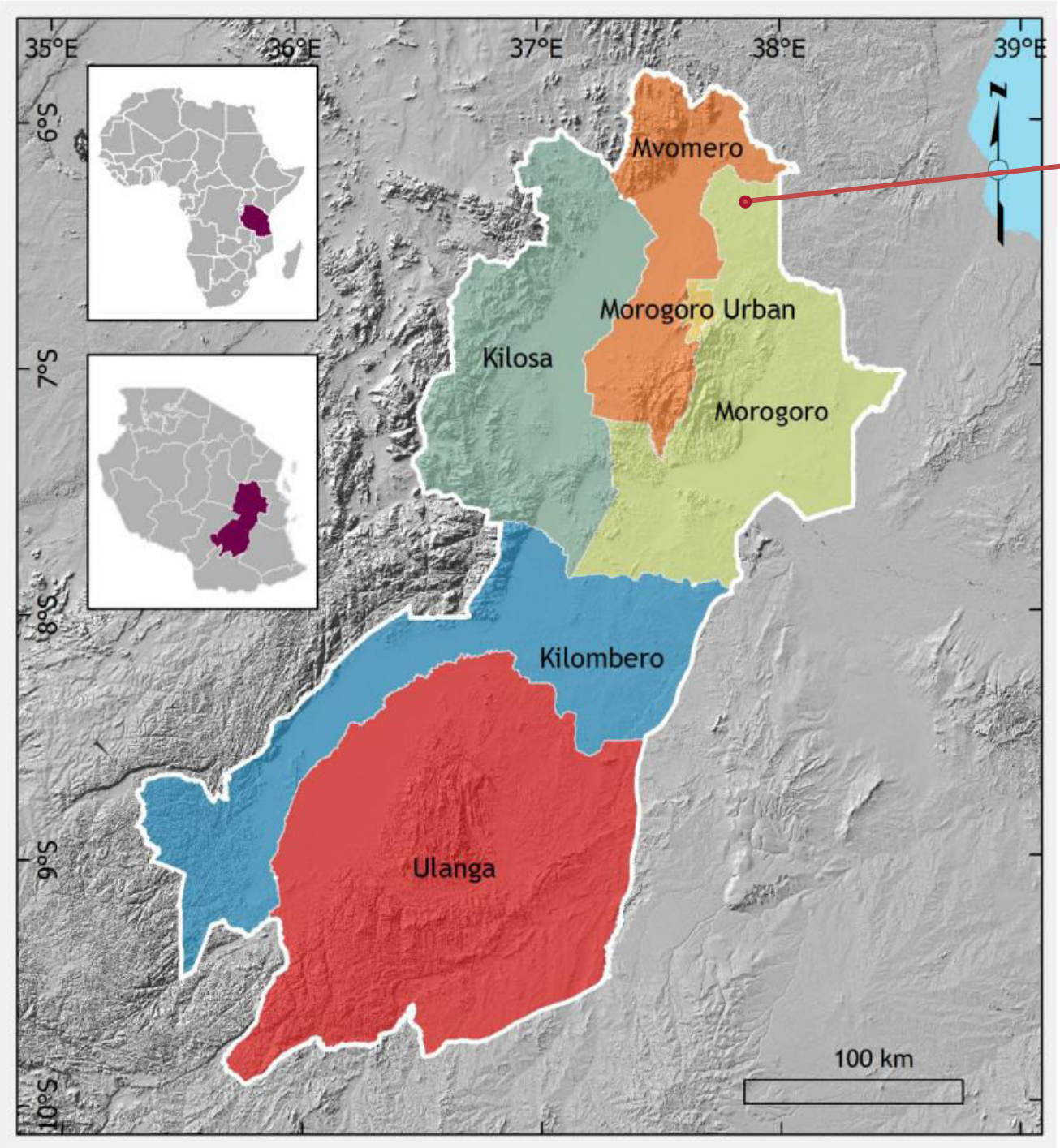
Non-SRI Rice



- 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,
Morogoro, Tanzania
SRI rice
Non-SRI rice



Mkindo irrigation scheme, Tanzania

- Four SRI and four non-SRI fields.

- Morogoro

- 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.

