RESEARCH PROGRAM ON
Grain Legumes
CGIAR

Biological control of cowpea insect pests: progress, challenges and opportunities

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& World Cowpea Conference

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AVANI Victoria Falls Resort and Conference Center
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www.grainlegumes.cgiar.org

Leveraging legumes to combat poverty, hunger, malnutrition and environmental degradation.

LED BY ICRISAT Science with a human face

IN PARTNERSHIP WITH CIAT Centro Internacional de Agricultura Tropical International Center for Tropical Agriculture

ICARDA

IITA Research to Nourish Africa

and public and private institutes and organizations, governments,and farmers worldwide

Our strategy for pest control in grain legumes

Preventive interventions

- Improving plant resistance to pests
  - Marker-assisted breeding
  - Interspecific crosses
  - Transgenics (Bt-cowpea)
- Improving ecosystems services
  - Biological control (inoculative and inundative)
  - Ecological engineering

Curative interventions

- Application of pest-control products
  - Safe and rational use of synthetic insecticides
  - Bio-pesticides
  - Semio-chemicals

Biological control: a non-obvious option for managing insect pests in cowpea (*Vigna unguiculata* Walp.)

Without insect control, estimated average production loss of 3.8 million tons, ca. 3 billion USD losses every year

Pesticides can provide effective control, **but….**

Need for more sustainable plant protection approach

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Need for more sustainable plant protection approach

Pesticides in West Africa: problems at several levels

Policy:
Unregulated market, cheap imports of doubtful quality
Permeability of borders

Sprayer/farmer:
Protective equipment: availability, affordability, tropical weather
Pesticide retailer is the ‘village scientist’
Lack of technical knowledge

Consumer:
Pesticide residues – no reliable local infrastructures
Post-harvest pesticides

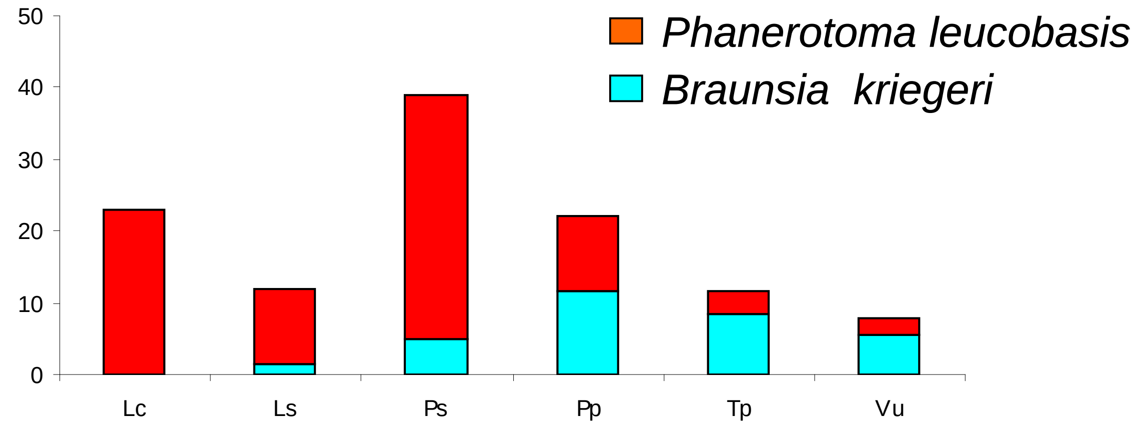
Environment:
Ground water contamination
Pesticide resistance, including in disease vectors
Pollinators
Natural enemies

An old enemy: the legume pod borer, *Maruca vitrata*

Attacks flowers and pods of various legumes, up to 80% yield loss

Biodiversity studies

Natural enemies of *Maruca vitrata* in West Africa



Lc: *Lonchocarpus cyanescens*

Ls: *Lonchocarpus sericeus*

Ps: *Pterocarpus santalinoides*

Pp: *Pueraria phaseoloides*

Tp: *Tephrosia plathycarpa*

Vu: *Vigna unguiculata* (cowpea)

Non-host specific parasitoids, low and insufficient parasitism rates

Arodokoun *et al,* 2006

What can we do??

