Rice intensification: could climate change interventions help African malaria elimination?

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Impacts of rice cultivation on malaria vectors

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Rice production, area and demand in Africa

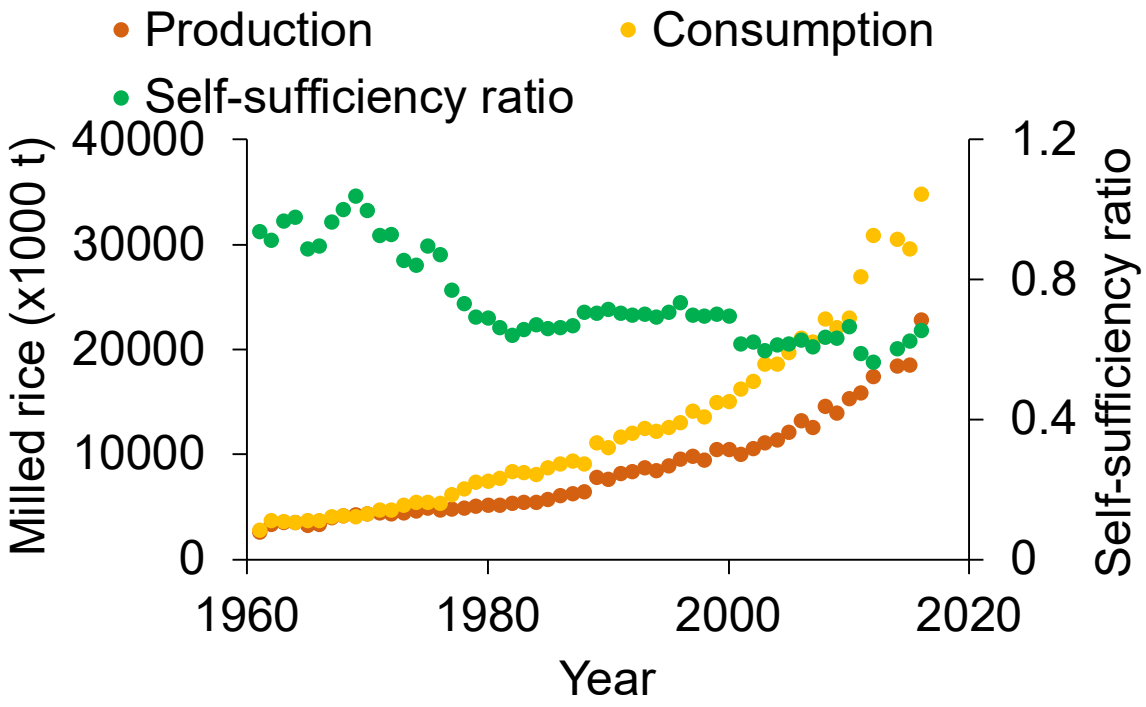


Fig 1: Production and demand in rice

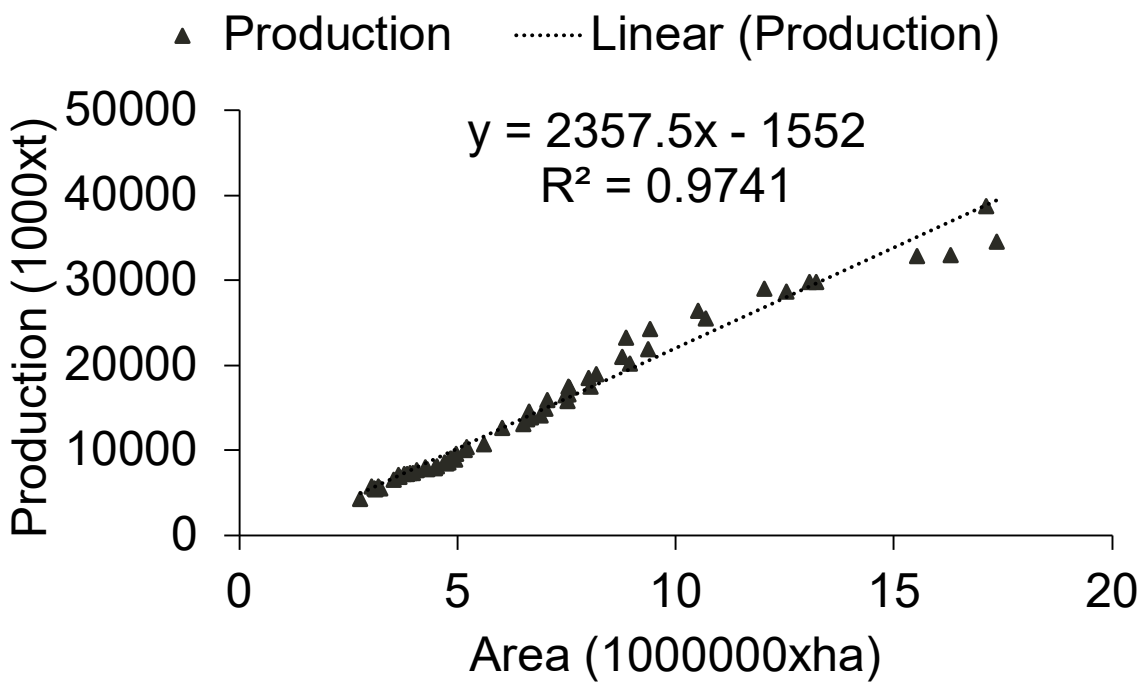


Fig 2: Production and area of rice

Rice production systems in Africa

Three major rice production systems in Africa.

- **Irrigated system with total water control** on large and small irrigated perimeters
- **Rainfed upland without water control**
- **Rainfed lowland with partial or no water control**

Fig 3. Irrigated system (A), rainfed upland (B) and rainfed lowland (C)

