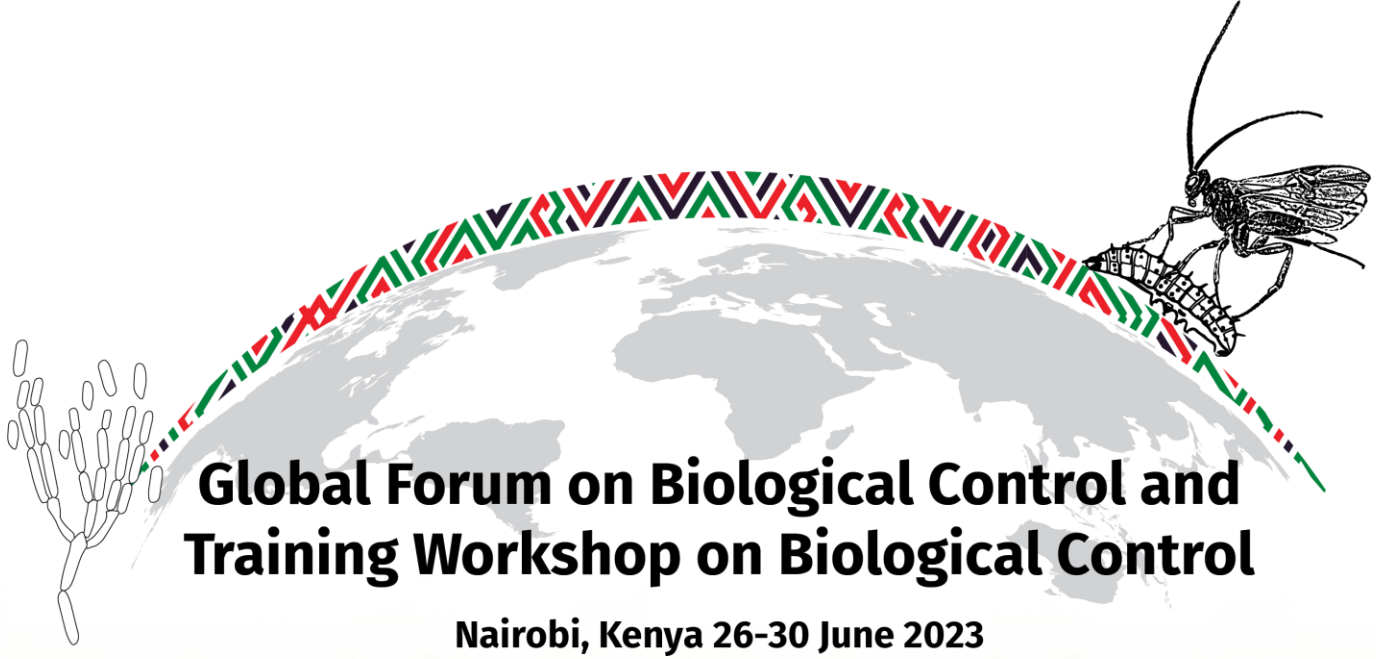

Global Forum on Biological Control and Training Workshop on Biological Control

Nairobi, Kenya 26-30 June 2023

Augmentative and classical biological control efforts for Fall armyworm in Africa

Samira A. Mohamed, Francis Obala, Peter Malusi, Mohamed Saadani, Abdualla Mkiga Beatrice Muriithi, Elfatih Abdel-Rahman, David Hughes, Georg GoergenSubramanian Sevgan

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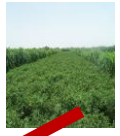
Presentation outlines

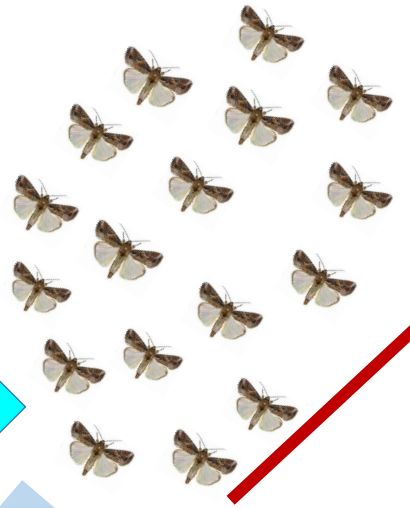
- **Background**
- **Augmentative biological control**
  - Laboratory assessment of the promising candidates
  - Field releases
  - Assessment of impact
  - Training of youths
  - Lab
- **Classical biological control**
  - Introduction from the aboriginal home of FAW into Benin
  - Pre-release assessment
  - Field releases and assessment of impact
  - Introduction into east Africa
  - Prerelease assessment
- **Capacity building**

