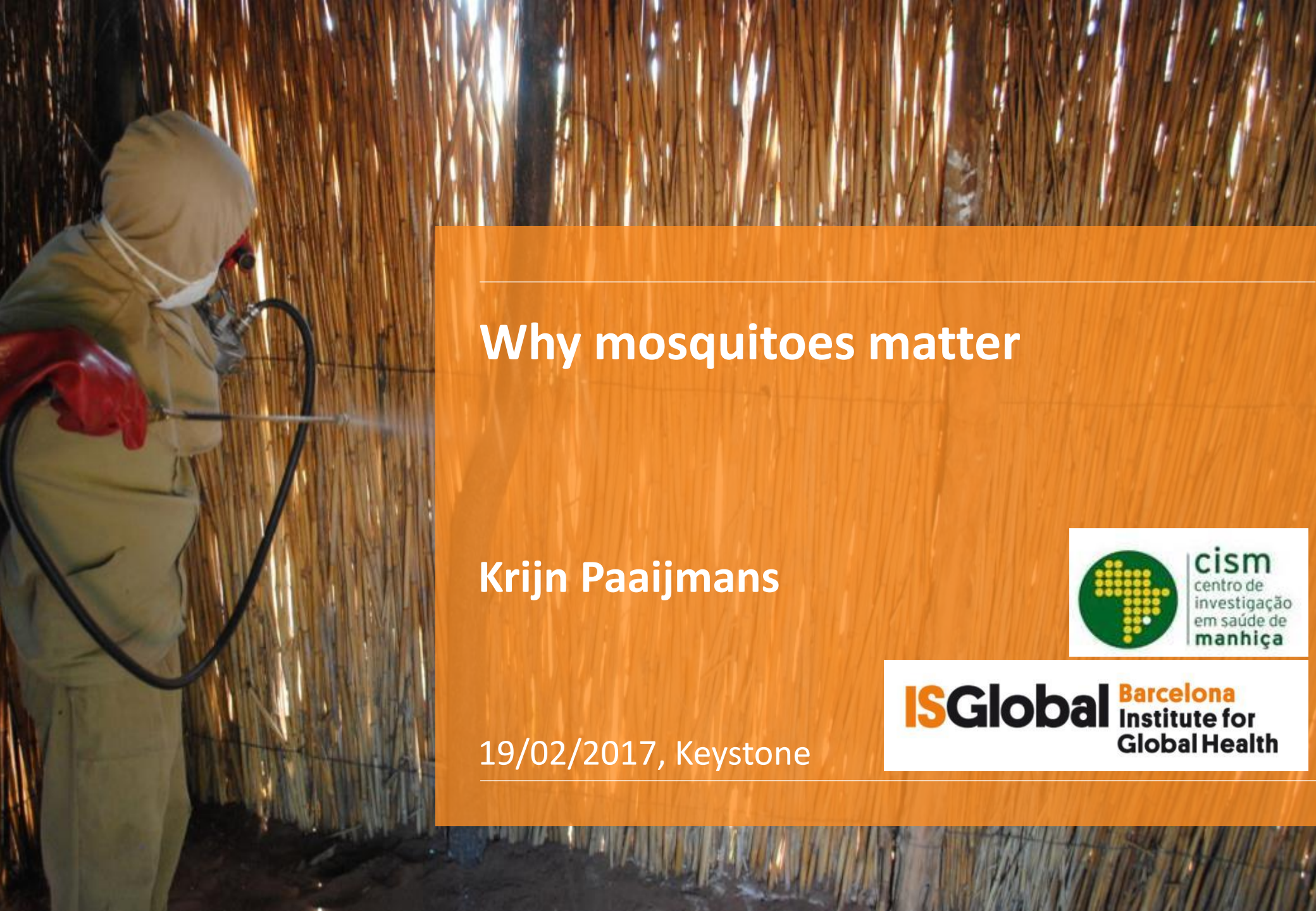

Why mosquitoes matter

Krijn Paaijmans

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19/02/2017, Keystone

Why mosquitoes matter

- They transmit infectious diseases
- Vector control is an important component in the overall strategy to control and ultimately eliminate malaria

Key concepts entomology

① **R**esistance to insecticides
② **R**esidual transmission

} Double *R* crisis

Surveillance

③ **T**ools

Why are mosquitoes so successful?

r-strategists

live in unstable environments and produce many offspring with a low survival rate

How do we fight the bite

Frontline tools: Universal coverage with LLINs and/or IRS

LLIN: Long-Lasting Insecticidal Nets

IRS: Indoor Residual Spraying

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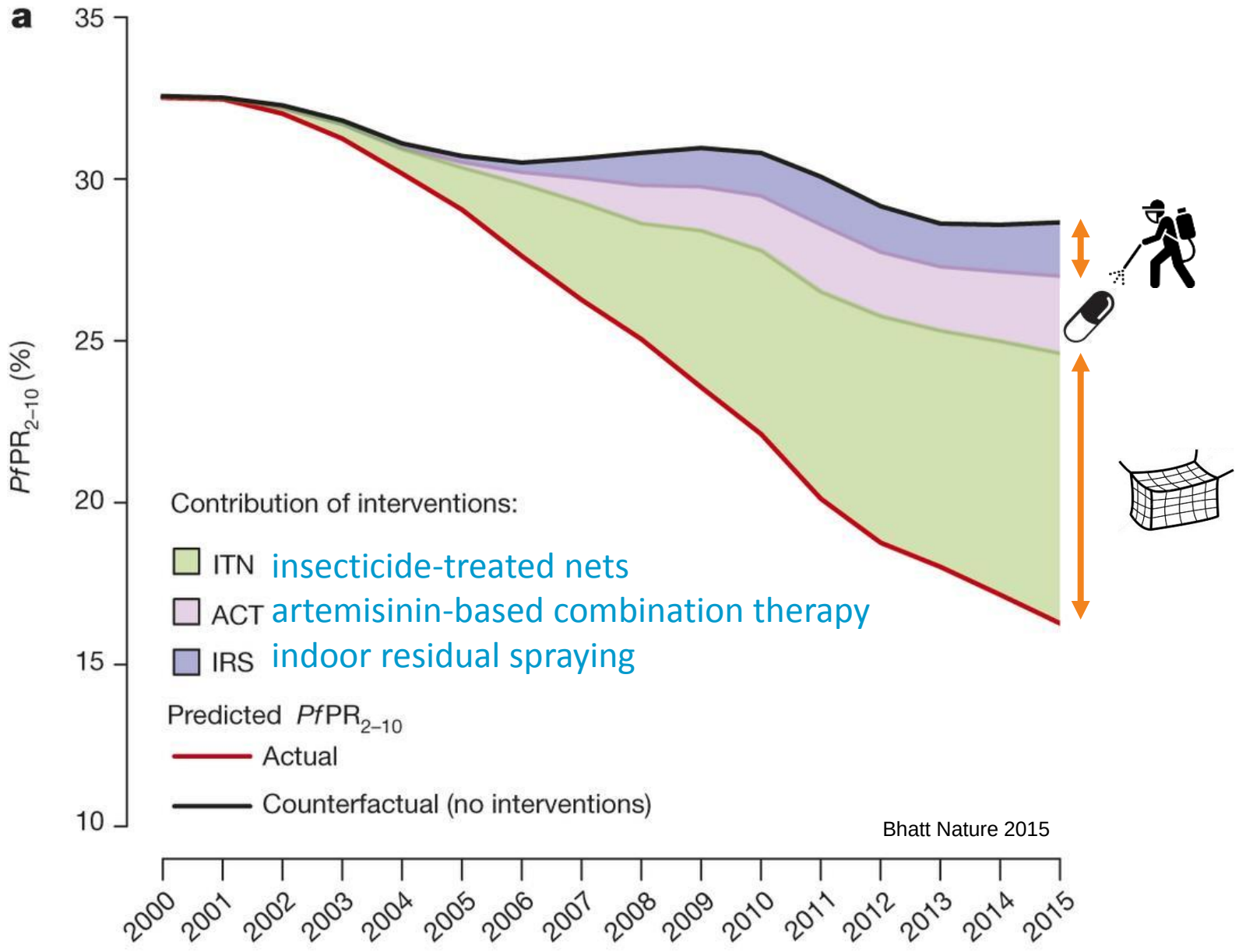
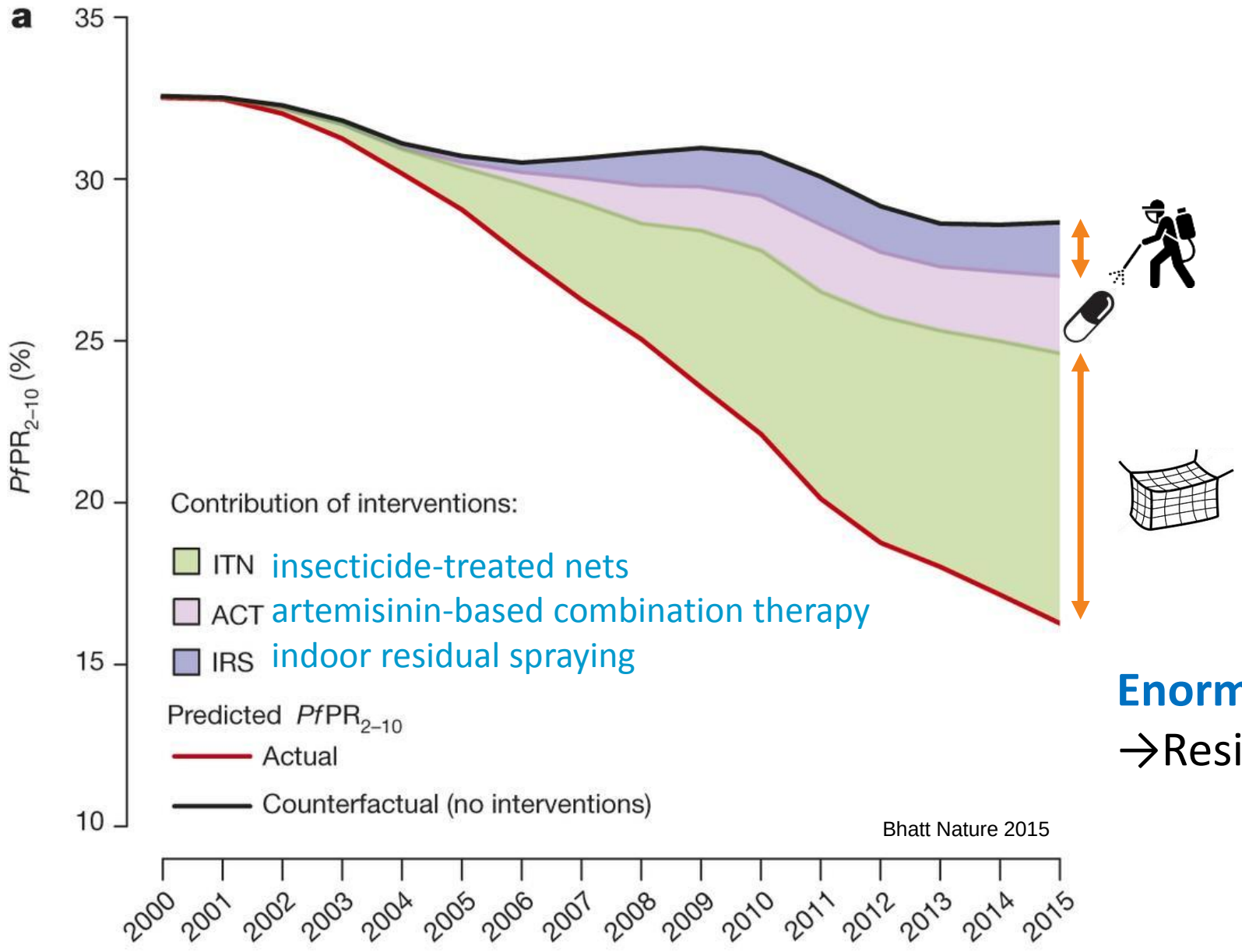
Our front-line tools are very successful