1) Need to provide farmers with alternatives to harmful pesticide regimes, in the immediate short term. Bio-pesticides can be produced locally: 3 different business models

2) Need to design, develop and deploy a range of sustainable solutions to cowpea pest problems with a longer term perspective in the context of precision-IPM

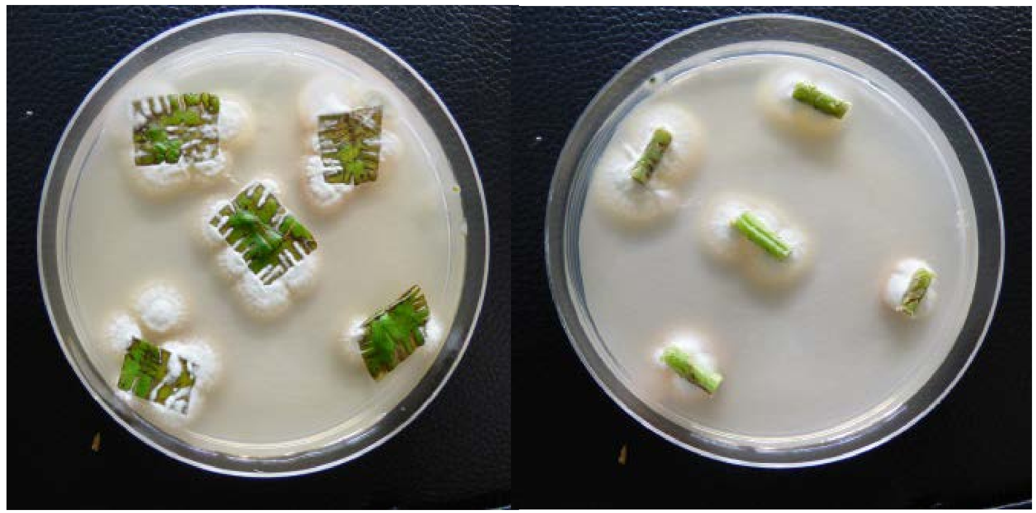
Business model #1: Social enterprise

Bio-fertilizers: useful and income-generating by-products, nematicidal effect, over 110 tons sold, supply cannot cover demand: **bio-pesticide value chain**

Bio-Phyto, Glazoue, Benin: 130 t of **neem** seeds collected by a community of 800 women during 1 year

Neem oil extraction, 500 l / week

Business model #2
Engaging with the private sector



Elephant Vert

- World largest production unit in Meknès (Morocco):
  For 2015, 50 000 tons of bio-fertilisers and 120 tons de bio-pesticides
- Exclusive MoU between Government of Benn, Elephant Vert and IITA for exploiting a fungal strain of the entomopathogen *Beauveria bassiana* under the Nagoja protocol for Access and Benefit-Sharing (ABS)