Rice production systems, yield, and yield gaps

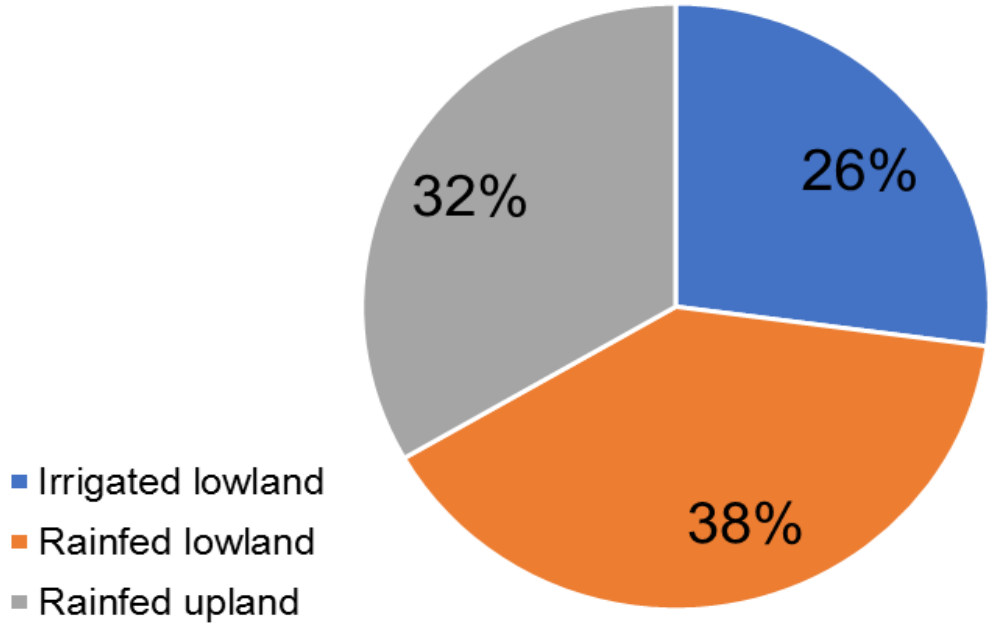