Bhatt Nature 2015

Our front-line tools are very successful



Enormous pressure

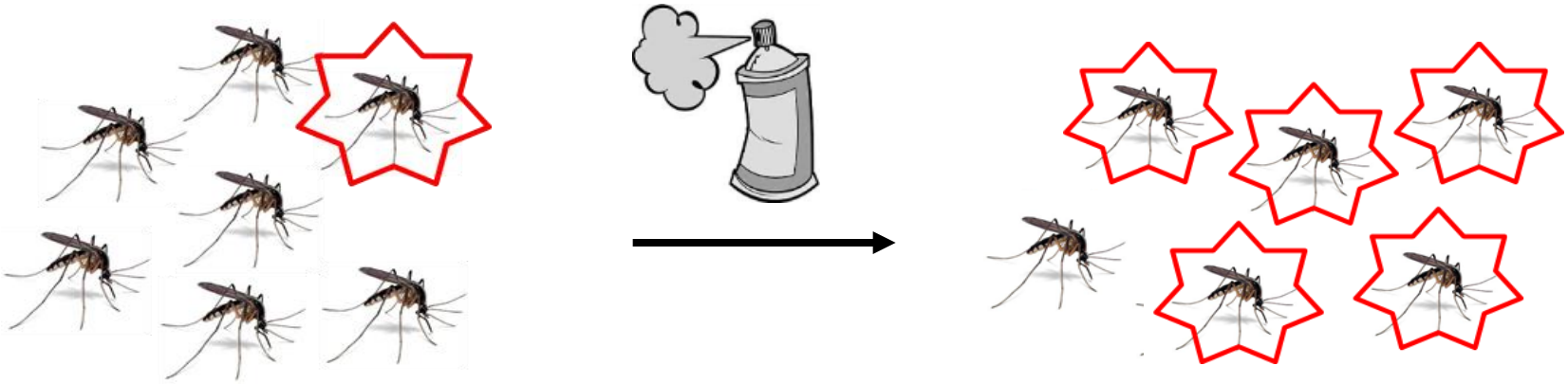
→Resistance

How can they counteract so rapidly?

r-strategists

more likely to have 1 mosquito with a mutation

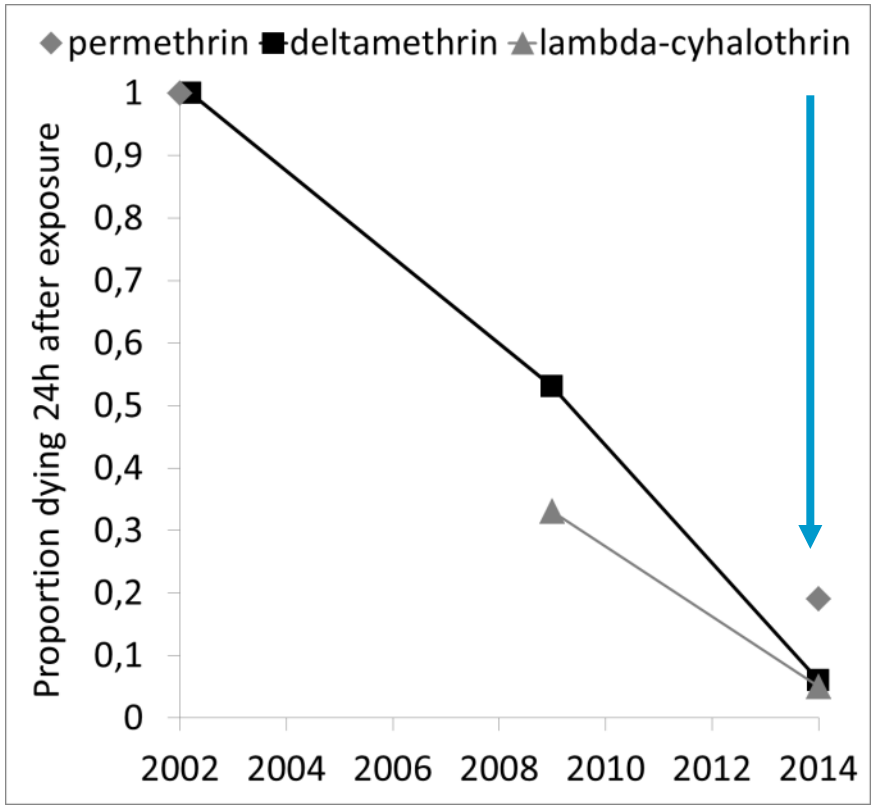
How can they counteract so rapidly?



Courtesy of Silvie Huijben

They counteract rapidly - Mozambique

Resistance to pyrethroids



Glunt 2015 Malaria Journal

Nearly fixed…

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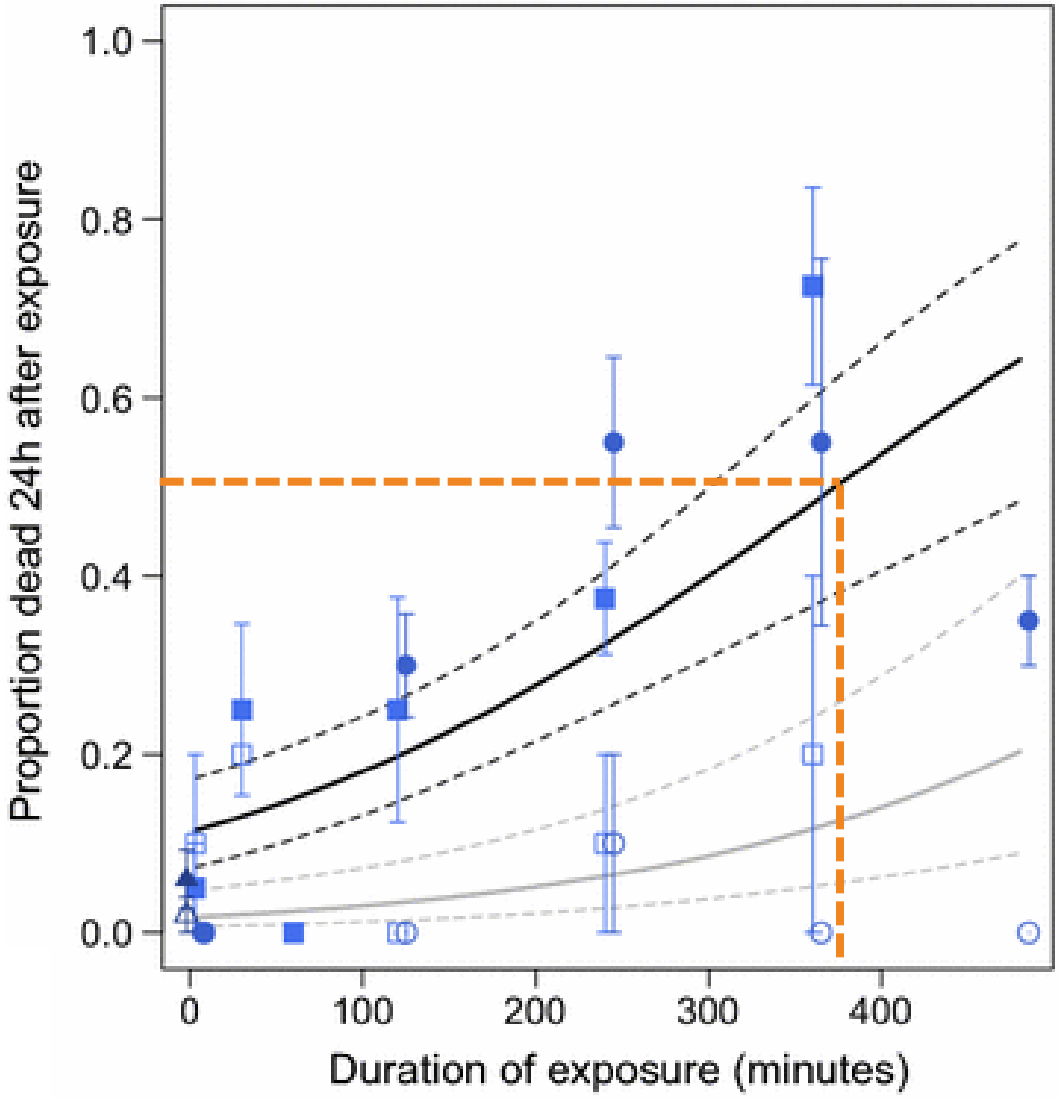
How can they counteract so rapidly?

- Mutations in the target proteins (target-site insensitivity)
- Lower penetration or sequestration of the insecticide
- Increased biodegradation of the insecticide due to enhanced detoxification activities (metabolic resistance)

Resistance to pyrethroids as a result of the **kdr mutation** (2-3-fold increase) may not have an operational impact, but the > 1000-fold increases due to **P450**-based metabolic resistance likely has (Hemingway 2014)

Intensity of resistance - Mozambique



An. funestus
PermaNet 2.0

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They counteract rapidly

A

"Today there is no country in Africa where the vectors remain fully susceptible to pyrethroids"

pyrethroids

B

carbamates

C

DDT

D

New insecticides for public health >2022

organophosphates

Key concepts entomology

① **R**esistance to insecticides
② **R**esidual transmission

} Double *R* crisis

Surveillance

③ **T**ools

Why are mosquitoes so successful?