Dynamic FAW in the invaded range and its drivers

coevolved Natural enemies

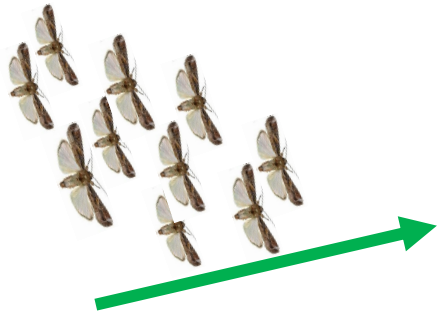
Suitable host plants





Conducive climatic conditions

High fecundity/dispersal ability



+

FAW-parasitoid new association in Africa

Egg/egg-larval parasitoids

Telenomus remus

T. chilonis

T. mwanzaii

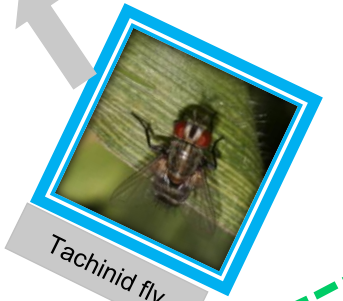
Chelonus bifoveolatus

Charops ater

Cotesia icipe

Coccygidium luteum

Tachinid fly



Larval parasitoids

Performance of egg, egg-larval and larval parasitoids on *Spodoptera frugiperda*

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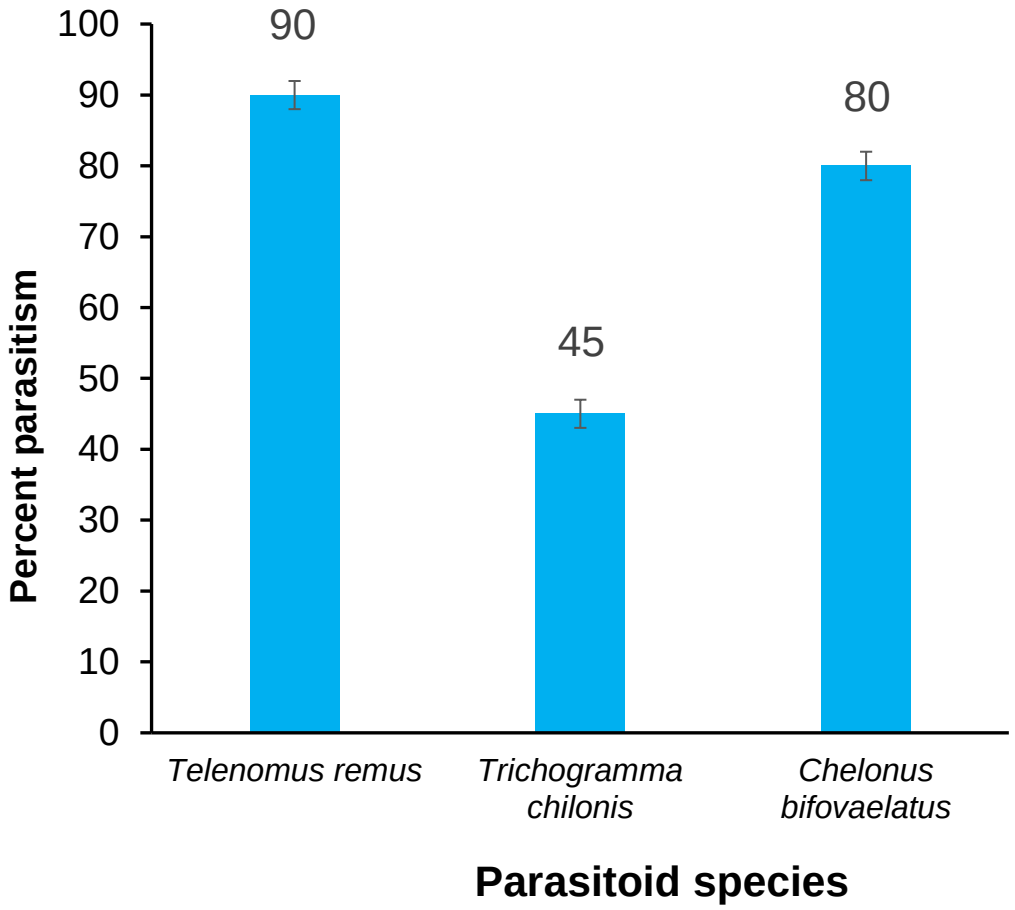
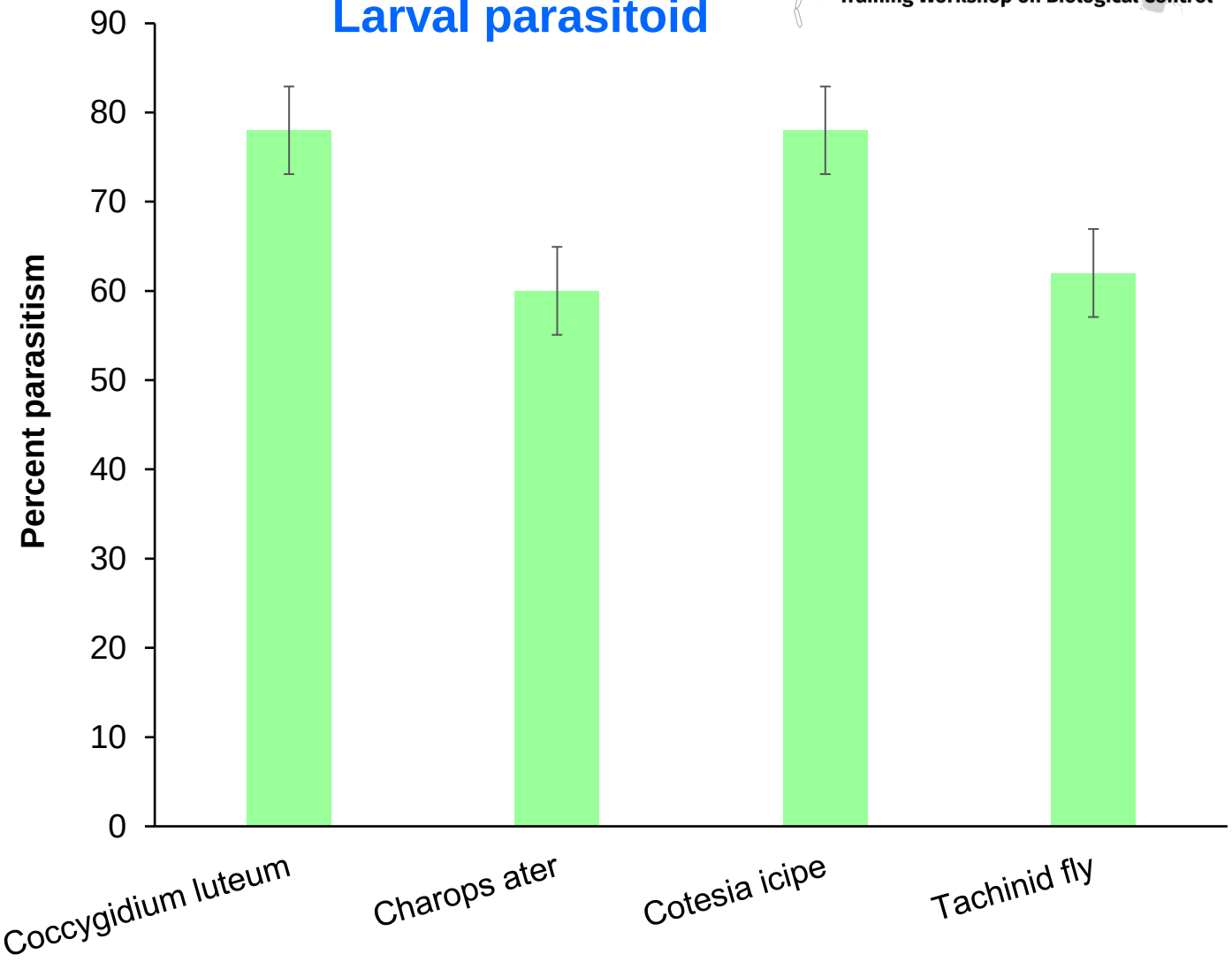
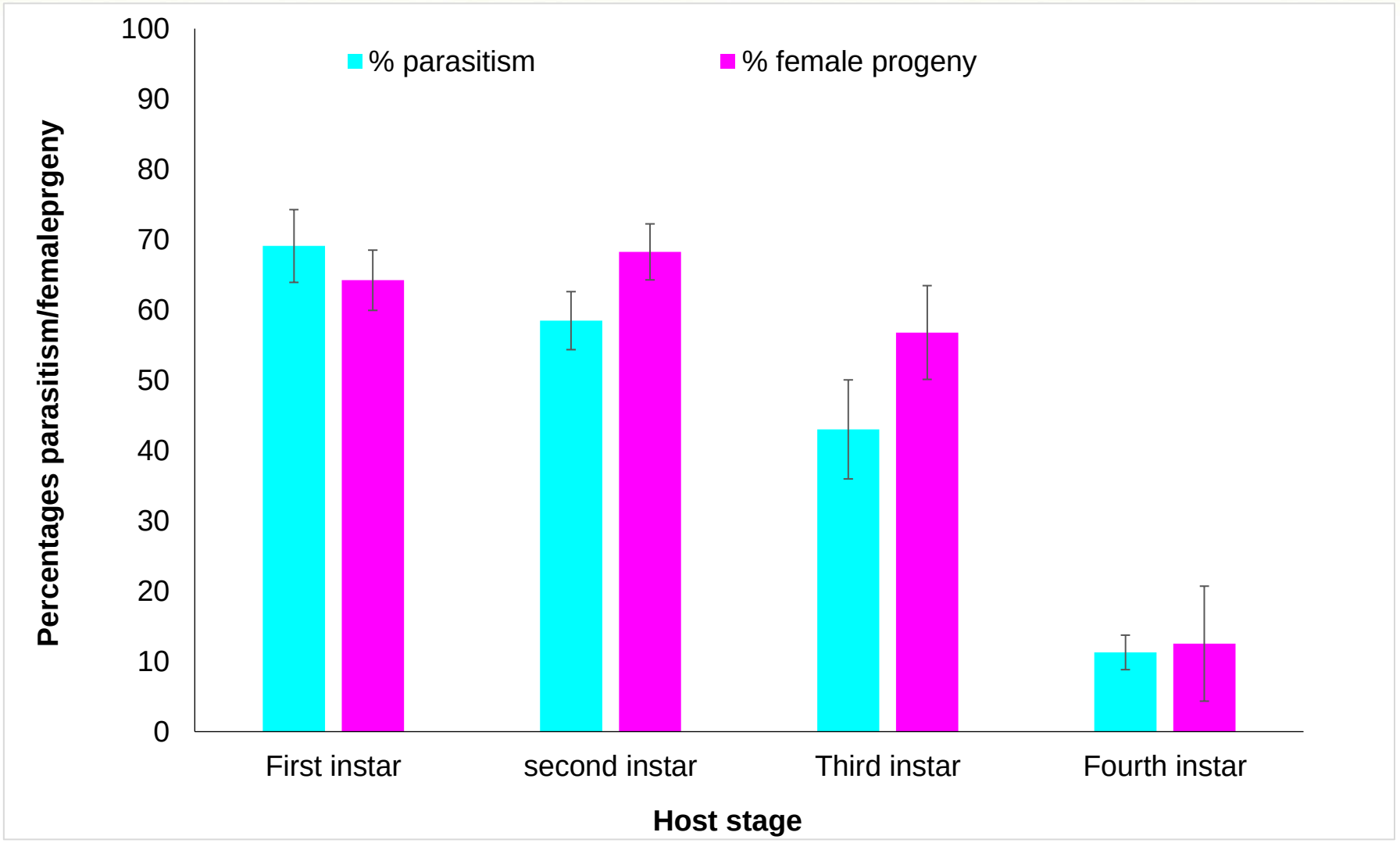
Egg, egg-larval parasitoid