Fig 4: Rice production systems

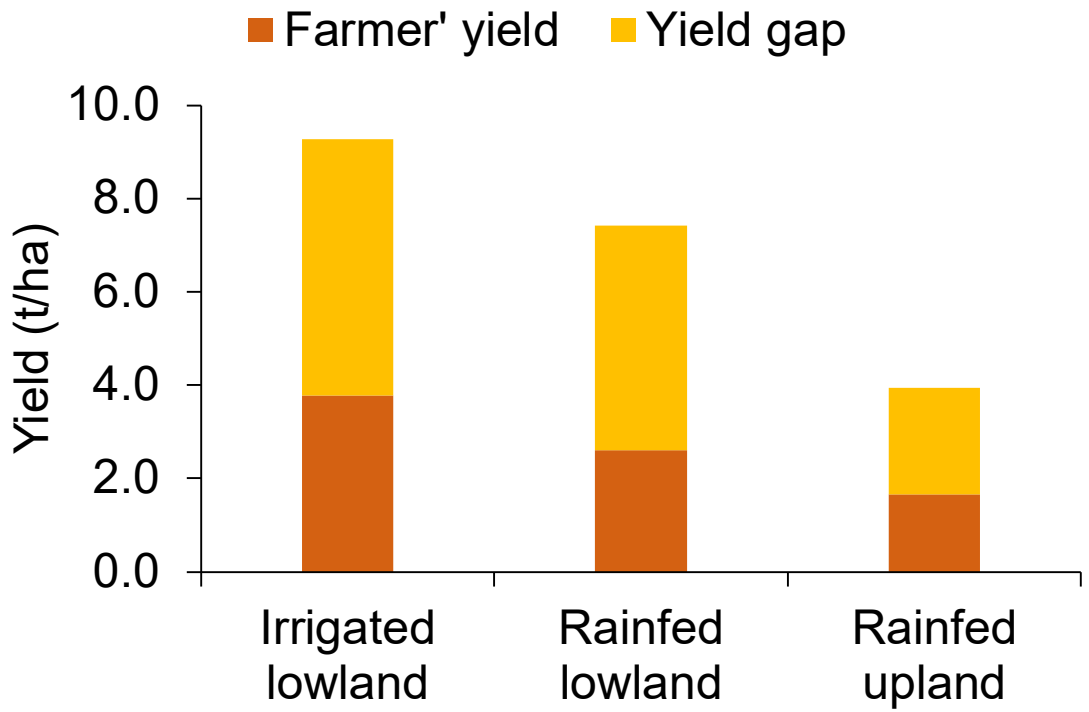
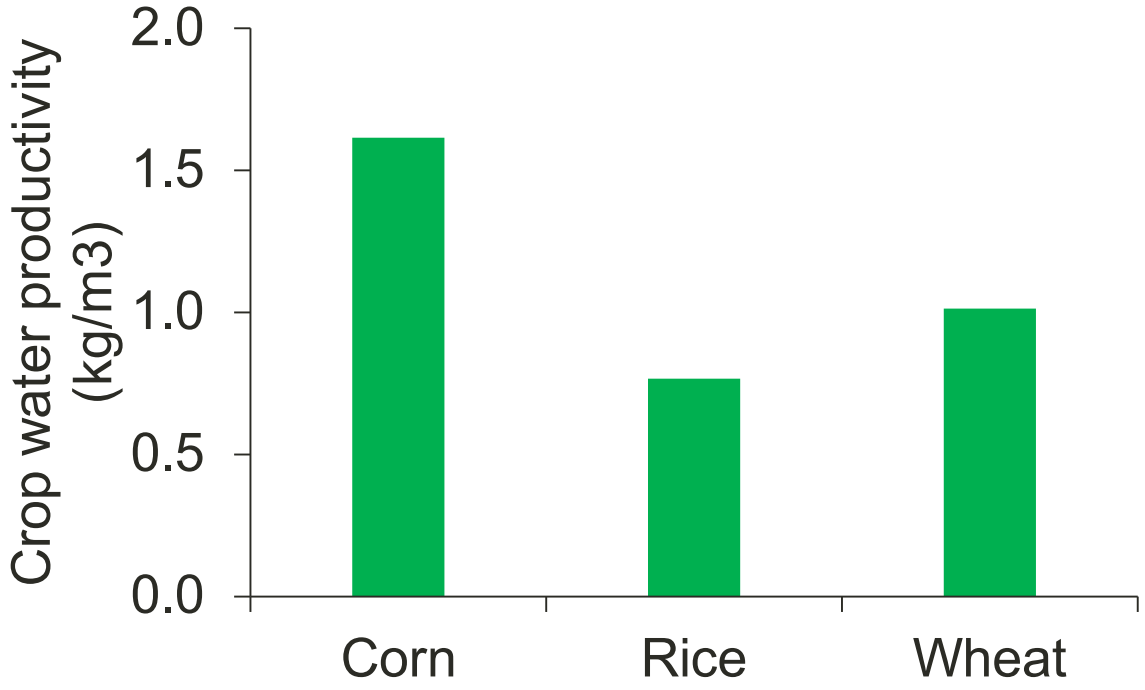