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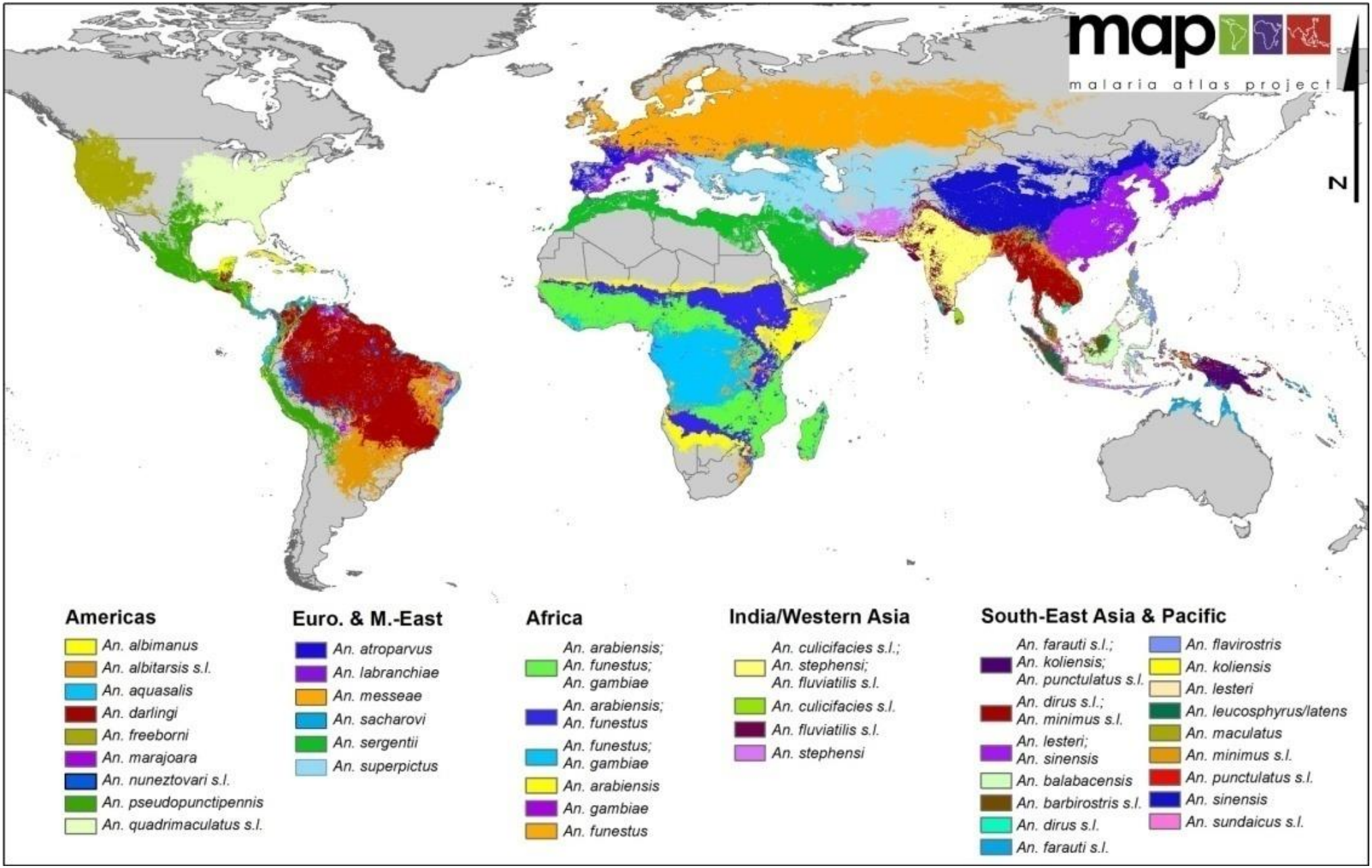
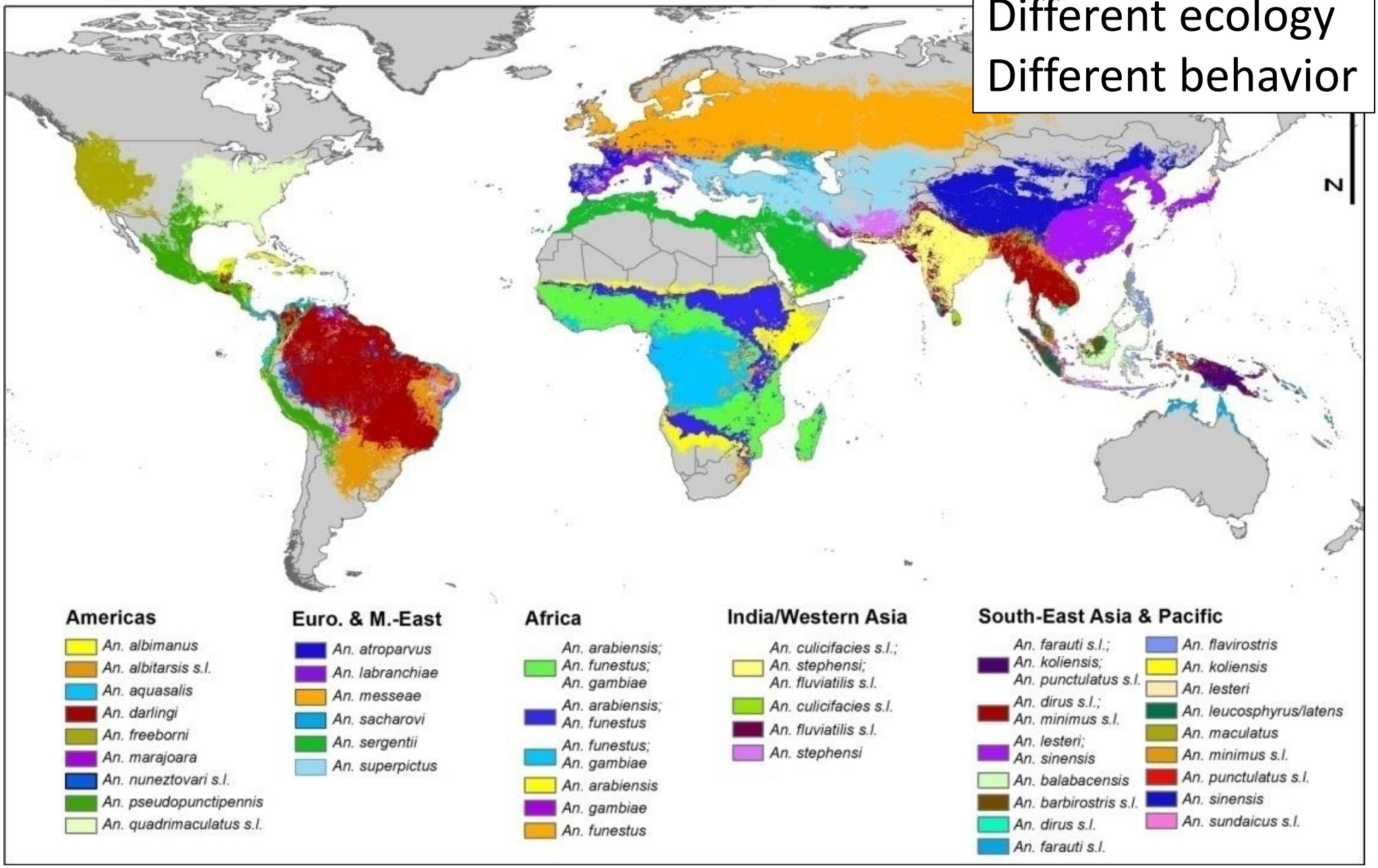
live in unstable environments and produce many offspring with a low survival rate

Why are mosquitoes so successful?



Why are mosquitoes so successful?

>100 species
Different ecology
Different behavior



What should entomologists measure?

That what really matters:

Vector-human contact

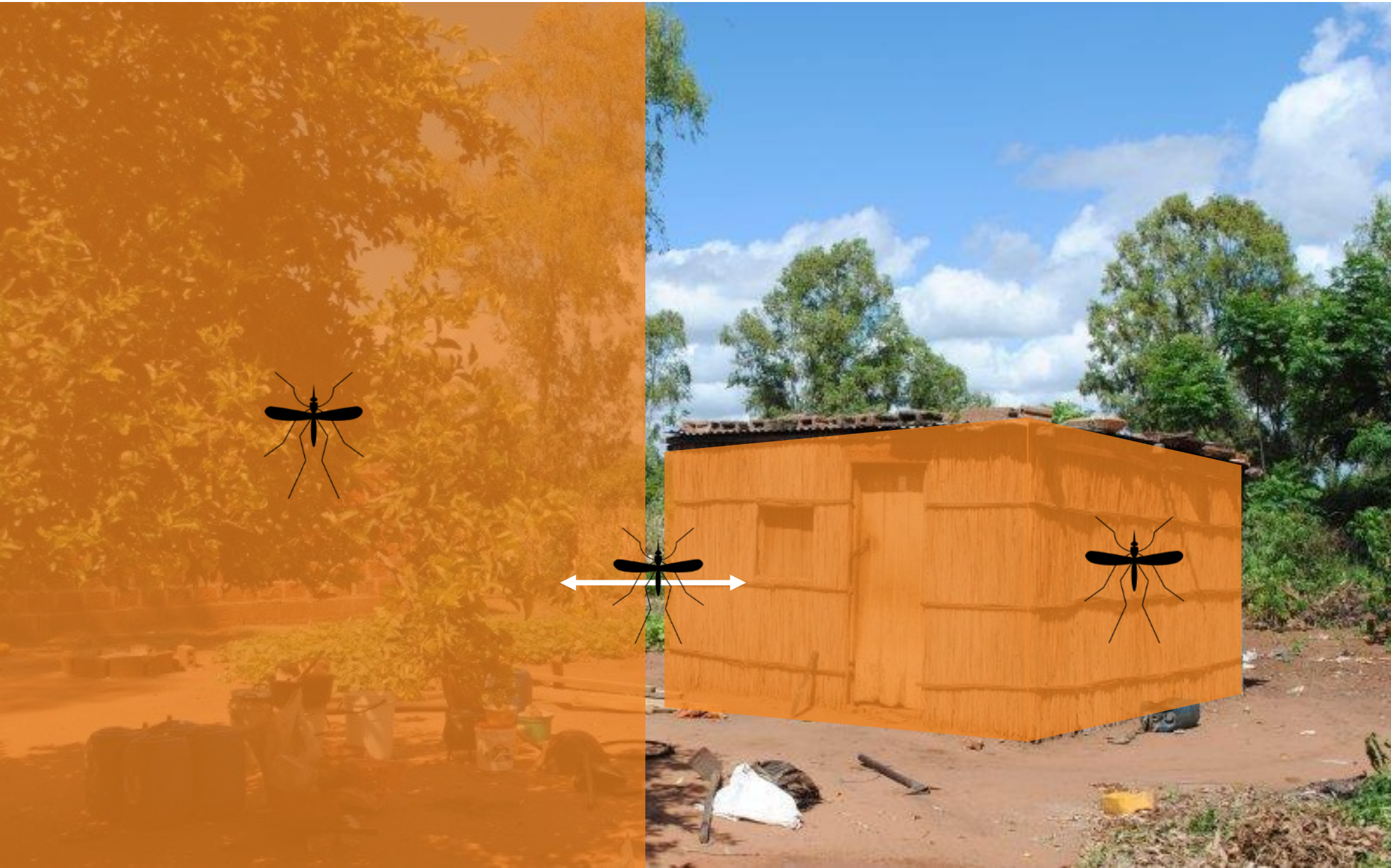
When and where does malaria transmission occur?