Larval parasitoid



Parasitism of *Cotesia icipe*



Mohamed *et al*. (2021) doi.org/10.1371/journal.pone.0253122

Preference and performance of *C. icipe* on FAW, and *Spodoptera littoralis and key stemborer species*

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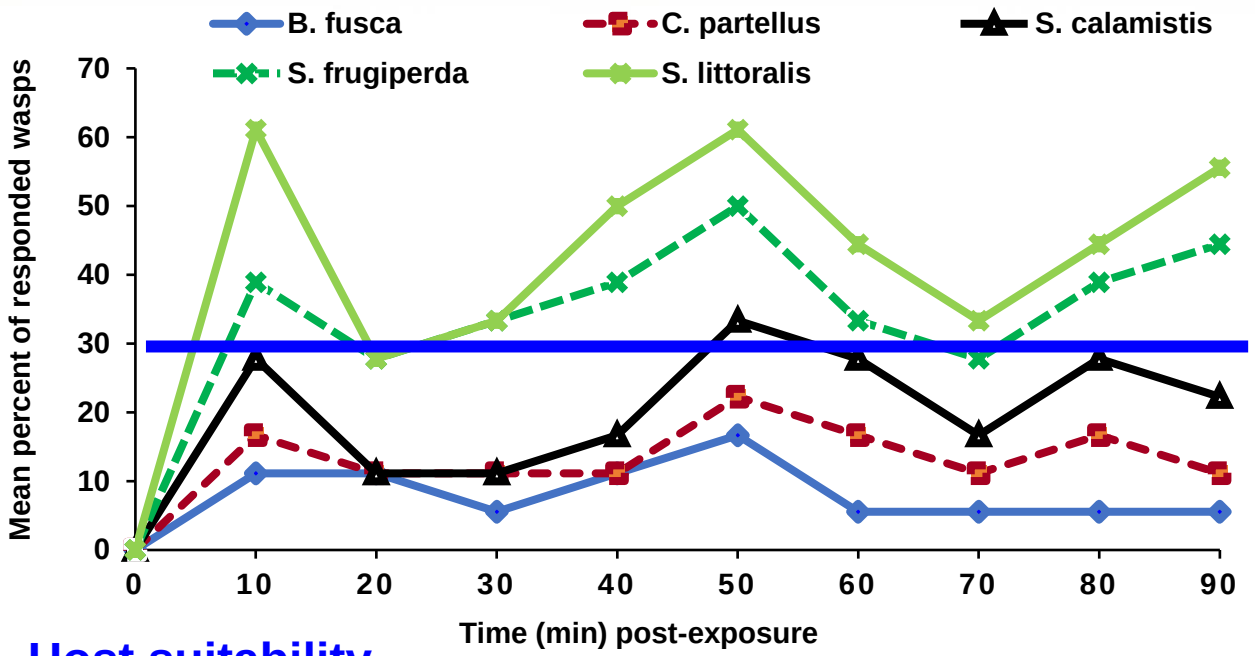
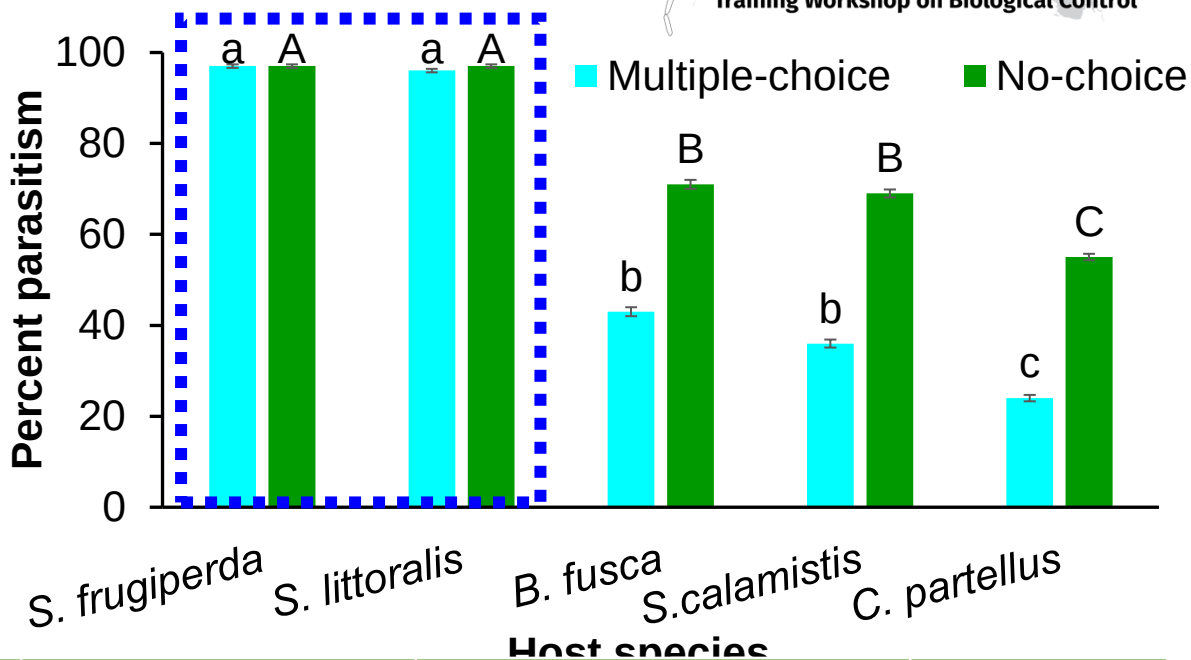
Host preference