Fig 5: Rice yield and yield gap

Crop water productivity and greenhouse gas emission



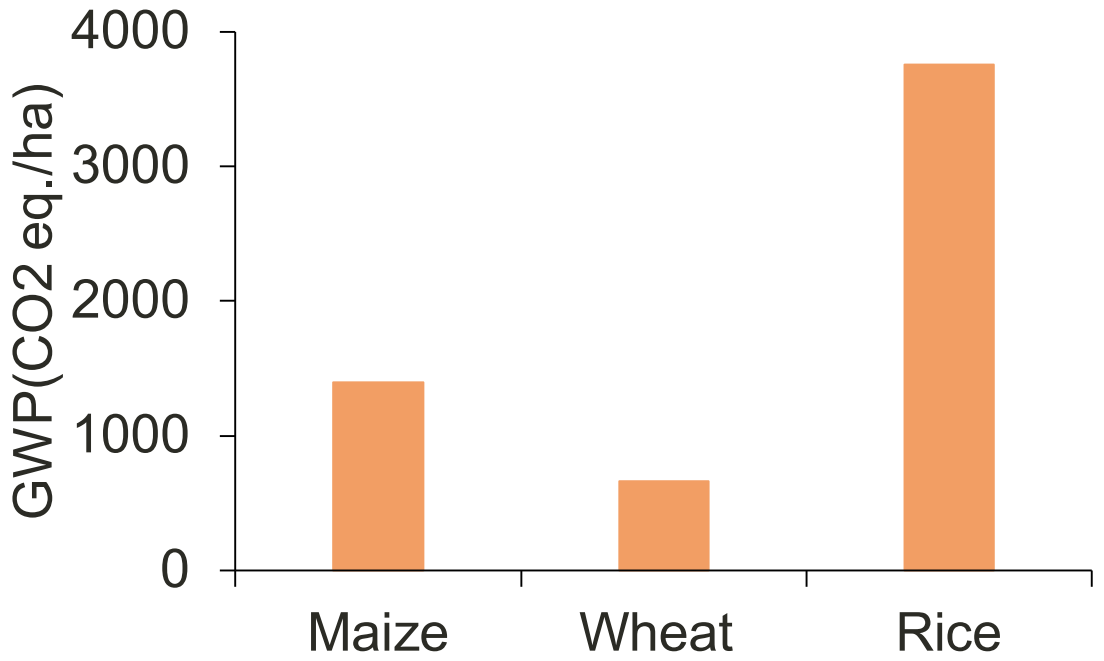


Fig 6: Crop water productivity (left) and greenhouse gas emission (right) of major cereals

Rice fields – a threat to malaria elimination

Rice fields are ideal breeding sites for *An. gambiae* s.l. mosquitoes

An. gambiae s.l. are the most efficient malaria vectors

However, previous reviews conducted in 1990-2000s in East & West Africa found **the paddies paradox**:

> Rice fields generate a large amount of malaria vectors, but the amount of malaria in rice communities remains unaltered or is decreased.

Re-assessing paddies paradox: a systematic review

Entomological inoculation rate

RR 2.03 (1.02 – 4.06) p=0.045 — Greater EIR in rice areas = mosquitoes are not harmless

Malaria prevalence before 2003

RR 0.82 (0.63 – 1.06) p=0.131 — Rice not associated with increased malaria prevalence

Malaria prevalence after 2003

RR 1.73 (1.01 – 2.96) p=0.045 — Greater risk of malaria infection in rice villages

Mosquito larvae sampling:

1 hectare of rice can make **> 5 million *Anopheles* females** per cropping season