Vector-human contact - key concepts

Vector-human contact - key concepts

Vector-human contact - key concepts

Vector-human contact - key concepts



Vector-human contact - key concepts

Exophagic Feeding
Exophilic Resting

Endophagic Feeding
Endophilic Resting

Vector-human contact - key concepts

Vector-human contact - key concepts

Vector-human contact - key concepts

Vector-human contact - complex

Residual malaria transmission

Persistence of transmission after good coverage has been achieved with high quality vector control interventions to which local vectors are fully susceptible

World Health Organization

Let's look at some hypothetical examples

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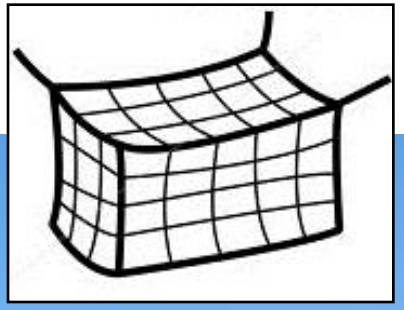
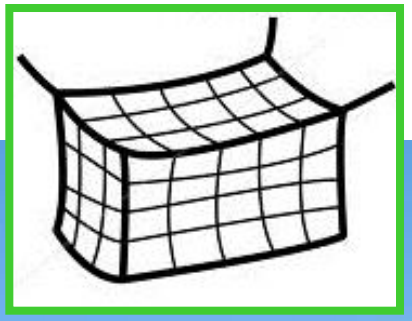
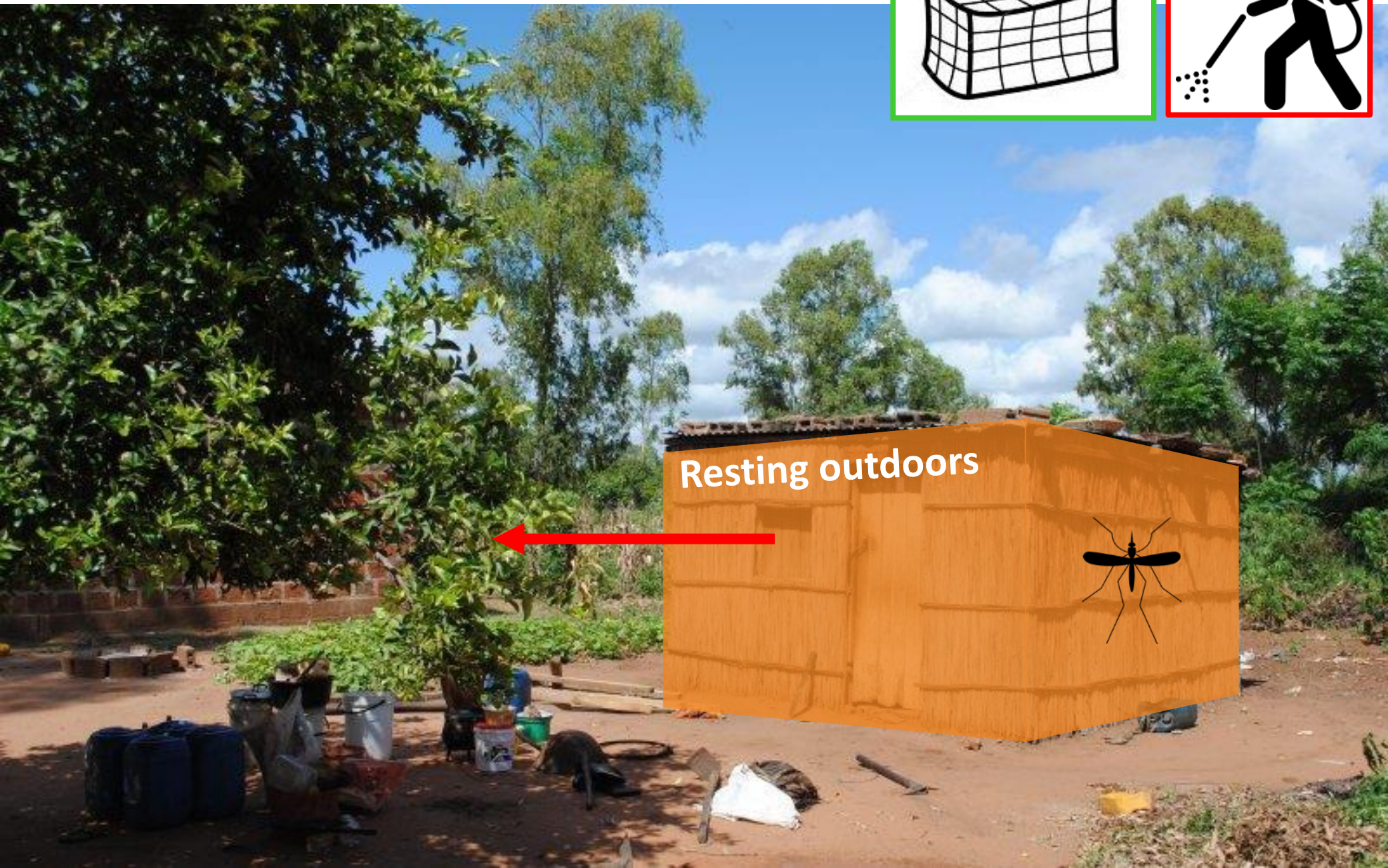
Vector-human contact