Host acceptability



Host suitability

Host species	Total develop. duration	Mean No. of cocoons formed	Mean No. of eclosed wasps	Mean No of eclosed ♂	Mean number of eclosed ♀	♀ progeny (%)
Spodoptera frugiperda	12.0 ± 0.00a	19.4±0.37a	18±0.29a	6.40a	11.6±0.76a	64.28±3.44a
Spodoptera littoralis	12.4 ± 0.22a	19.4±0.37a	19±0.29a	6.60a	12.4±0.48a	65.23±2.03a
Busseola fusca	19.2 ± 0.52c	14.2±0.91b	13.6±0.64b	5.20ab	8.4±0.48b	61.76±4.55a
Sesamia calamistis	15.2 ± 0.44b	13.8±0.81b	12.8±0.69b	5.20ab	7.6±0.48b	59.38±3.71a
Chilo partellus	23.6 ± 0. 36d	11±0.67c	9.2±0.55c	3.80b	5.4±0.48c	58.70±4.50a

Obala et al (in press). Pest management science

Food and Agriculture Organization of the United Nations
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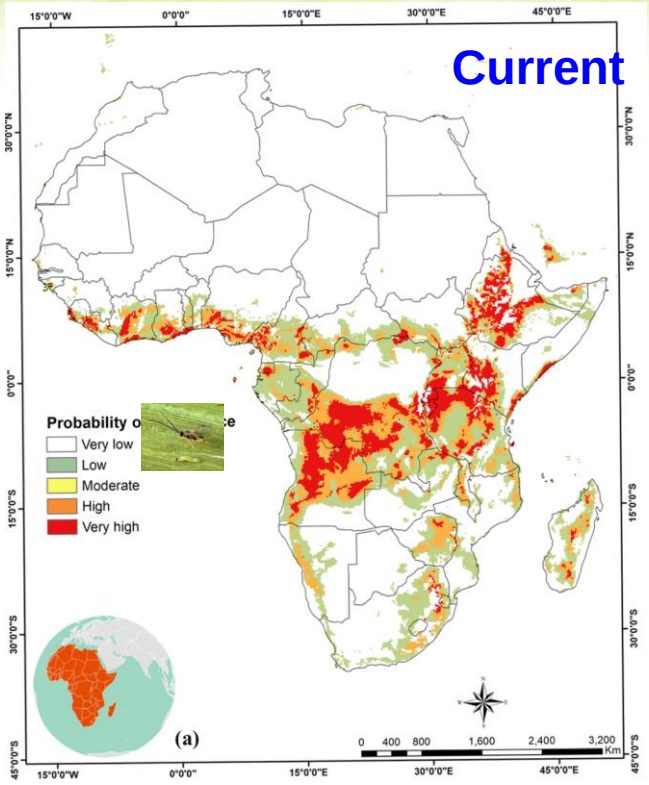
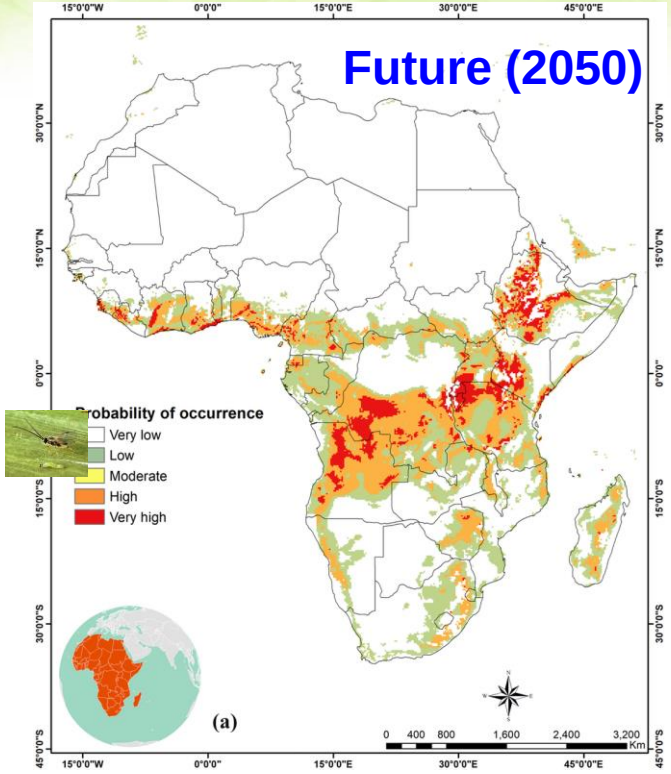
Habitat suitability of *Cotesia icipe* (Hymenoptera, Braconidae) based on bioclimatic variables





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Maxent

Accuracy:
AUC = 0.99

- Under the current climate conditions, most areas in **Eastern, Central and Western Africa are predicted to be suitable/ highly suitable** for *C. icipe* establishment
- With the climate change and projected increase in temperature by 2°C by 2050, the habitat suitability would largely remain similar to the current potential distribution

Mohamed *et al*. (2021) doi.org/10.1371/journal.pone.0253122

Food and Agriculture Organization of the United Nations

icipe

Augmentative Biocontrol of FAW in Kenya

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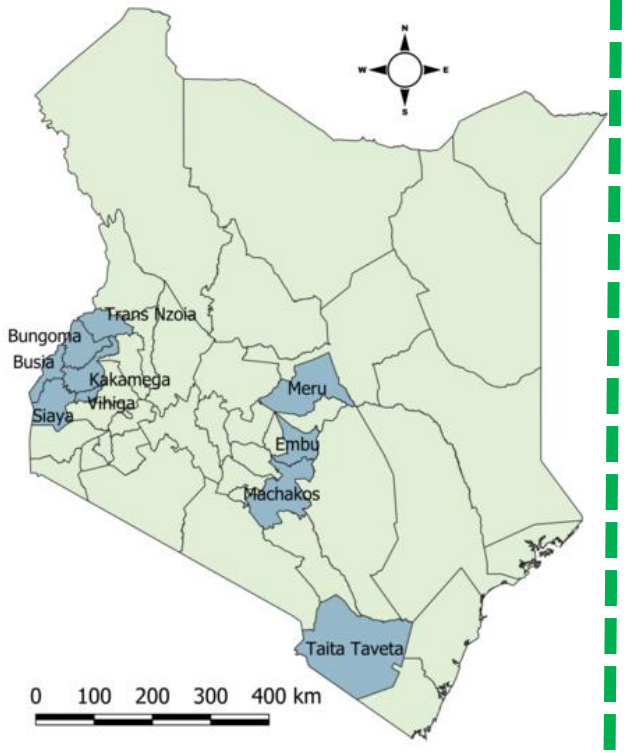
- Farmer sensitization
- Pre-release assessment

- 100,000-150,000 of egg parasitoids (*Telenomus remus*, *Trichogramma chilonis*) wasps (parasitized egg mass) released per ha
- 600-800 wasps (cocoons) of *C. icipe* per ha
- Over **8 million** wasps of both *T. remus* and *T. chilonis* and over 6,000 *C. icipe* wasps were released
- Impact of released parasitoids assessed in terms of parasitism
- Dispersal range of released parasitoids estimated