Image: Ojoyi et al. (2015) *Tropical Conservation Science,* 8(3):662-680.

Mosquito emergence trap

Hardy, H., *et al.* (2022)

Floating emergence trap

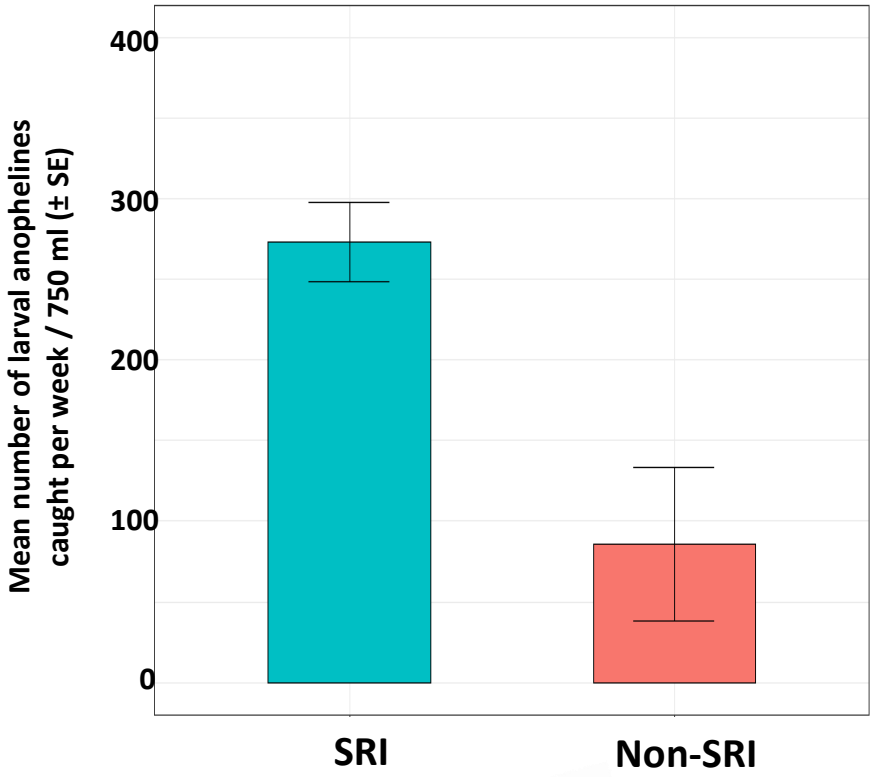
Fillinger, U., *et al.* (2009)