Vector-human contact



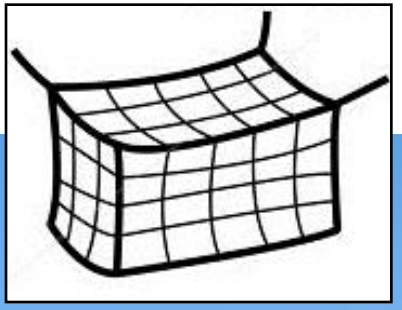
Vector-human contact



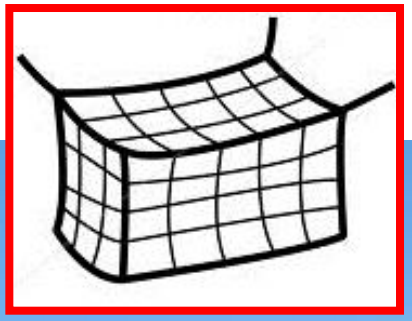
Vector-human contact

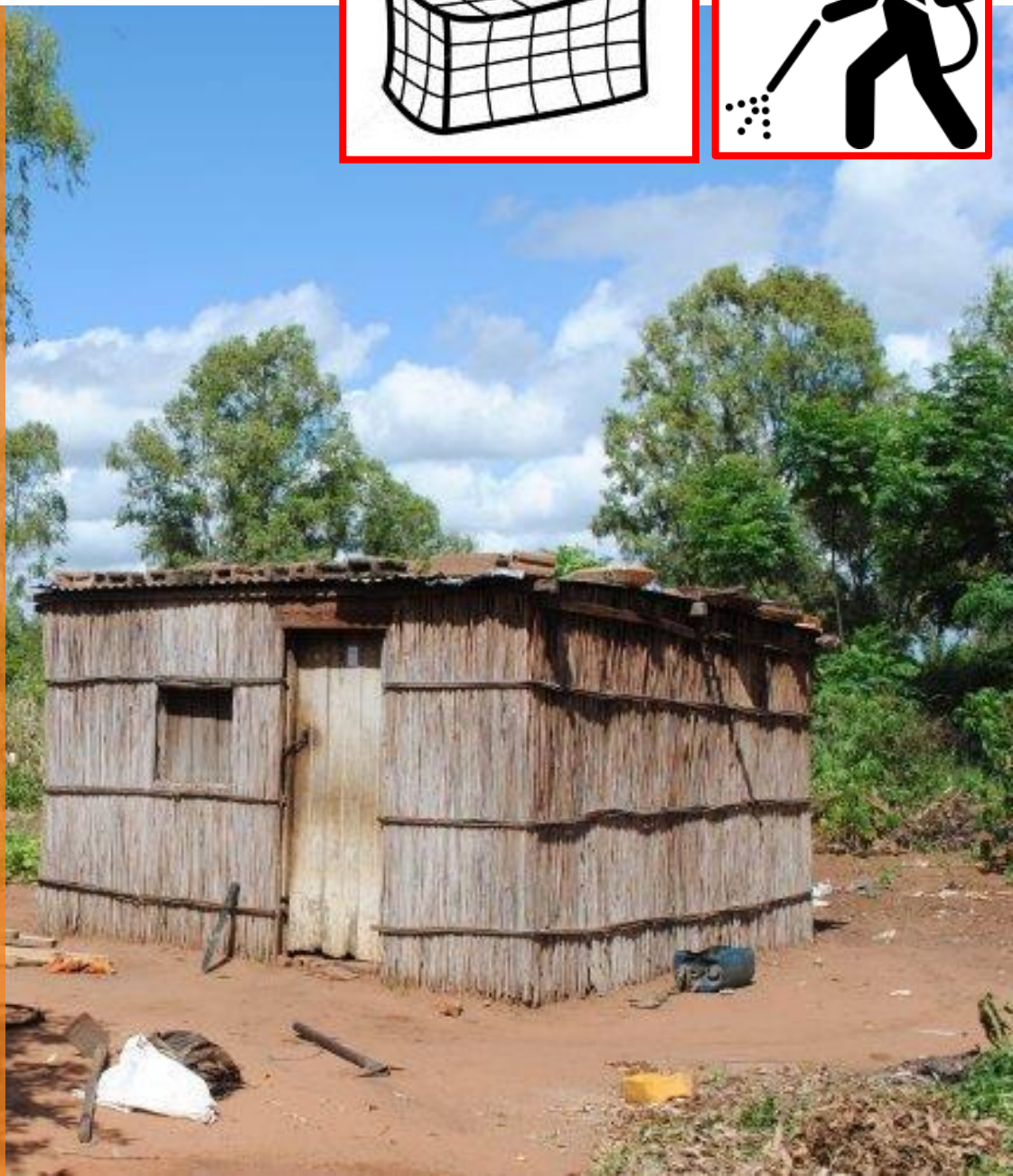
Vector-human contact

Vector-human contact

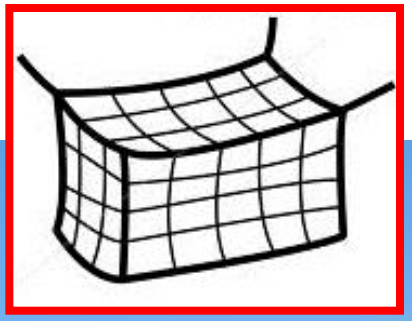


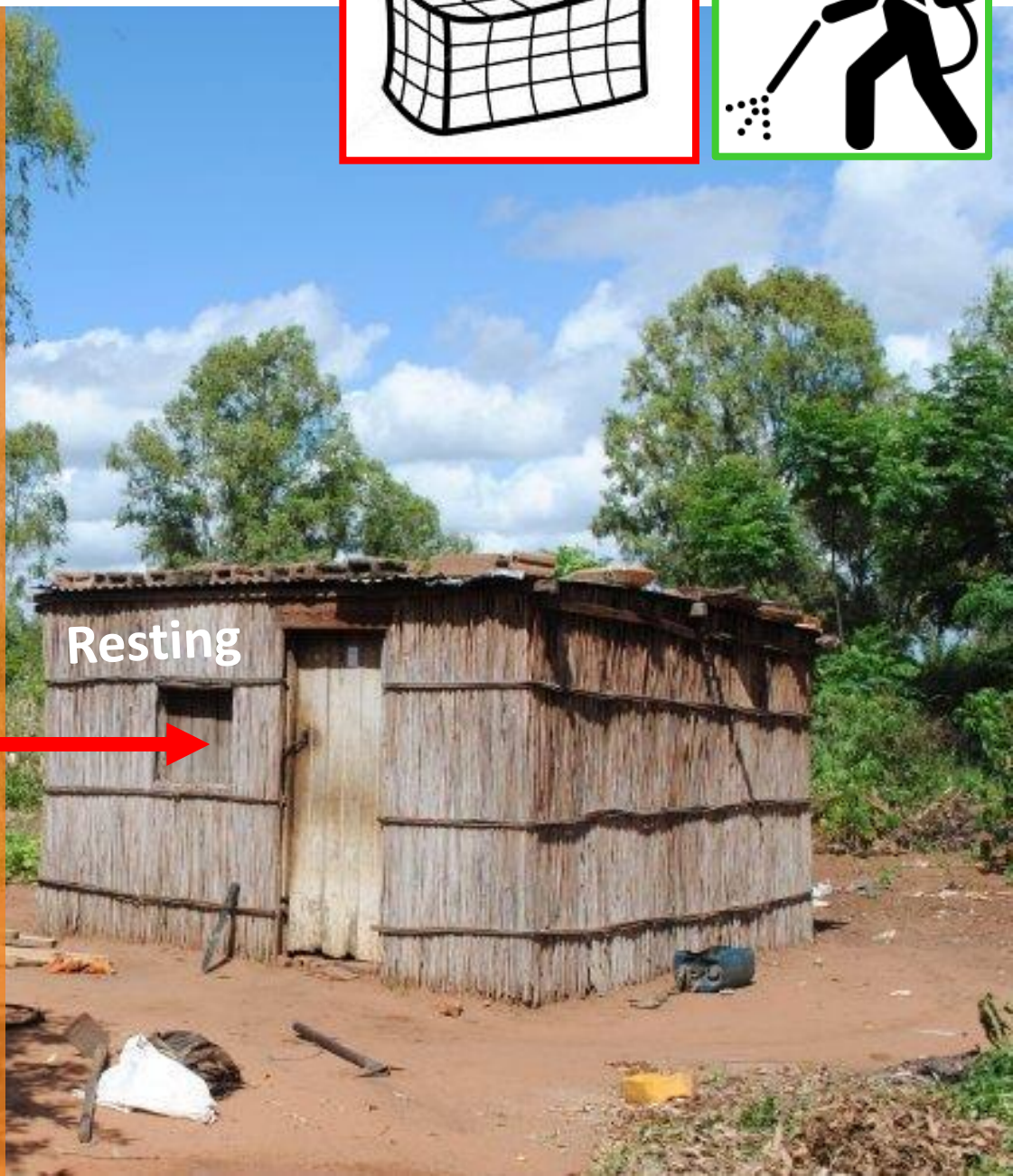
Vector-human contact



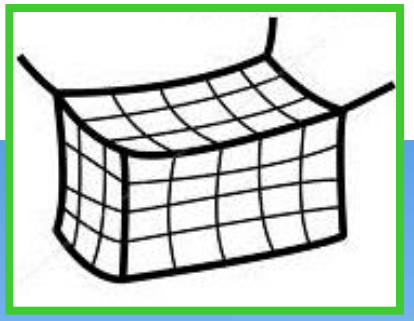


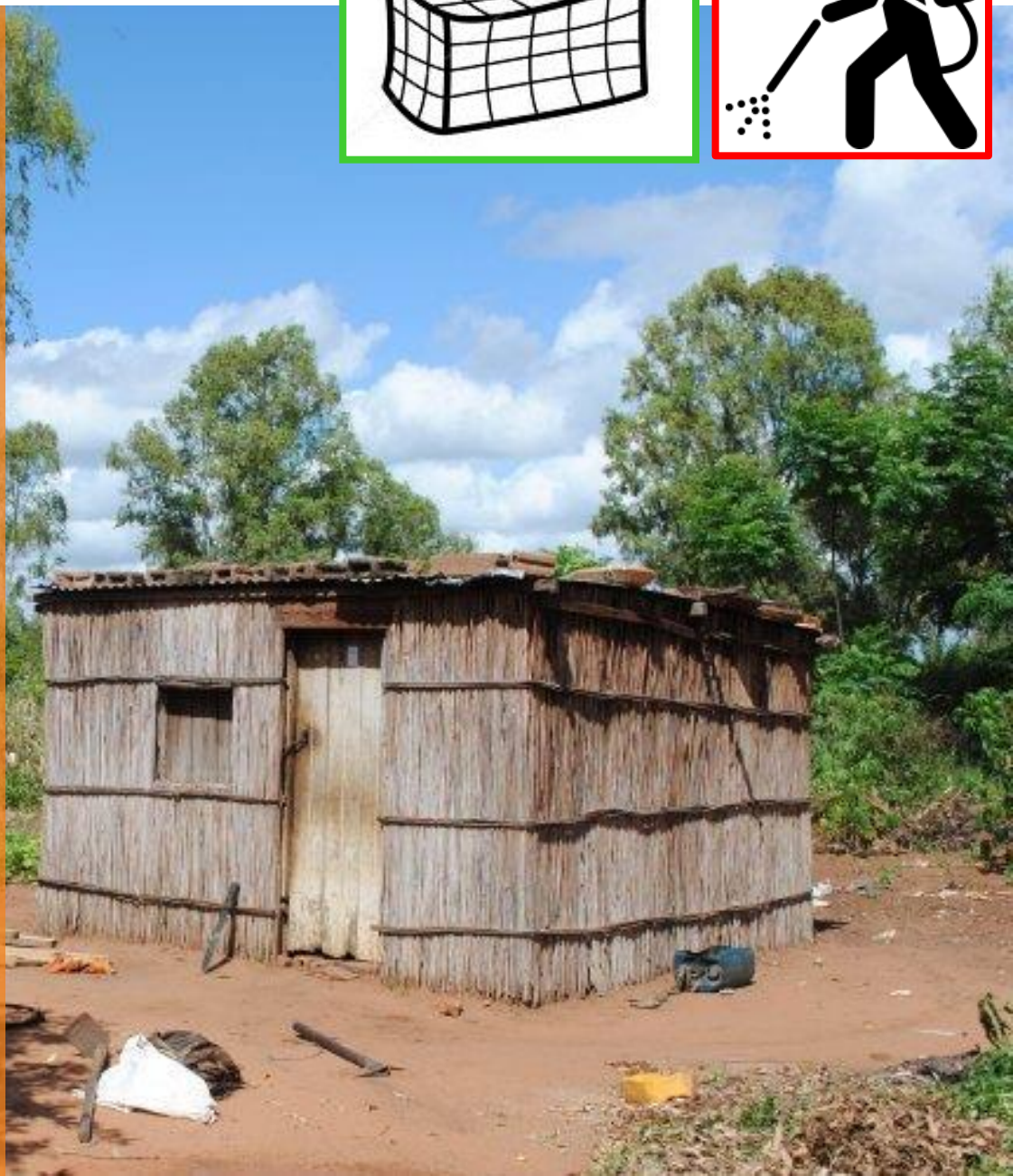
Vector-human contact



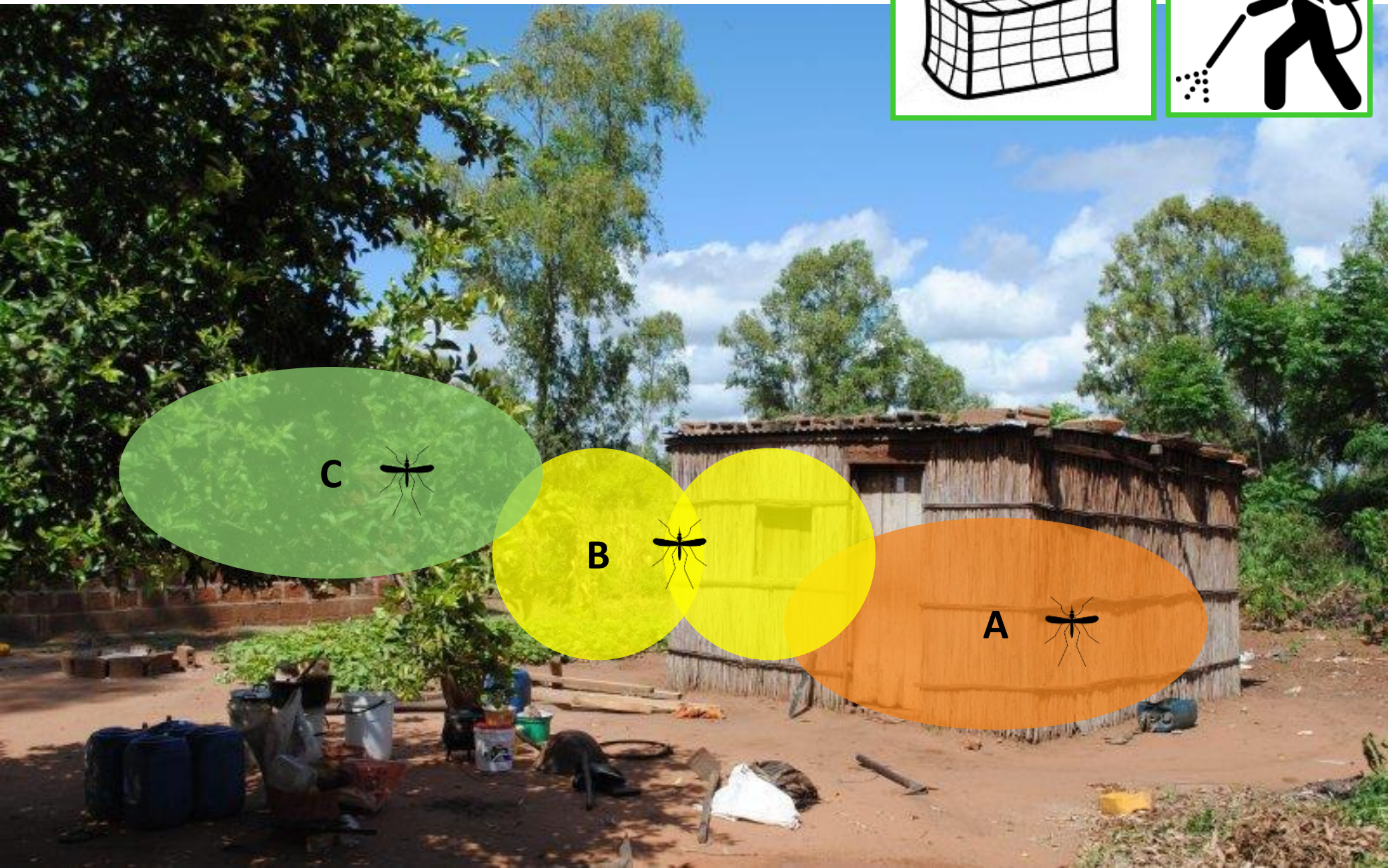


Vector-human contact