Additional release by partners/collaborators

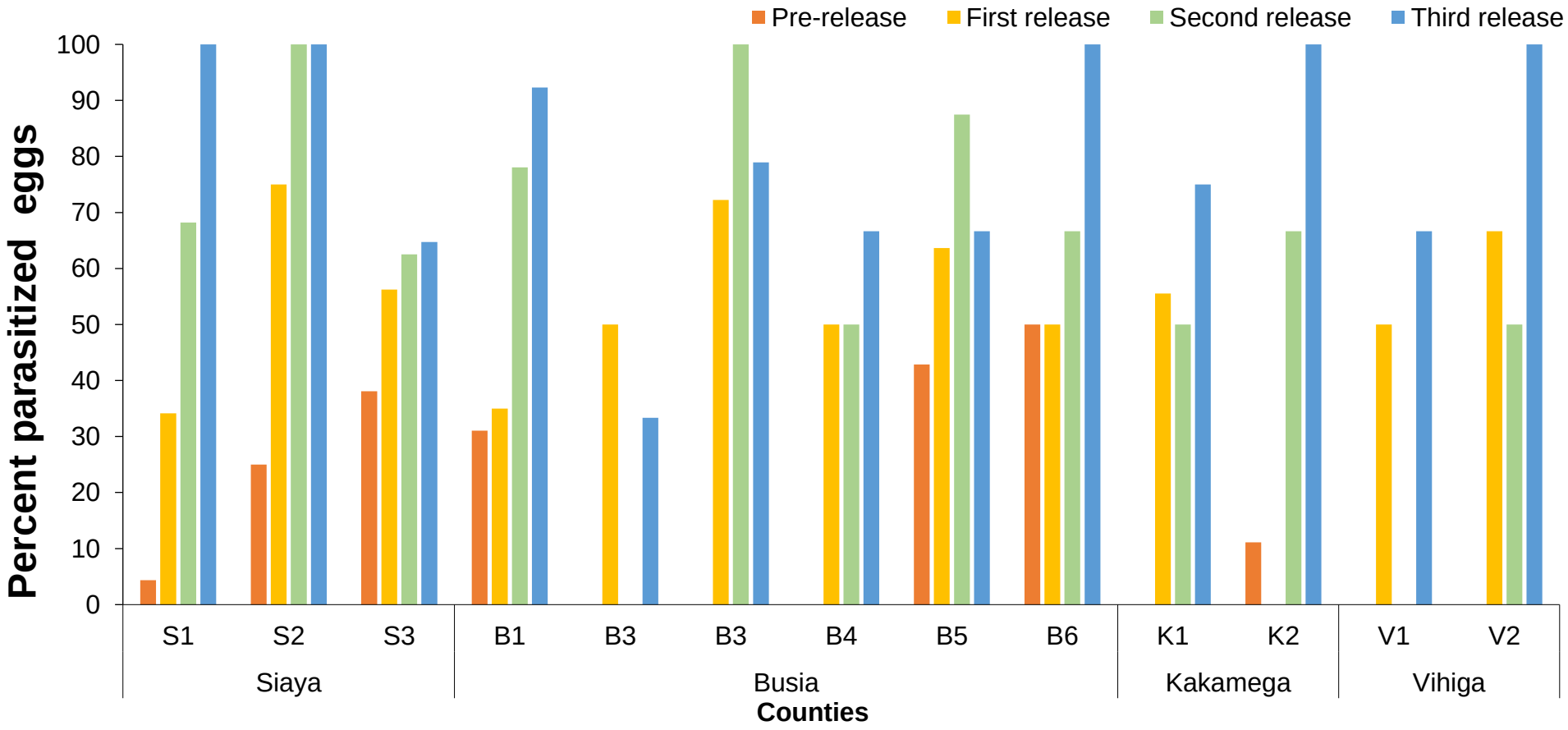
Dream team Kenya

- **Release 63 millions in 13 counties**

Biological control Center, Kibaha Tanzania

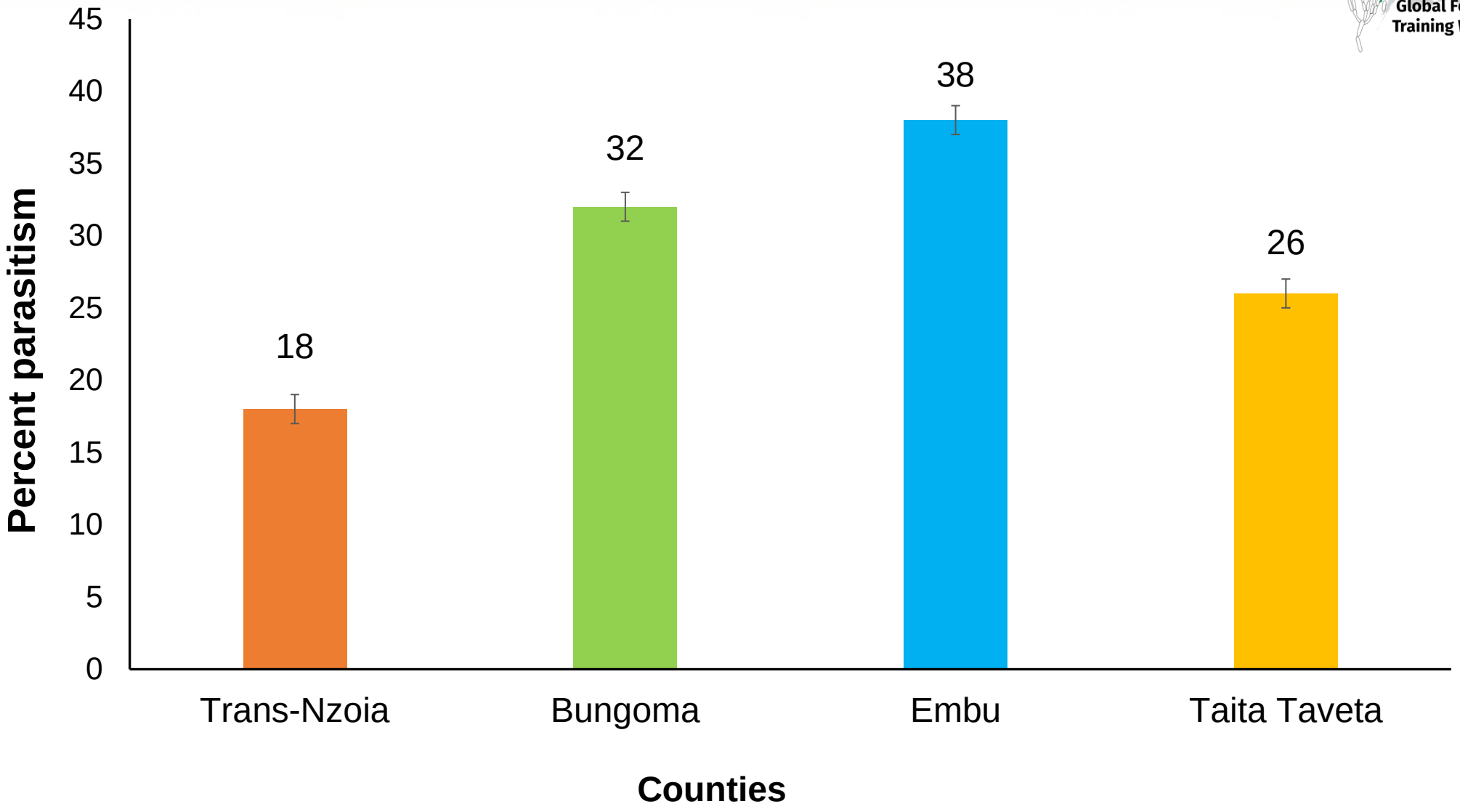
- Released 4 millions wasps
  - *Trichogramma sp;*
  - *Telenomus remus*
  - *Cotesia icipe,*
- Morogoro region and Coast regions of Tanzania