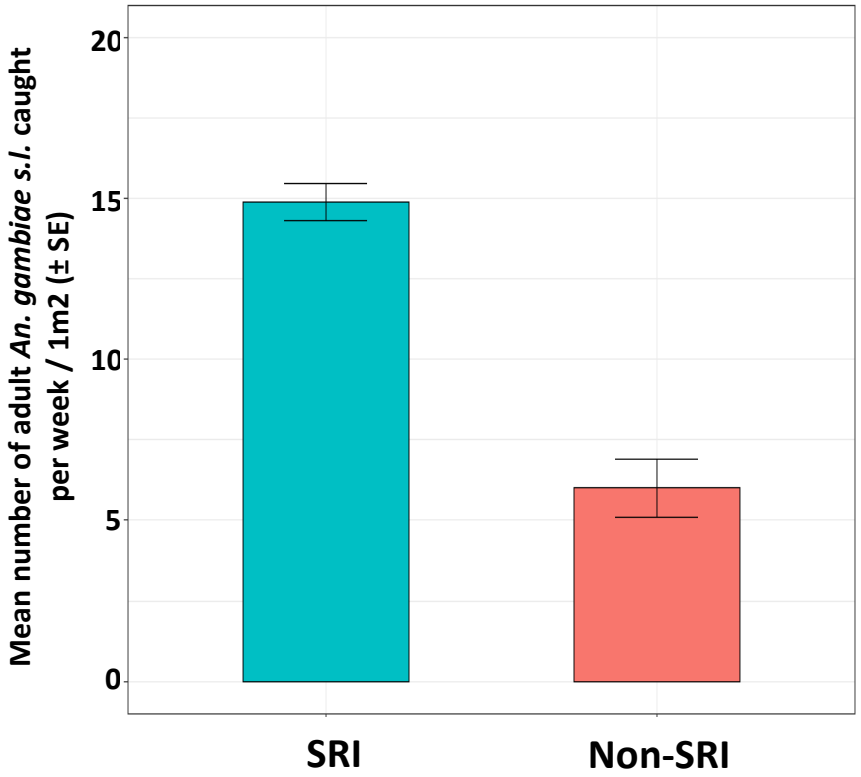
Aquatic emergence trap - NHBS

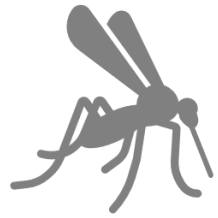
https://www.nhbs.com/aquatic-emergence-trap

Vector bionomics: Larval and adult density

- SRI is associated with significantly higher vector densities.
- > 2X in SRI!
- 150K adults / ha in SRI.