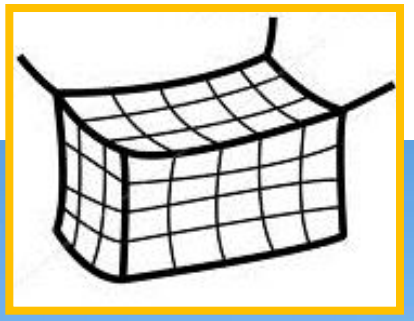




Vector-human contact - complexities



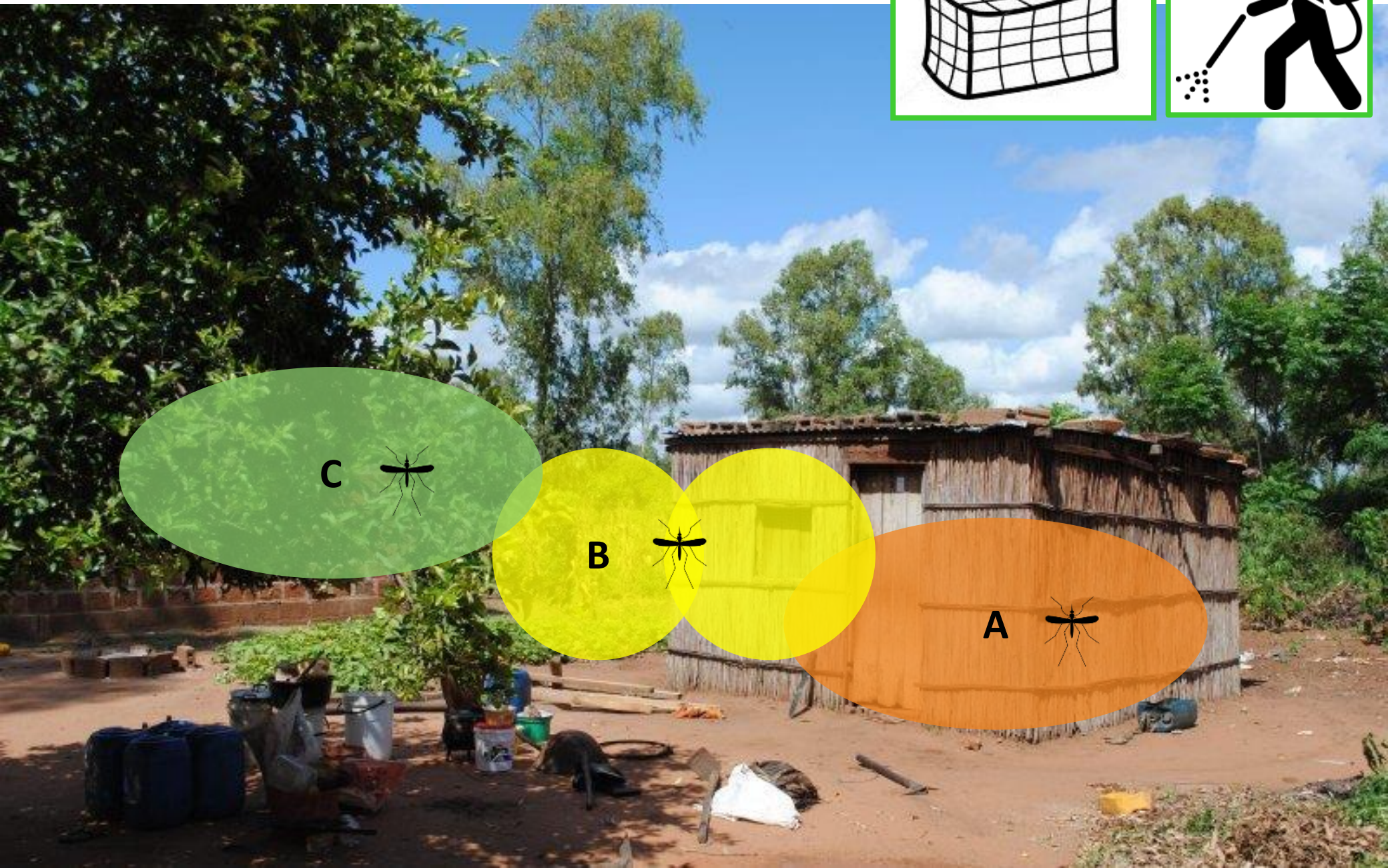
Vector-human contact - complexities



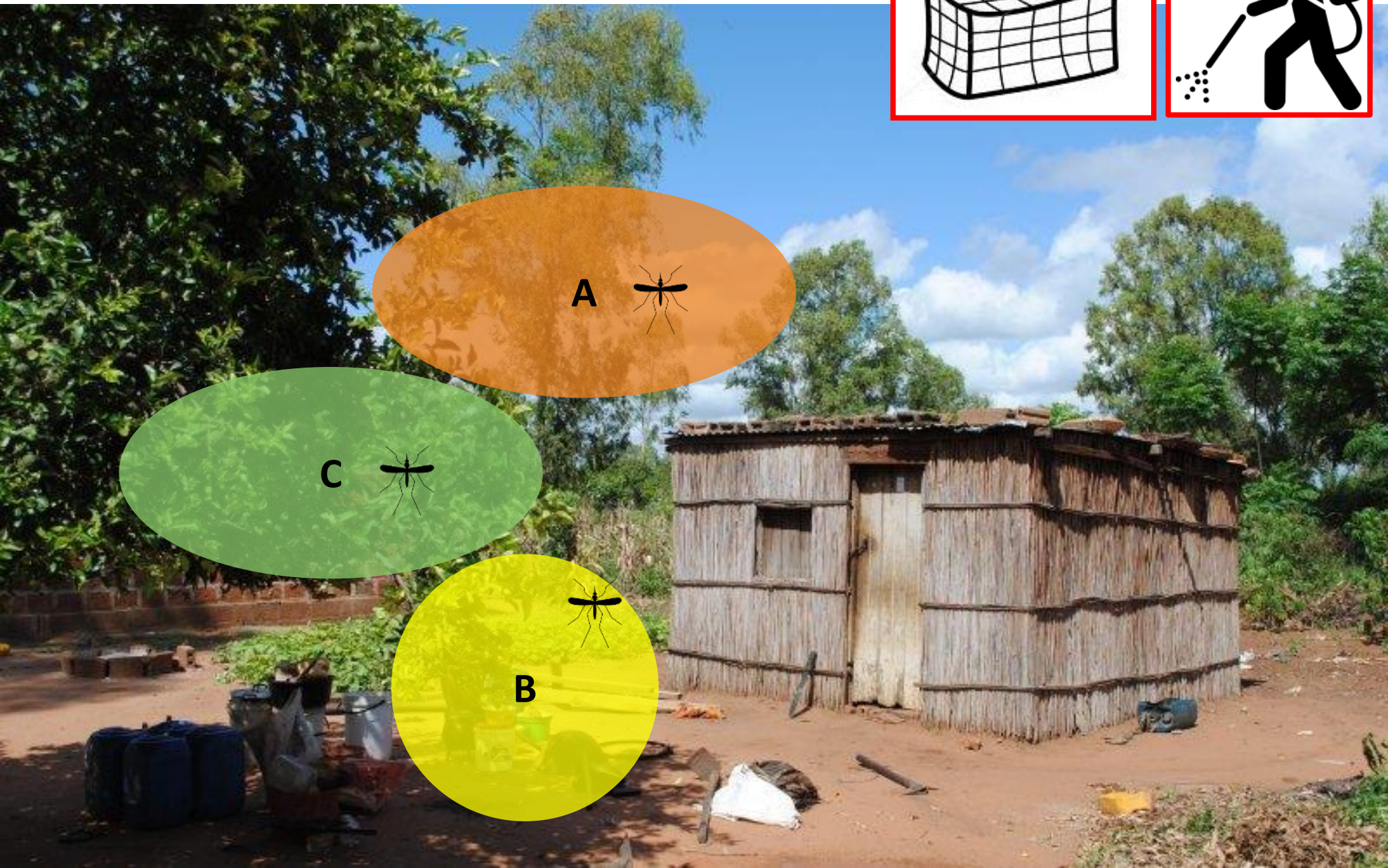
C

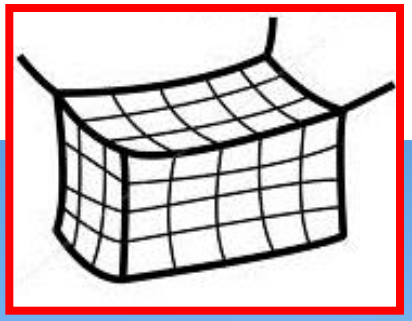
B

Vector-human contact - complexities

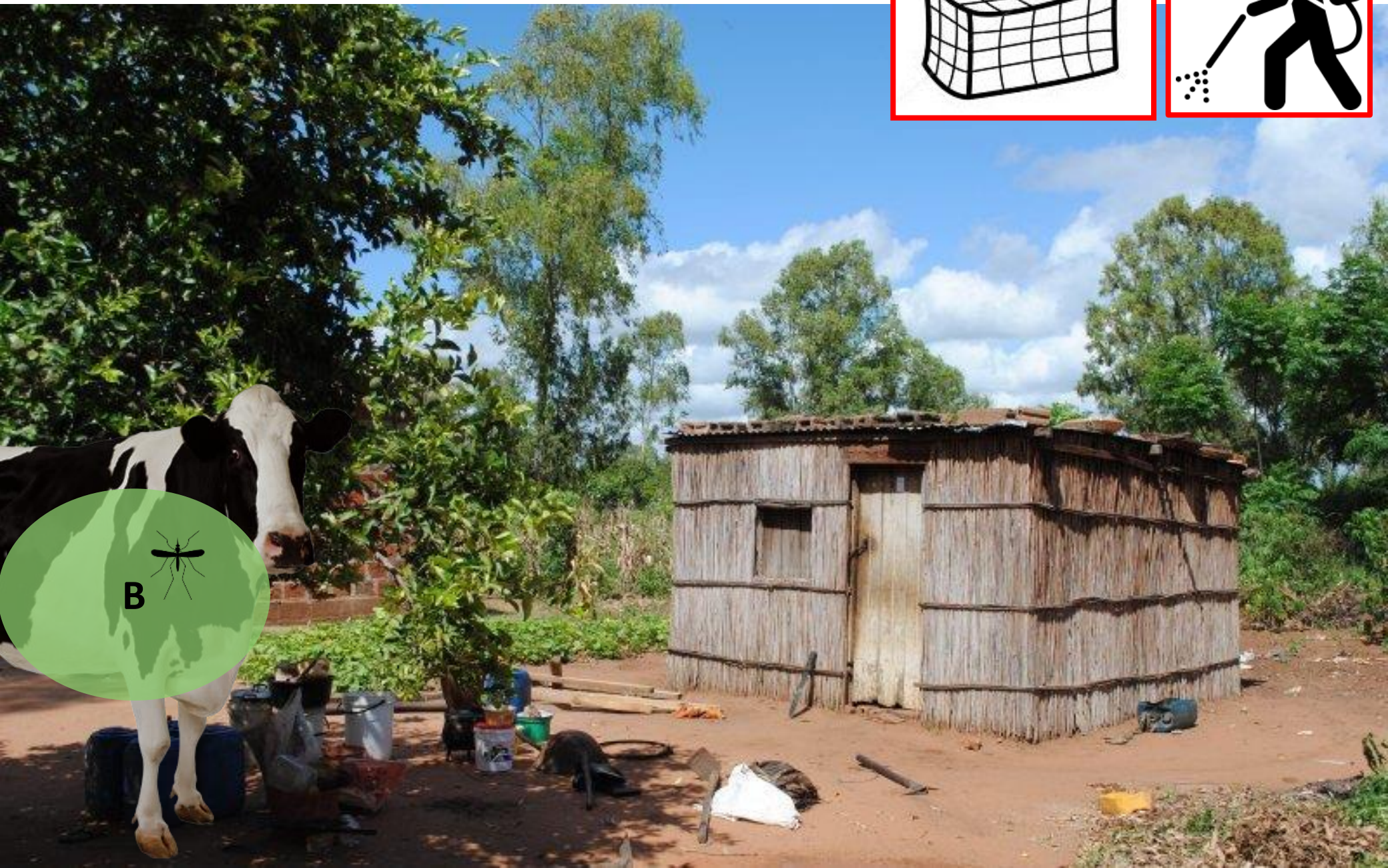


Vector-human contact - complexities





Vector-human contact - complexities



Residual malaria transmission

World Health Organization