Impact of egg parasitoid (*T. remus* *T. chilonis*) on FAW population in maize fields

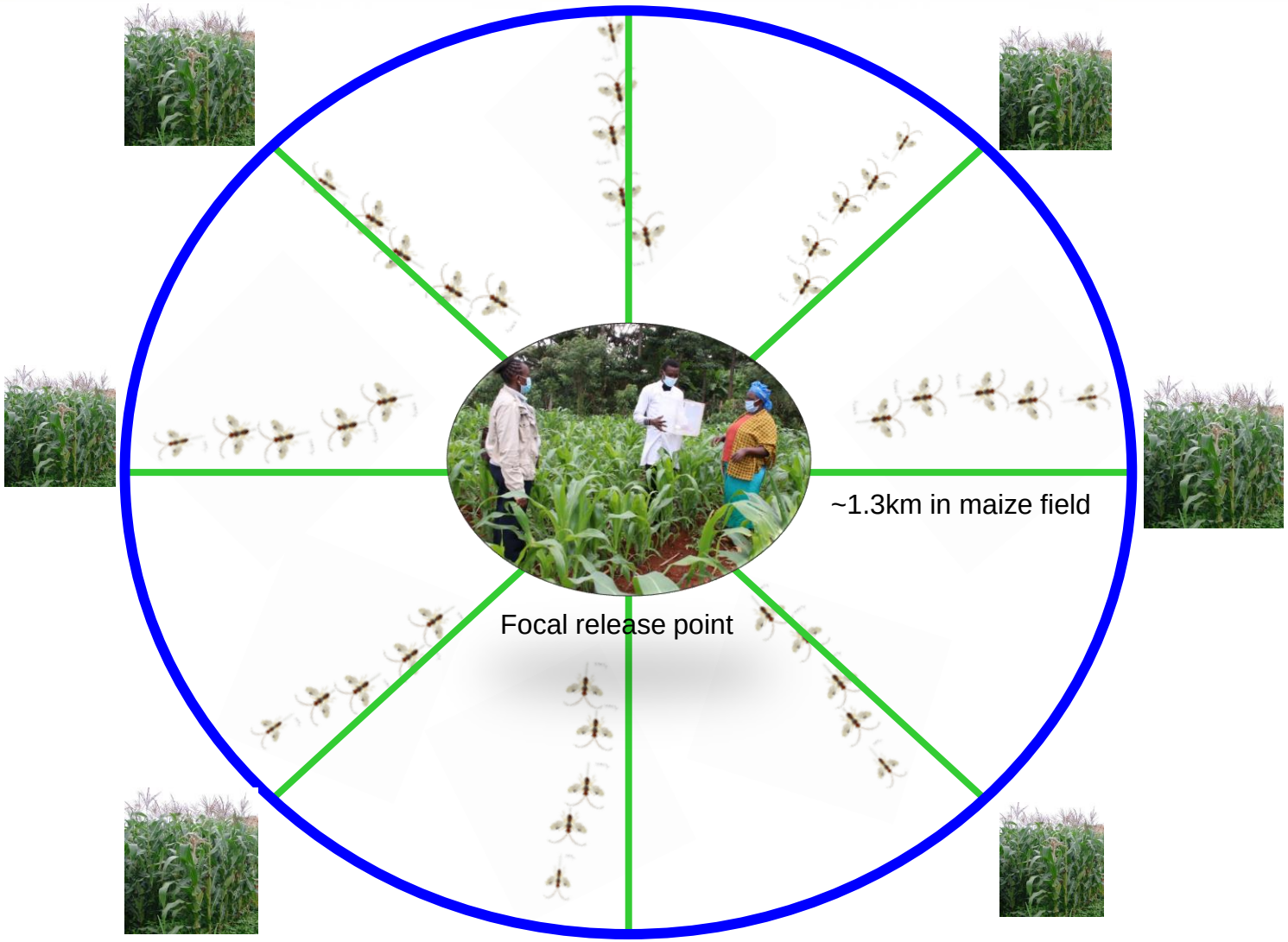


- Pre-release parasitism is quite low in some study sites
- Augmentative releases increase FAW parasitism in all sites

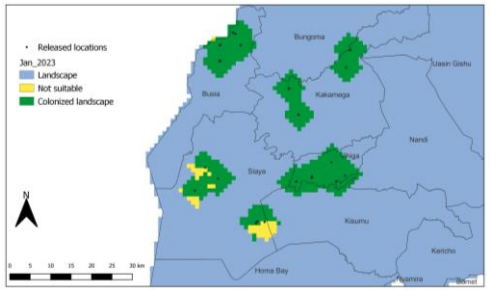
Impact of *C. icipe* on FAW population in maize fields



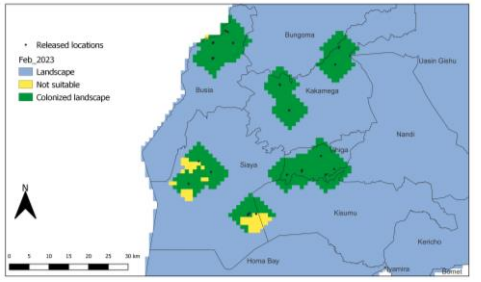
Dispersal of *Telenomus remus* and *Trichogramma chilonis* in maize fields