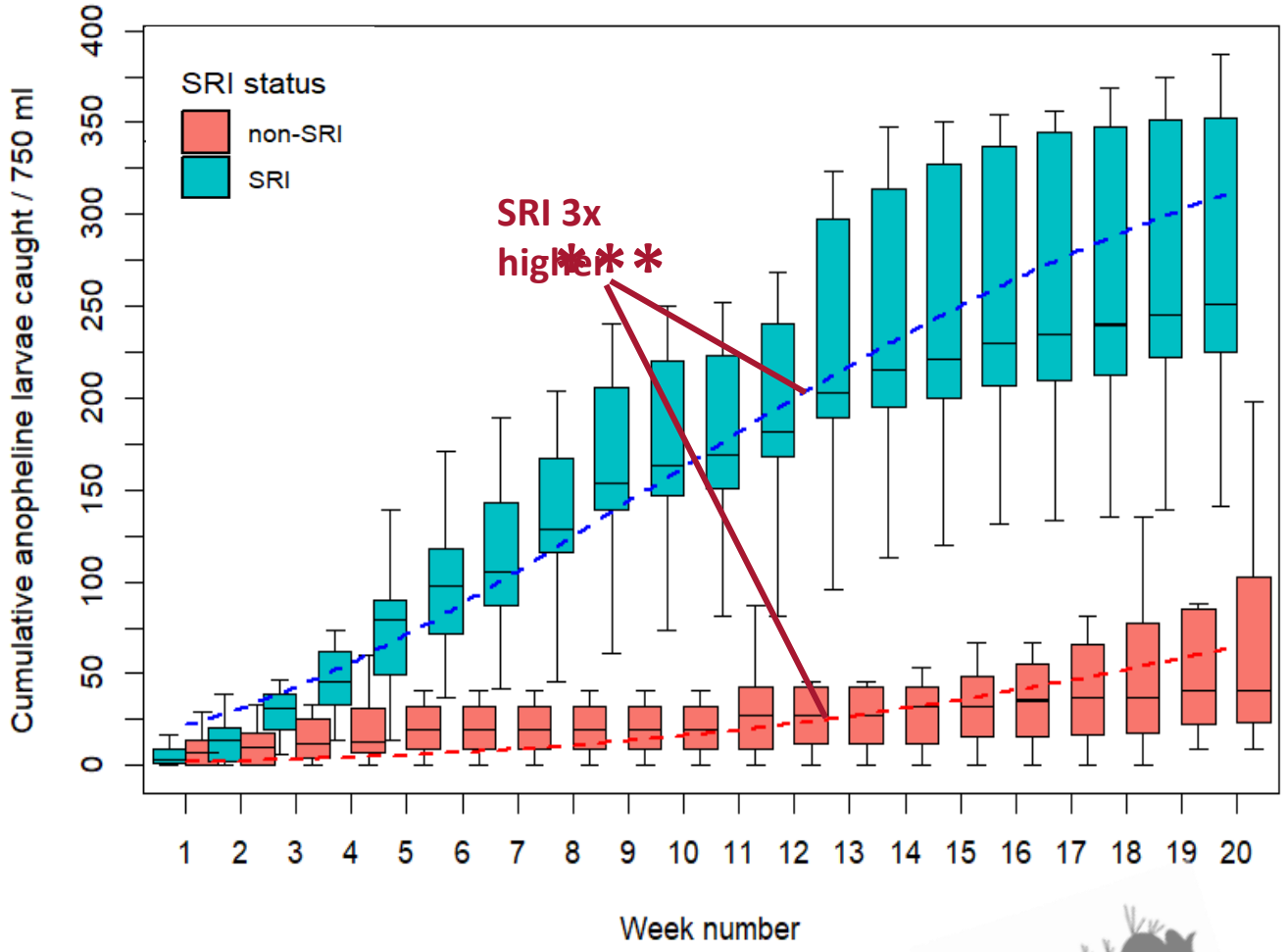






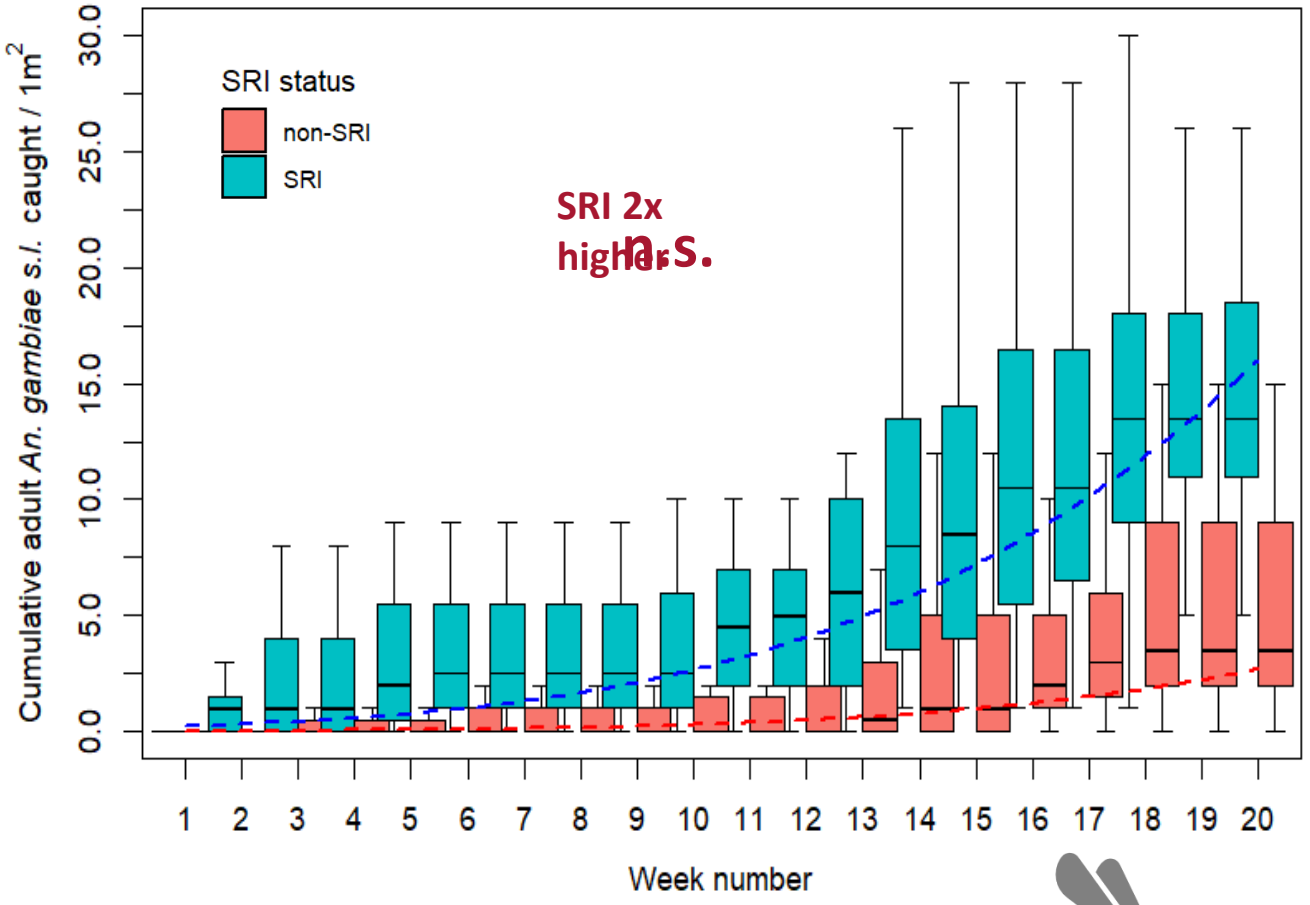
Larval anopheline population growth

- Early on, larval population growth diverges between SRI/Non-SRI.
- SRI is associated with significantly higher larval population growth rates.
- Maximal growth rate ~ 3 x greater in SRI.