Both **human and vector behaviour** is responsible for such residual transmission, such as people staying outdoors at night or local mosquito vector species displaying behaviour that allows them to avoid core interventions.

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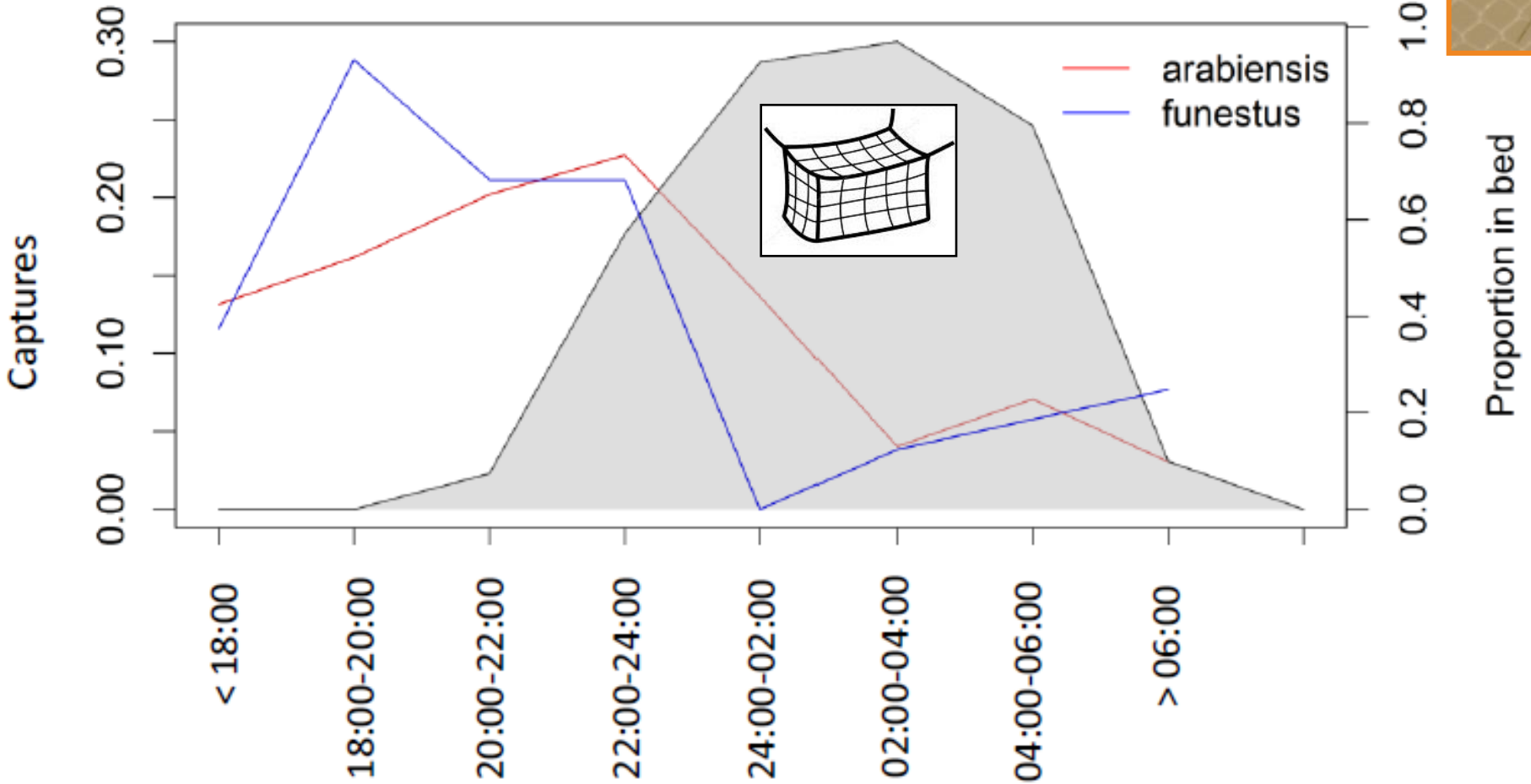
Linking human & mosquito behaviors



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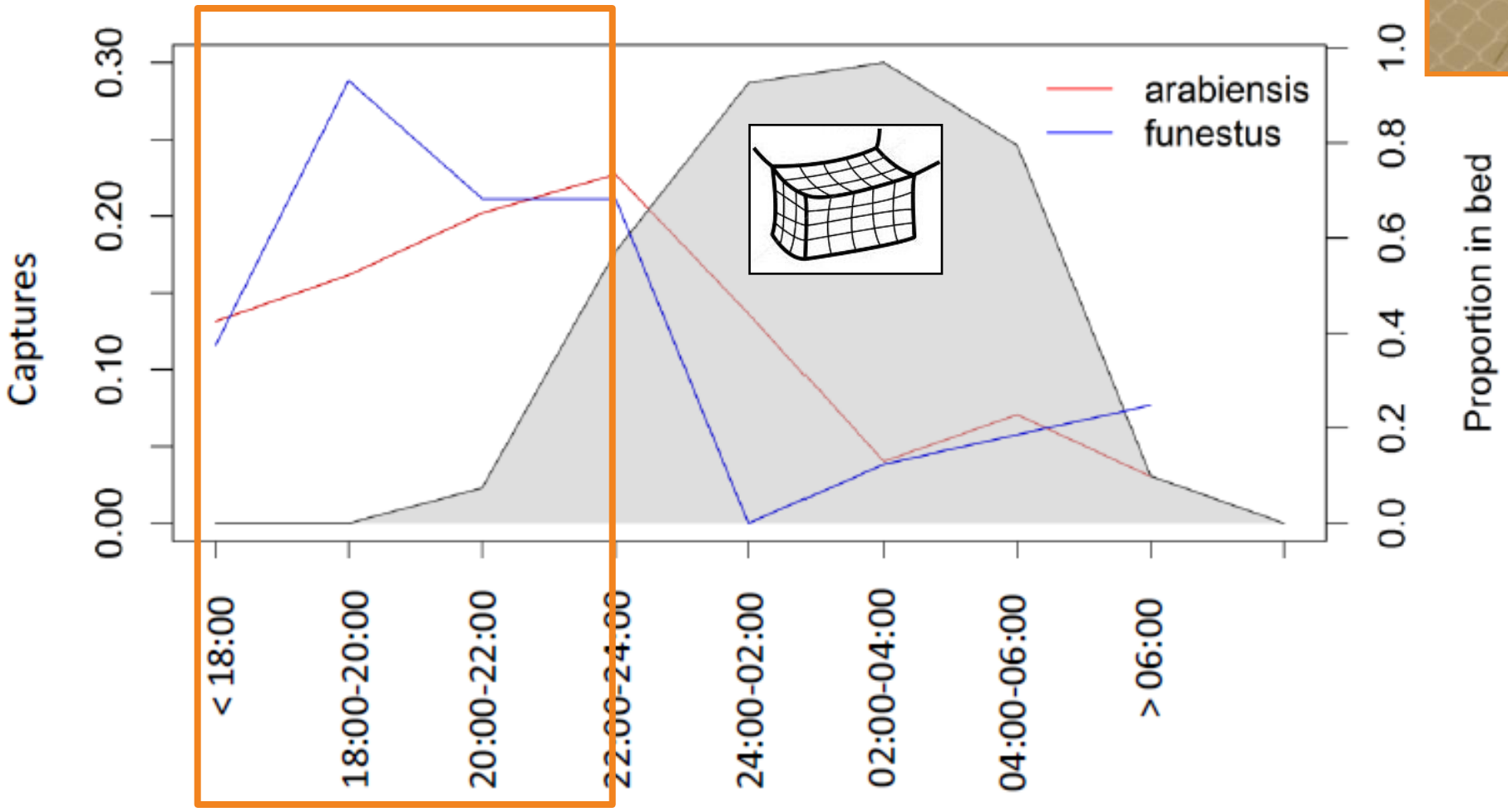
Linking human & mosquito behaviors

Protective gap



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How to capture all this?

How to capture all this?