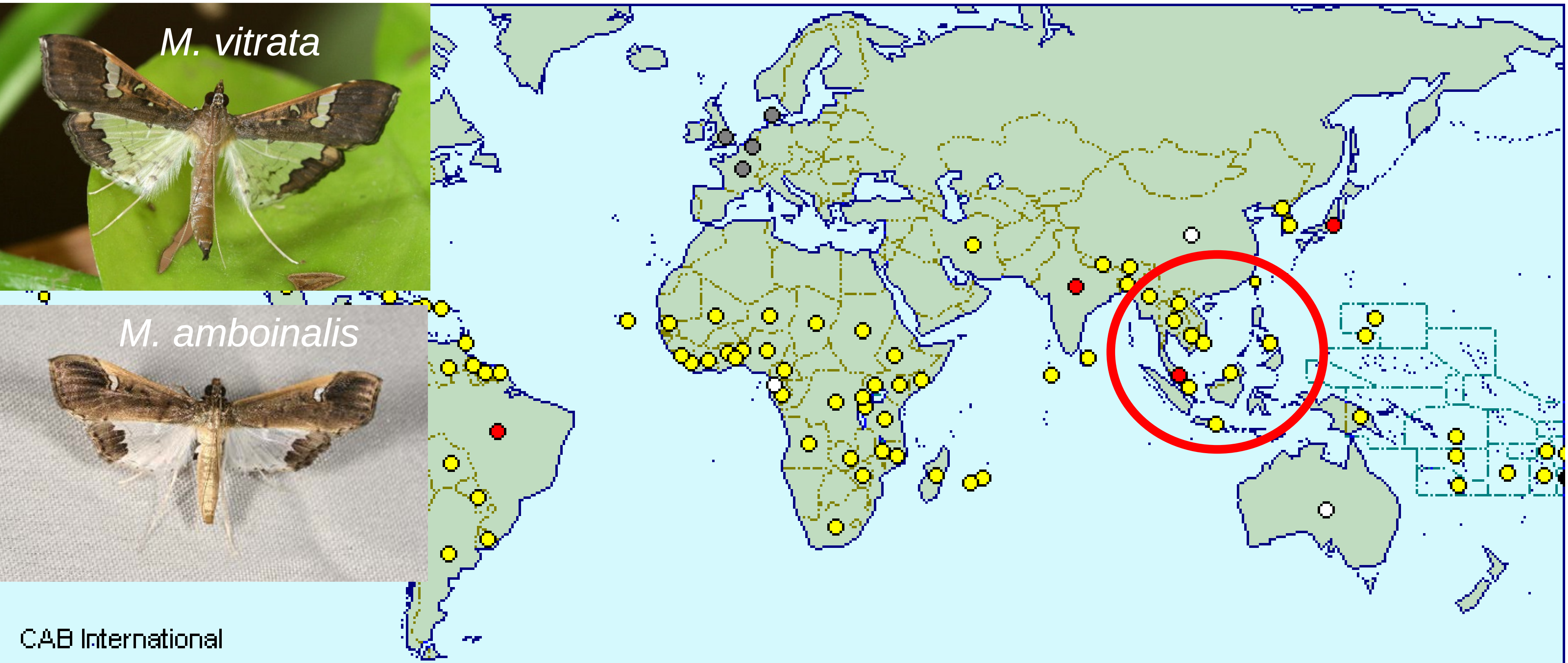
http://www.elephantvert.ch/elephant_vert_maroc/

Maruca vitrata Multiple Nucleopolyhedrovirus *Mavi*MNPV discovered at AVRDC

Treatment	1st rainy season Cowpea yield kg/ha	2nd rainy season Cowpea yield kg/ha
Unsprayed control	522,95 ± 28,20a	282,00 ± 21,88a
Chemical control (Decis)	868,62 ± 68,09b	652,75 ± 62,94b
Neem oil	826,42 ± 52,80b	691,22 ± 22,18b
Jatropha oil	867,90 ± 28,29b	533,60 ± 45,31b
MaviMNPV	875,12 ± 47,83b	545,07 ± 54,50b
Neem oil+ MaviMNPV	1082,10 ± 58,78c	552,47 ± 27,32b
Jatropha oil + MaviMNPV	1096,30 ± 26,05c	614,33 ± 11,34b

Sokame et al, 2015

In the meantime: what's the origin of *M. vitrata* and why do we bother?