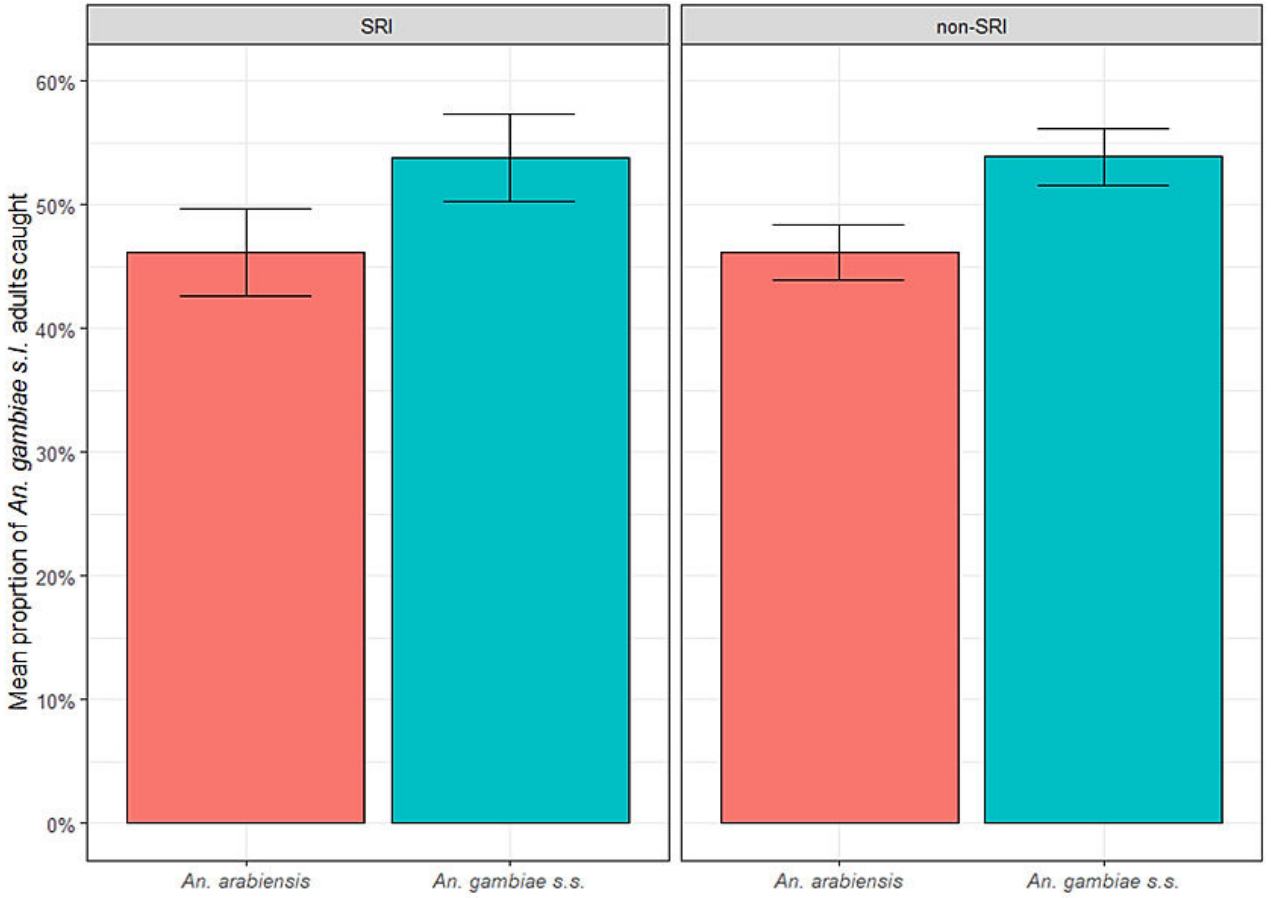
Adult anopheline population growth

- Growth rate diverged towards the middle of the rice growth period.
- SRI growth rate higher but not significantly different compared to Non-SRI.
- Maximal growth rate ~ 2 x greater in SRI.