Various surveillance tools

- Human Landing Catch (HLC)
- Pyrethrum Spray Catch (PSC)
- Odor-baited traps
- Tent traps
- Window exit traps
-
-
-

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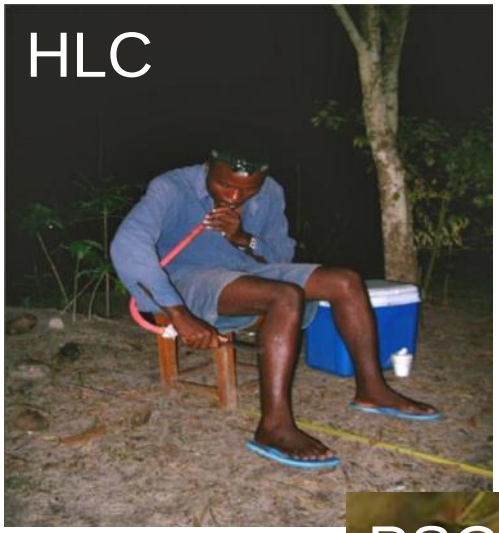
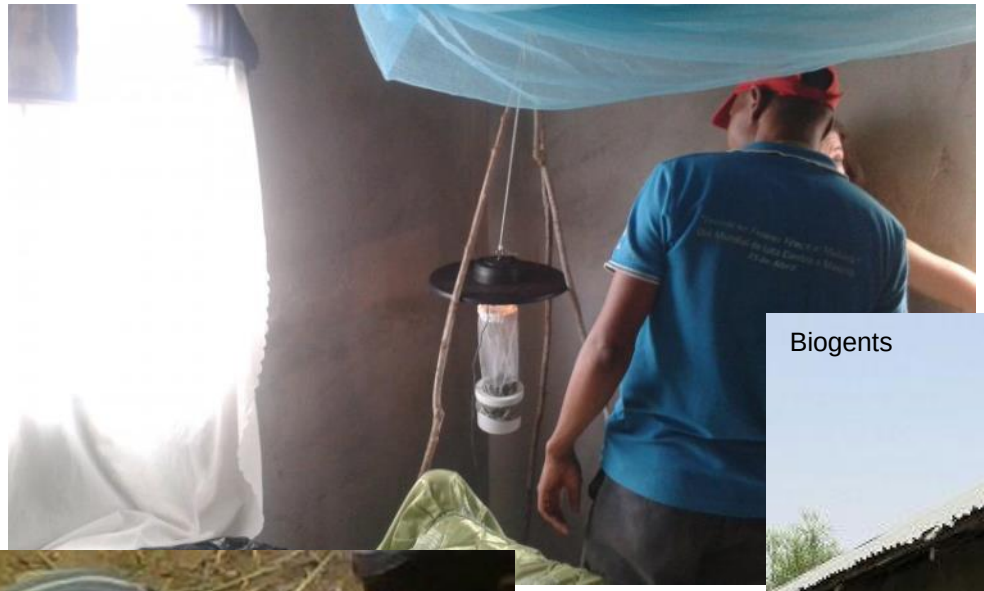
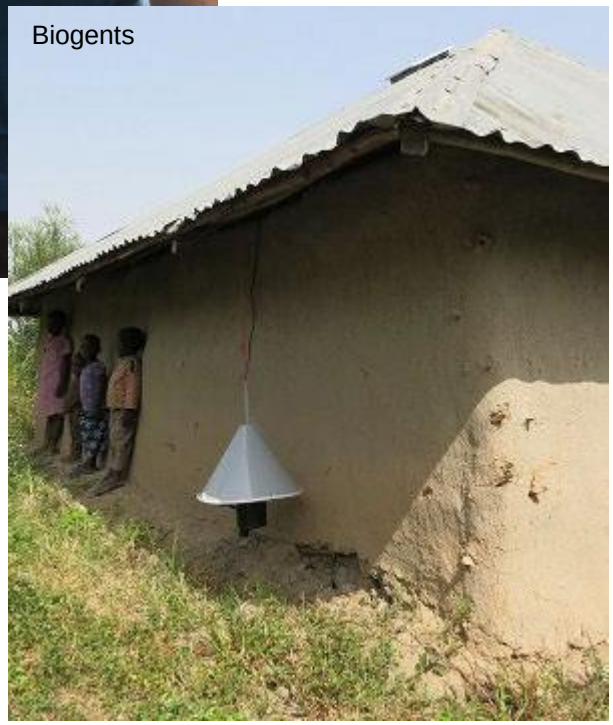
How to capture all this?



limn.it/nature.com



Biogents



WHO

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But be aware!

Different tools → different behaviors

host seeking, resting, ovipositing

Selection depends on your question

Pyrethrum Spray Catch (PSC)

Resting @ 6am
Impact of IRS

Pyrethrum Spray Catch (PSC)

Pyrethrum Spray Catch (PSC)

Key concepts entomology

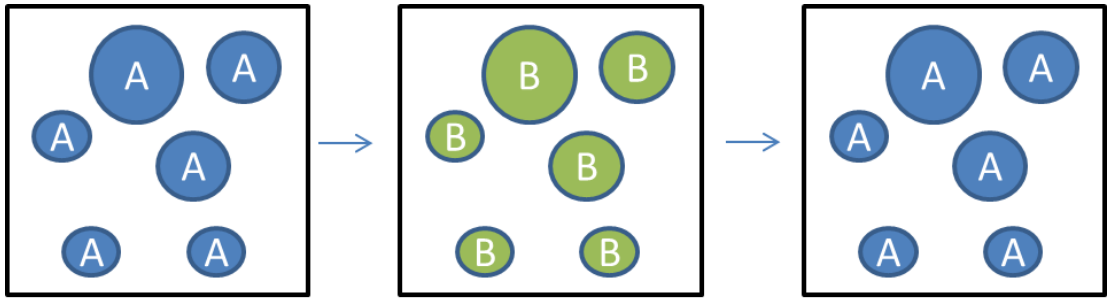
① **R**esistance to insecticides
② **R**esidual transmission

} Double *R* crisis

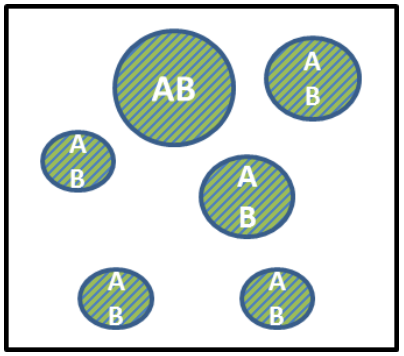
Surveillance

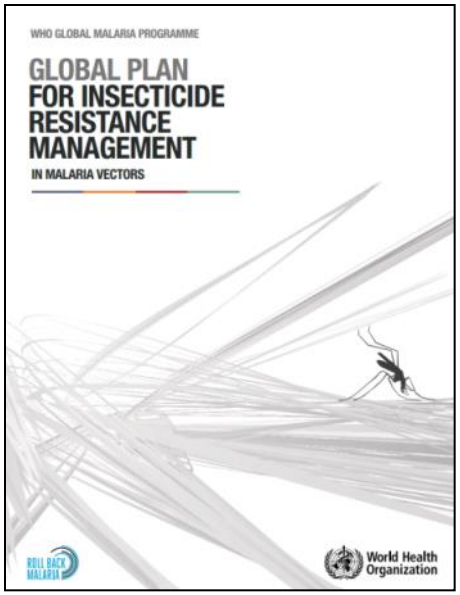
③ **T**ools

IR - Smarter with insecticides

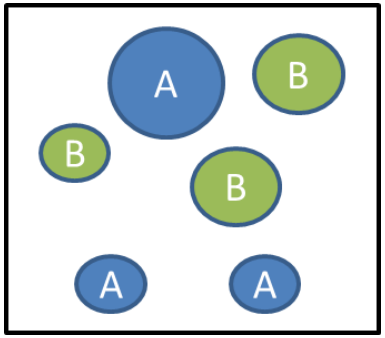


- Rotation of insecticides
- Mixtures





- Mosaic spraying

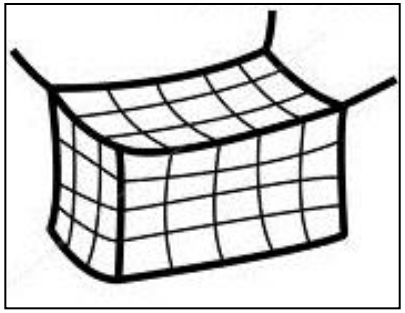


A: 1/100.000, B: 1/100.000, AB: 1/10.000.000.000

IR - New insecticides

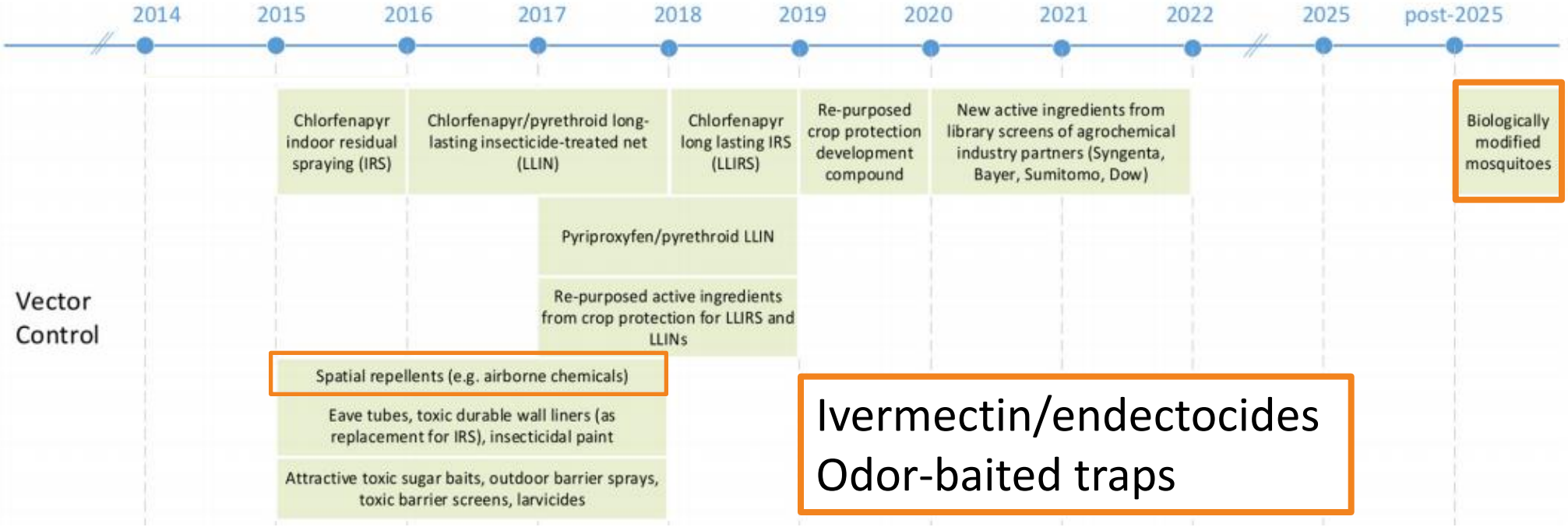
- 3 new Active Ingredients (AI)>2020

- Nets with synergist
- Nets with 2 insecticides



We need to look beyond insecticides

Vector control pipeline



More work is clearly needed

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Mosquitoes matter … a lot

Effective vector control can be complex and difficult…
Regular and adequate surveillance is key

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