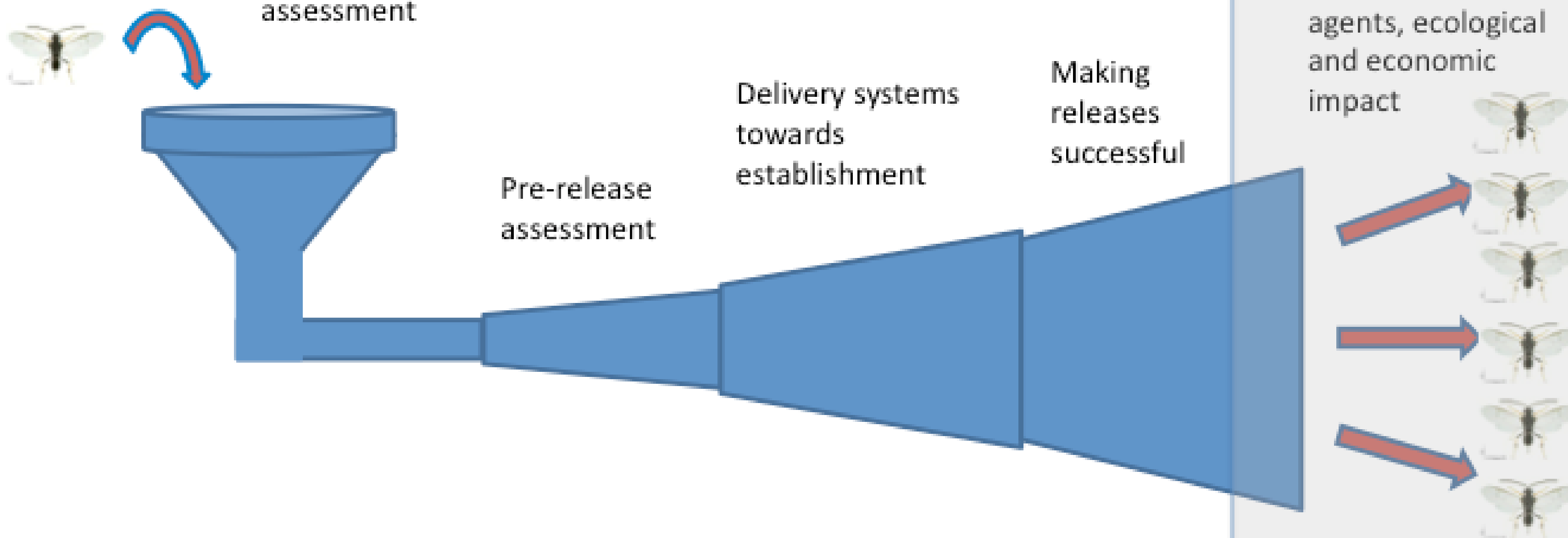
Source: CABI Crop Protection Compendium

Evidence of South Asian origin supported by latest population genetic studies (Periasamy et al, 2015)

Larger diversity of *M. vitrata* natural enemies in Asia: novel opportunities for biological control

- Our first case study: the exotic parasitoid *Apanteles taragamae,* an interesting biological control candidate
- up to 60 % parasitism on *M. vitrata* feeding on *Sesbania cannabina* in Taiwan (Huang et al, 2006)
- Poor ecological adaptation in W Africa, but useful for developing and testing the biocontrol pipeline (Dannon et al., 2012)

The biocontrol pipeline



	Discovery of biocontrol candidates	Technical assessment	Pre-release assessment	Delivery systems towards establishment	Making releases successful	Scaling of release of biocontrol agents, ecological and economic impact
Science involved	Biodiversity, ecology, biology, population genetics	Eco-climatic suitability, colony establishment, rearing methods, ex-ante socio-economic assessment	Host range, host finding behaviour, biosecurity, impact on biodiversity, interactions with other IPM methods	Suitability of gender-equitable mass production by private enterprises, innovative delivery/nursery systems	Capacity development, novel ICT methods for technology dissemination, targeting of release sites	Changes in pest population abundance and dynamics, yield data, savings from pesticide use, environmental, social and human health benefits

Steps in the pipeline towards delivery

How to feed the pipeline: novel biocontrol agents through joint GIZ-project with AVRDC

Therophilus javanus is the best ever parasitoid against *M. vitrata*, replacing *A. taragamae* in Taiwan

Diversity of *Therophilus* spp. in Vietnam and Cambodia

Up to 40% field parasitism on yard-long beans

Phaenrotoma philippinensis best candidate in Thailand

Picture of *Bassus (Therophilus) javanus* taken in Malaysia in 1995

Biological potential of parasitoids

Species	**Intrinsic rate of increase (r_m)**	**Finite rate of increase (λ)**
Therophilus javanus	**0,24**	**1,27**
Phanerotoma syleptae	**0,14**	**1,15**
Maruca vitrata	**0,19**	**1,20**

Dannon et al., unpublished data

After 2 years of confined testing: first experimental releases of *Therophilus javanus*

Therophilus javanus: the next biocontrol hero?