Adult species composition

- *An. gambiae s.l.* comprised majority of the mosquitoes caught.
- No significant difference in the proportion of *An. gambiae s.s.* and *An. arabiensis* between SRI and Non-SRI.



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.

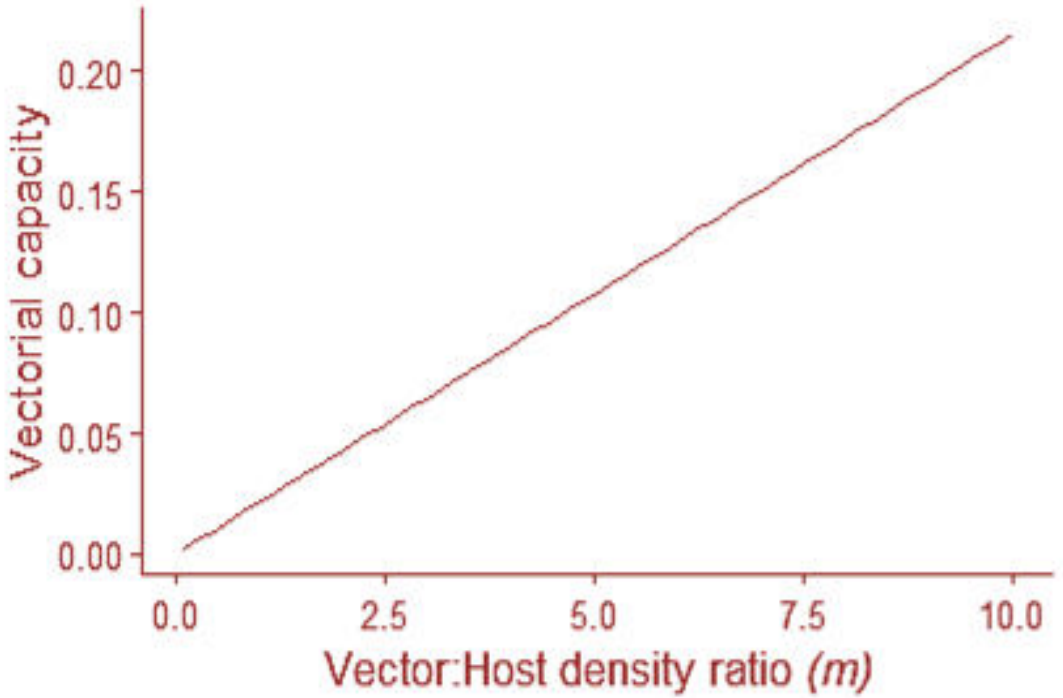
$$V = \frac{ma^2bp^N}{-log_e(p)}$$

Vectorial capacity

- **Why is this occurring? Canopy structure; predator ecology; habitat availability; habitat attractivity.**

SRI and malaria transmission

- On average, SRI produced 148% more adult malaria vectors.
- Vector:Host density ratio (*m*) has a positive linear relationship with vectorial capacity.
- Holding all other factors constant, a 148% increase in vector density leads to a corresponding increase in vectorial capacity.



Key takeaways

- **SRI rice fields can produce a greater number of malaria vectors compared to more conventional cultivation methods.**

  - Around double the number from SRI and at a greater growth rate.

- **SRI practice may unintentionally exacerbate malaria transmission burden.**

  - We need to focus on rice intensification methods that don't concurrently intensify malaria.

- **Modification of cultivation practice to control or not enhance vector populations is critical but must not impinge on yields.**

Big picture – closing remarks

- **To meet the dual demands of greater rice production and malaria elimination in Africa, we need to work together.**

  - The rice production industry, rice agronomists, medical entomologists, and policy makers must work together.

- **The rice production industry and associated research bodies need to take responsibility for their *possible* role in the *potential* exacerbation of malaria transmission.**

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

Thank you

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