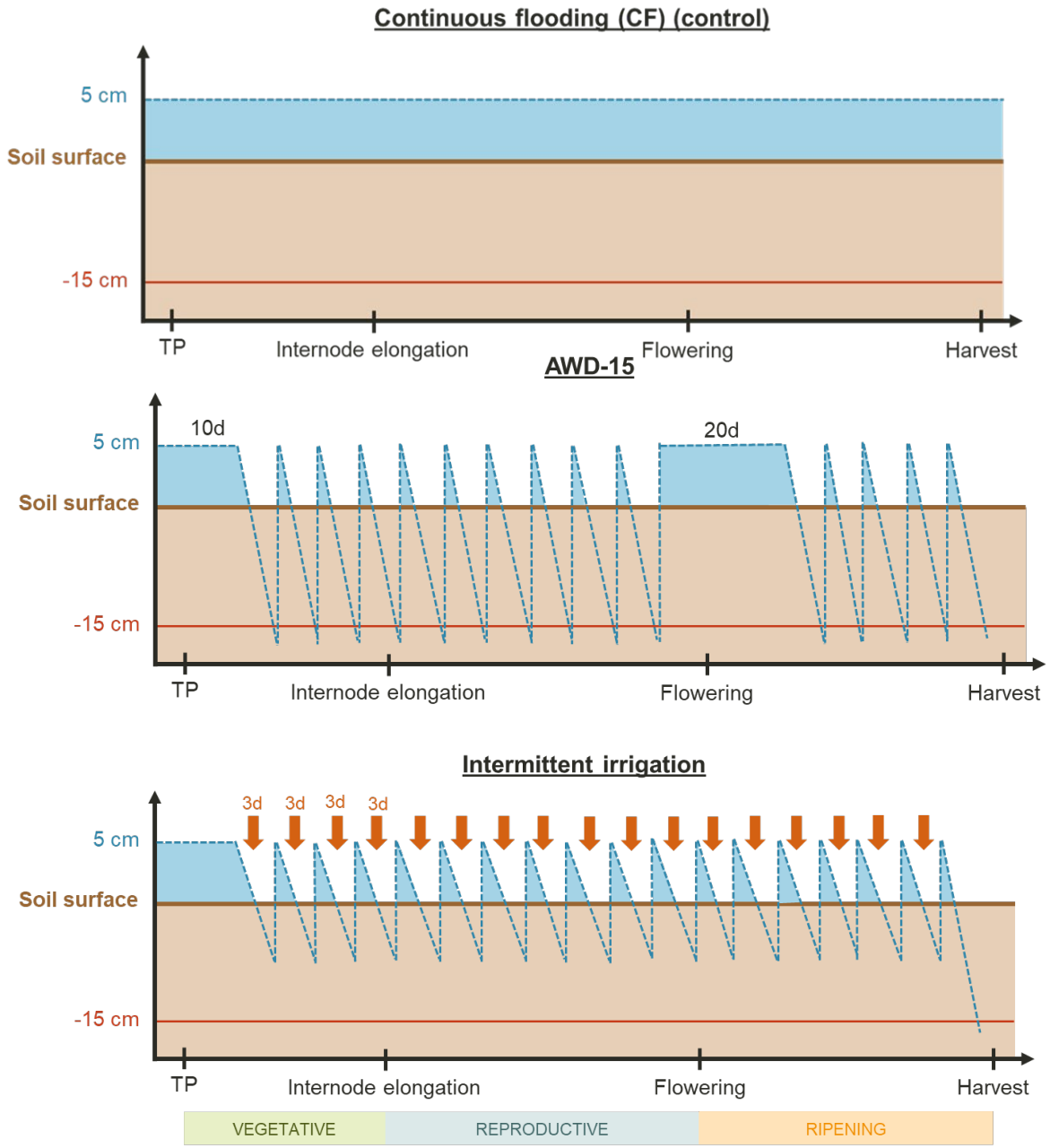
Objective

To identify rice intensification strategies that :

a. Increase rice yield
b. Reduce water use
c. Increase water productivity
d. Reduce greenhouse gas emission
e. Reduce malaria transmission potential