Pre-release sensitization campaign

Release sites

Beterou

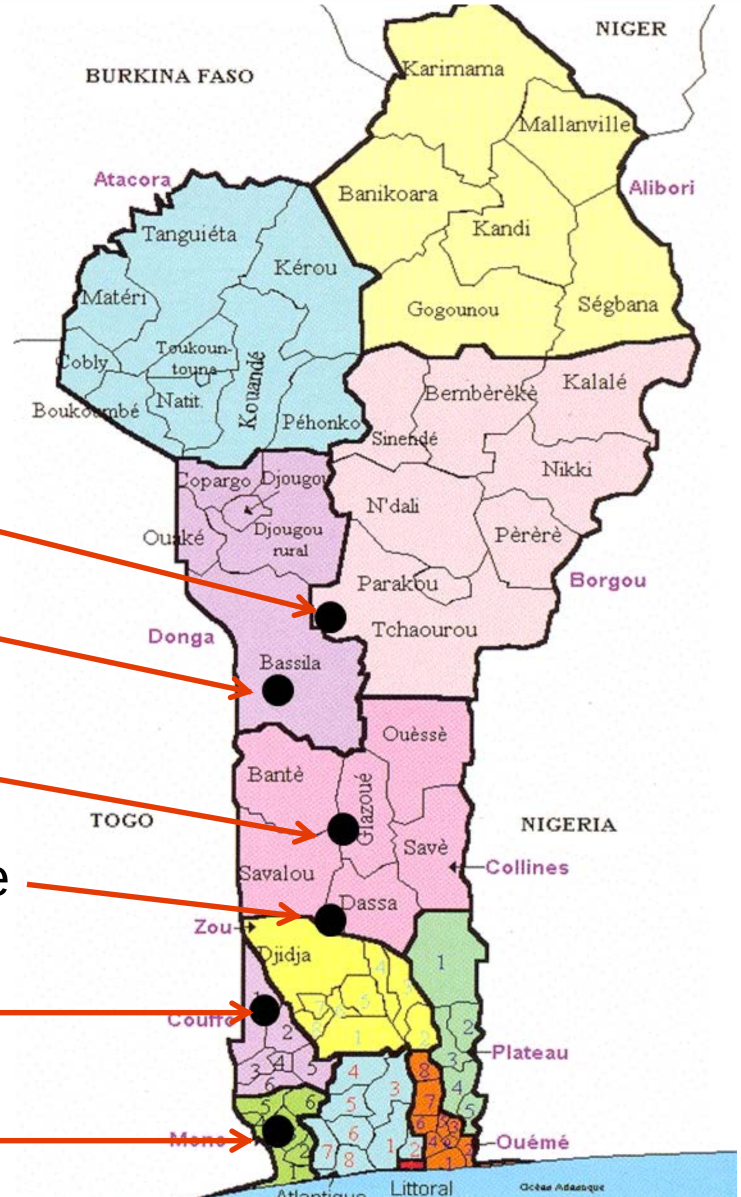
Bassila

Glazoue

Dassa-Zoume

Klouekanme

Houeyogbe



Alternative host plants flowering along major rivers

Releases using adult stages of parasitoids

For each site

- 2000 *Therophilus javanus*
- 1500 *Phanerotoma syleptae*

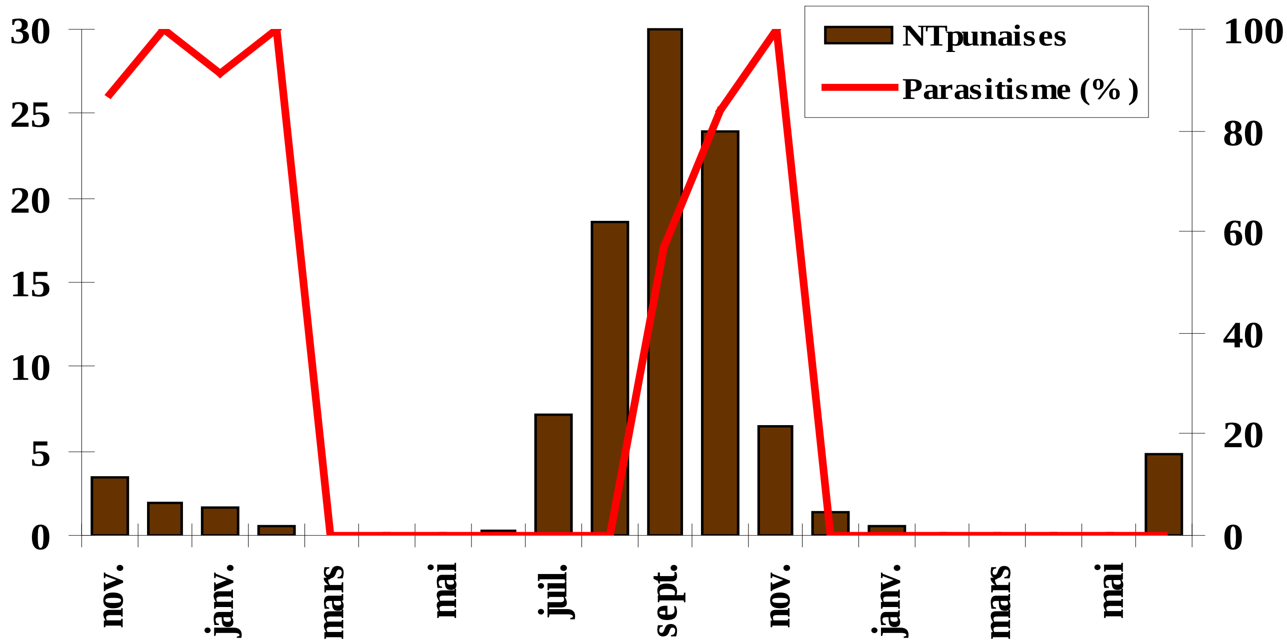
What am I going to report at the next conference in 4-5 years ?