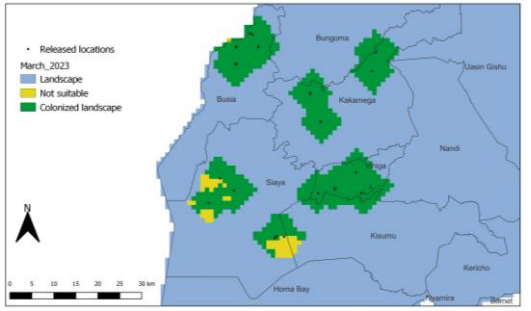


January 2023

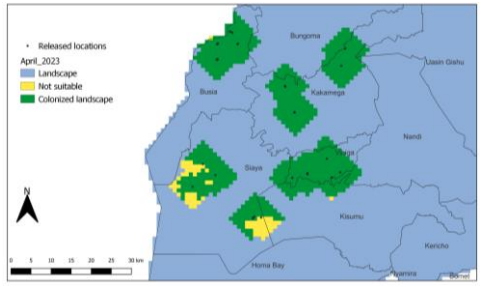


February 2023





March 2023



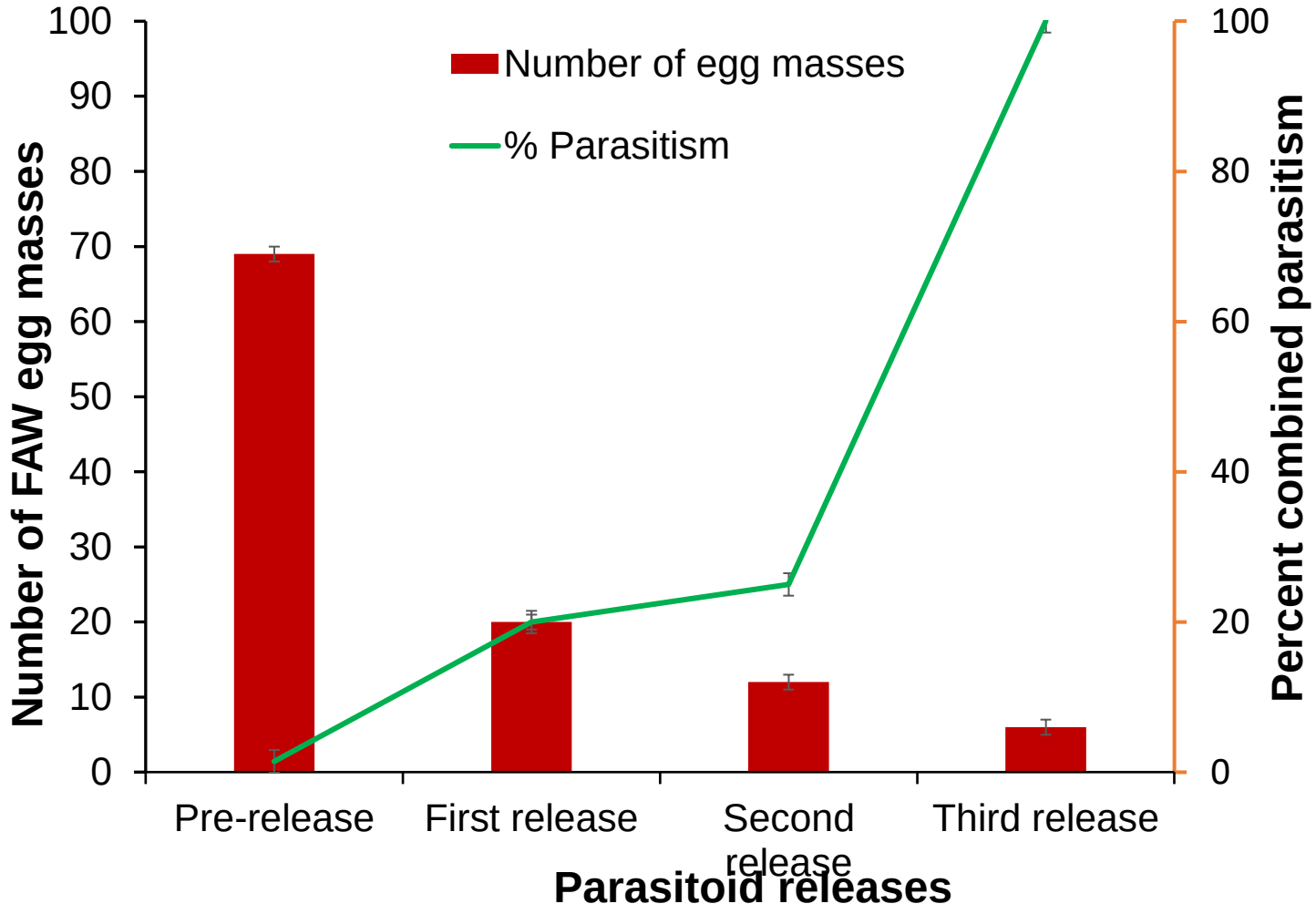
April 2023

Development of parasitoid augmentation device

- Subjected FAW egg to parasitism by *Telenomus remus, Trichogramma chilonis,* separately
- Placed the exposed egg mass in empty bottle, with layer of sand, then placed the basin with water
- Placed the cage in a Perspex cage
- Parasitoid emergence/escape and larval mortality monitored
- Up to 100% FAW larvae (L1) mortality
- Over 90% parasitoid recovery

Field evaluation of the efficiency the developed augmentorium

- 25,000 wasps of each species (*Telenomus remus, Trichogramma chilonis)*
- Egg masses were collected and placed inside the augmentorium, for three consecutive releases
- Number of FAW egg masses, % parasitism on FAW eggs and %larval mortality were assessed



- 100% mortality of FAW larvae
- >80% recovery of *T. remus* and *T. chilonis*

Establishing parasitoid colonies in laboratories of the national system

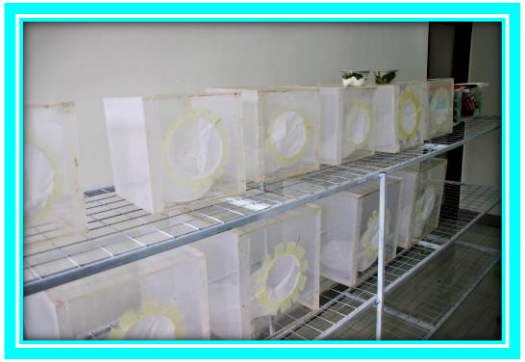
Global Forum on Biological Control and Training Workshop on Biological Control

TARI, Tanzania, Ukiriguru Centre

- *Telenomus remus*
- *Trichogramma chilonis*
- *Cotesia icipe*

NARO, Uganda

- *Telenomus remus*
- *Cotesia icipe*



Dream team Tanzania

- *Telenomus remus*
- *Trichogramma chilonis*

Classical Biological Control

Introduction of efficient co-evolved parasitoid from aboriginal home of the pest

❖ *Telenomus remus* (egg parasitoid)

❖ *Chelonus insularis* (Egg-larval parasitoid)

❖ *Cotesia marginiventris:* larval parasitoid,

- ❖ Early larval instar
- ❖ can persist at low host densities.

❖ *Eiphosoma laphygmae:* larval parasitoid on older instars; relatively specific to the genus *Spodoptera*.

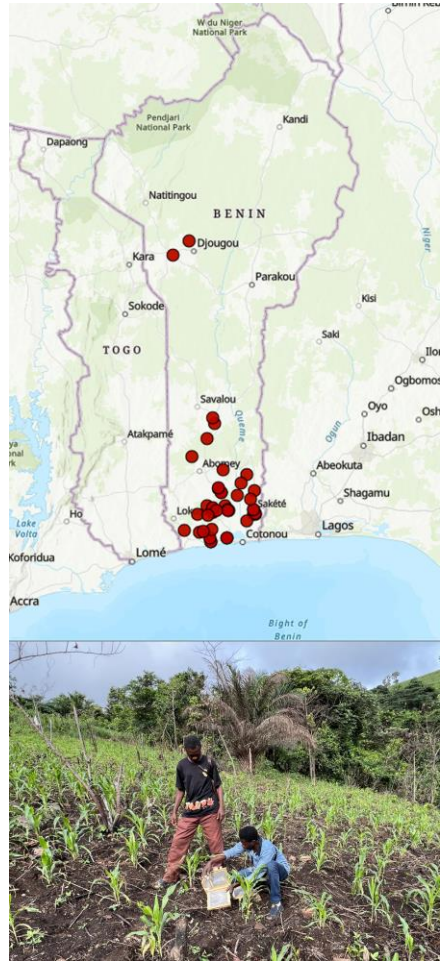
Field release in west Africa

Chelonus insularis

- Total of **102 500 wasps** were field released
- 42 sites in Benin and Togo

Cotesia marginiventris

- Total of 149 000 wasp were field released
- 47 sites in Benin and Togo



Monitoring for establishment of both species is on-going

Introduction of efficient co-evolved parasitoid from IITA Benin into Kenya

MINISTRY OF AGRICULTURE
KENYA PLANT HEALTH INSPECTORATE SERVICE
BIOLOGICAL IMPORTATION PERMIT
(Plant Protection Act Cap 324)

Date: 01/03/2023

Permit No: BIP/22768/2023

One copy of this permit must be furnished by the importer to the supplier before the biological shipment is dispatched

Permission is hereby granted to: Dr. Samira A. Mohamed, International Center of Insect Physiology and Ecology (ICIPE), P.O Box 30772-00100 Nairobi, Kenya.
To import from: Georgen George ITA,Benin, 08 BP 0932 Tri Postal, Cotonou,Republic of Benin.