Experiment - Water & nutrient management

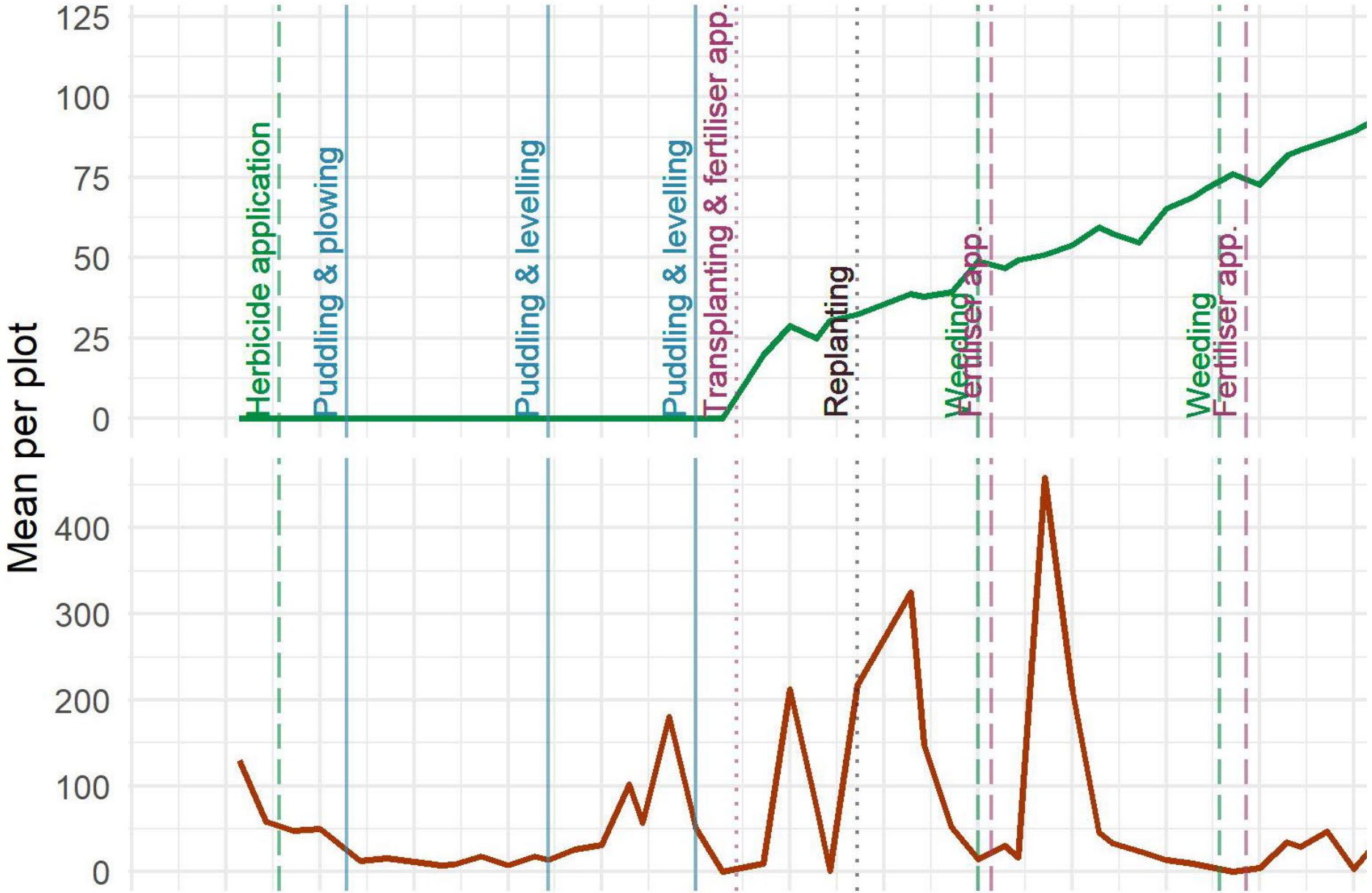
Treatment	Water management	Nutrient management
T1 (control)	CF	Standard
T2	AWD-15 (10 DAT)	Standard
T3	AWD-15 (2 DAT)	Standard
T4	Intermittent irrigation	Standard
T5	CF	No fertiliser
T6	CF	Forced drainage prior application
T7	CF, without rice cultivation	No fertiliser



Experiment - Water & nutrient management

Treatment	Water management	Nutrient management	Yield (t/ha)	Water productivity (kg/m3/ha)	Pupae
T1 (control)	CF	Standard	5.7 a	0.73 bc	0.69
T2	AWD-15 (10 DAT)	Standard	5.6 a	1.05 ab	0.42
T3	AWD-15 (2 DAT)	Standard	5.7 a	1.75 a	0.27
T4	Intermittent irrigation	Standard	6.2 a	0.56 b	0.31
T5	CF	No fertiliser	3.0 b	0.33 c	0.11
T6	CF	Forced drainage prior application	7.3 a	1.01 ab	0.28
T7	CF, without rice cultivation	No fertiliser	-	-	0.08

Rice field monitoring and mosquito



Conclusions

1) Paddies paradox

Rice brings more malaria vectors, which are **not harmless**
If rice farmers had protection and fewer mosquitoes, they would be even better off

2) Estimating the vector productivity of rice fields

~ 5 million adult *An. gambiae* s.l. produced in 1 hectare of rice in 1 cropping season

3) Crop management

- Alternate wetting and drying reduced mosquito density and increased water productivity
- Fertilizer application increased mosquito density and water productivity
- Puddling and transplanting appeared to increase mosquito density
- Further studies being conducted on the effects of field operations on mosquito density
- Mosquito sampling requires more time and labour than agronomic data collection
- A simple tool to estimate mosquito density from rice fields in needed for agronomist to integrate mosquito sampling in their work.

Thank you

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