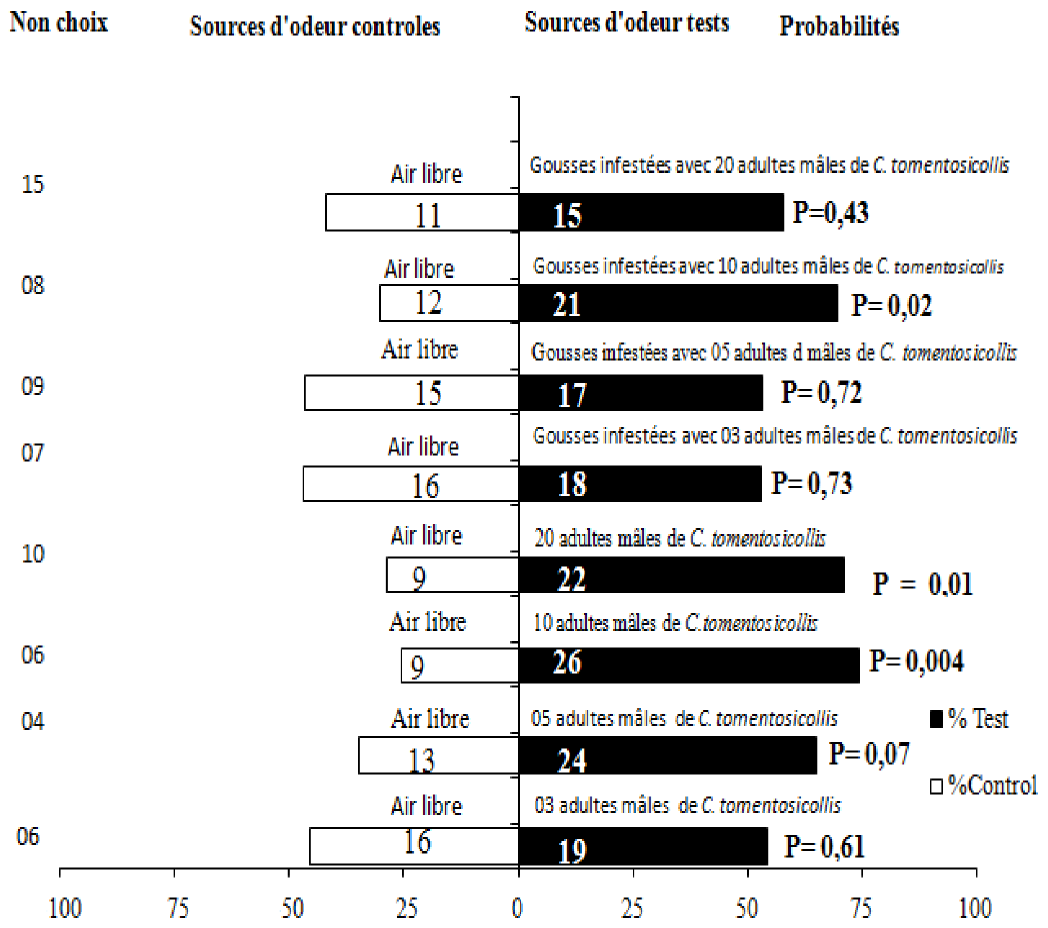
Expected impact:

- Released parasitoids colonize patches of wild host plants, from where they can follow the migration of *M. vitrata* when it invades the cowpea fields during the cropping season
- Overall *M. vitrata* population reduction of 40-60% depending on agro-ecological region
- Integration of biological control with compatible IPM measures such as Bt-cowpea and bio-pesticides
- Leading to an overall reduction of chemical pesticides by >90%

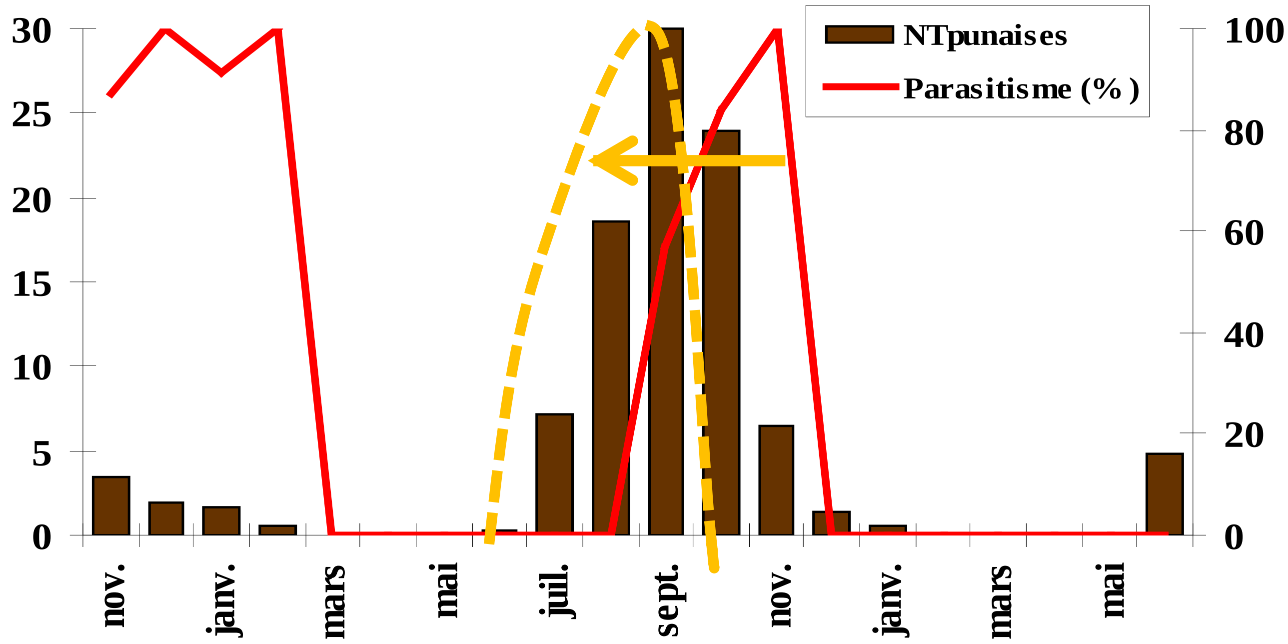
Collaboration with INERA and *icipe* to start tackling a neglected yet important problem of pod sucking bugs from an ecological perspective

Population dynamics of the pod bugs *Clavigralla tomentosicollis* and its egg parasitoid *Gryon fulviventre*





Empirically derived evidence of male aggregation pheromone emission, currently being investigated at *icipe*



Can we engineer a system where the egg parasitoids are attracted earlier in the season by the male aggregation pheromone and attack first generation egg masses?

Research to Nourish Africa

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Next steps: BMGF precision IPM project

Three main pillars:

1) Development of a **prototype Expert System (ES)** for modeling pest attack combined with a **Farmer Interface Application (FIA)** that has the potential for both receiving data and delivering pest control recommendations

2) Experimental releases of **biological control agents** and assessment of their effectiveness

3) Completion of ex ante economic and financial analyses to **estimate the potential impact of biologicals** with complementary financial analysis of community biopesticide production

Thanks to all our collaborators

In Africa

Cowpea farmers, extension agents, NGO personnel

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Thanks for your attention !