The organism described below:

1. Genus, Species, Author : **5000 pupae of *Chelonus insularis* and 5000 pupae of *Cotesia marginiventris*.**
2. Type of Parasite: **Parasitoids**
3. Predator of weed.....N/A.....
   Predator of insect: **N/A**
4. Stage(s) shipped:**N/A**
5. Dates originally field collected....**N/A**
6. Location (Nearest Town, province,/ State, Country: **Benin**
7. Original host (Genus, Species, Author) **N/A**
8. Stage/part attacked **N/A**
9. a) Intended host if different from original....**N/A**
   b) Other alternative hosts **none**
10. Laboratory host (If different from original host) ....**N/A**
11. Host plant of host pest: **N/A**

Intended use	Intended Host	Type of release study
A. Immediate field Release	N/A	see 11. Below
B. Lab. Culture with Eventual field release	N/A	N/A
C. Lab. Culture with Study of evaluation only	N/A	N/A

For Research Purpose Only.

12. A statement of where the biological agent has already been used and the degree of success attained.....
    Benin
    Importation of the organism is subject to the following conditions:
13. Condition of Release
    i) The supplier must provide documents endorsing that an authorised officer of the plant protection service examined the shipment of the live organisms and were found to be to the best of his knowledge free from any undesirable species (hyperparasites, pest insects of predators, weed seeds, etc.)
    ii) The importation shall be restricted to ...See 11. Above
14. All packing material must be entirely free from soil, live plant material, leaf mould and must be autoclaved before discarding

"The permit is valid for [illegible] days of issue, and may be cancelled at any time by the Director of Agriculture or by the officer issuing the permit on his behalf"

Official stamp: (NAIROBI) 01 MAR 2023

BENARD MUKOYE
For: Director of Agriculture

* Permission hereby granted is [illegible] any permission or licence required under any other law

Laboratory assessment of the performance of introduced parasitoids on *Spodoptera frugiperda* and

stemborer species (*Busseola fusca*, *Chilo partellus*, and *Sesamia calamistis*)

Preliminary findings:

Chelonus insularis

1. Parasitism on FAW eggs of up to 80% under laboratory conditions.
2. Accepted to oviposit on *C. partellus;* however, it has failed to attack *B. fusca*

Cotesia marginiventris

- ❖ Parasitism on FAW larvae of ~90% under laboratory conditions
- ❖ parasitizes *B. fusca*, *Chilo partellus* and *Sesamia calamistis,* with higher parasitism rate on *B*. *fusca*.

Postgraduate training

Global Forum on Biological Control and Training Workshop on Biological Control

M.Sc. Students

Mercy Kibii (Kenya)

Anah Namara (Uganda)

Francis Obala (Kenya)

Birhanu Sissay (Ethiopia)

PhD students

Emanuel Peter (Nigeria)

Sokame è Mawuko

Birhanu Sissay (Ethiopia)

Jalloh Abdul A. (Liberia)

Post-doctoral fellow/Visiting Scientists

Dr. Mark Wamalwa (Kenya)

Dr. Sokame Mawuko (Togo)

Adeyemi O. Akinyemi (Nigeria)

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ToT and maize growers awareness

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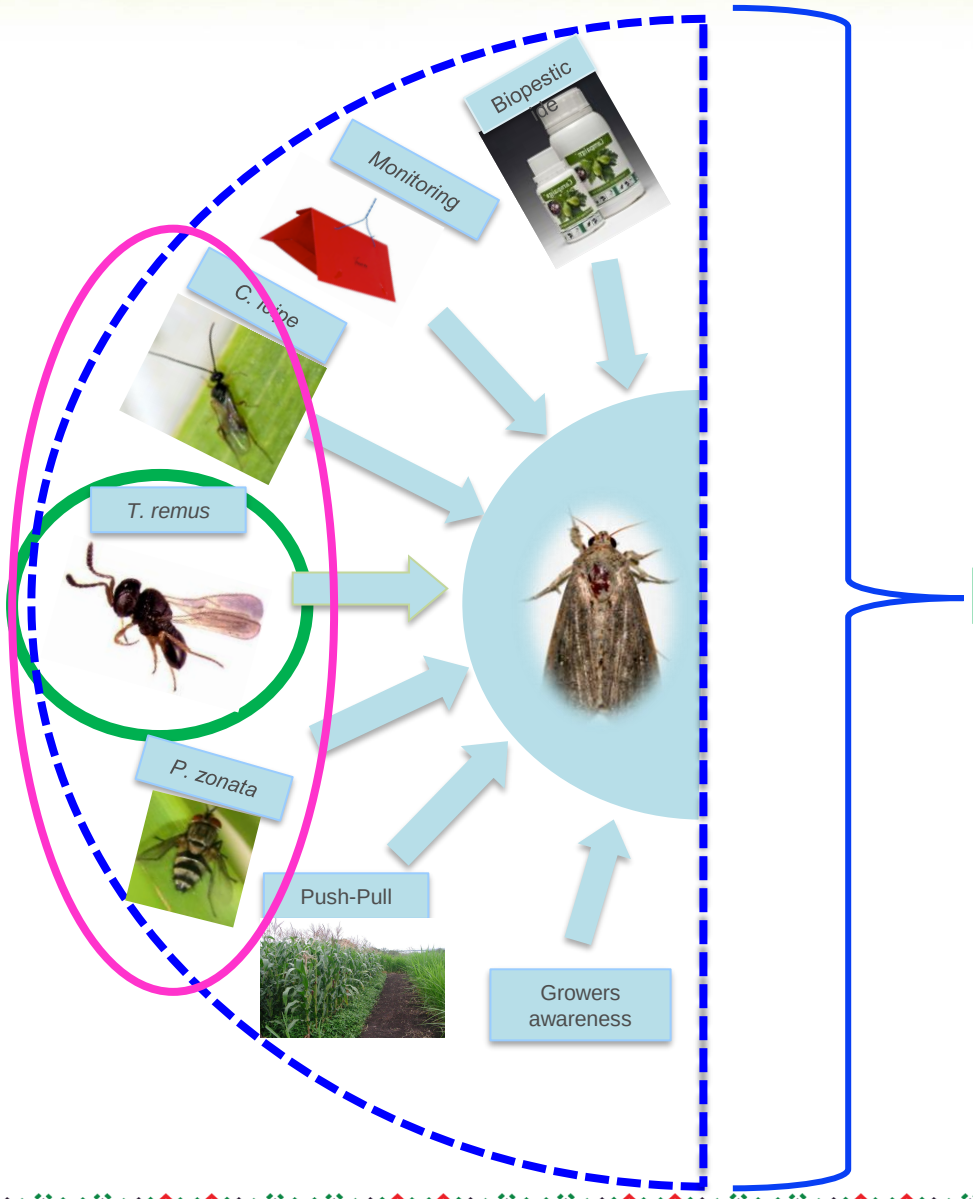
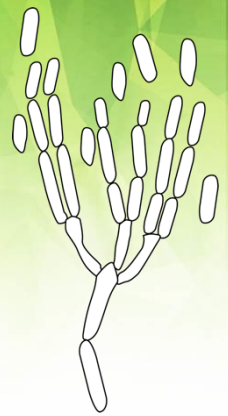
Use of parasitoid as key component of sustainable Agroecological IPM based approach for FAW management



- Enhanced productivity and food security
- Safer environment and farm produce
- Improved livelihood



Thank you

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