RÉPUBLIQUE FRANÇAISE
Liberté Égalité Fraternité

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CULTIVER PROTÉGER autrement

MINISTÈRE DE L'ENSEIGNEMENT SUPÉRIEUR, DE LA RECHERCHE ET DE L'INNOVATION
Liberté Égalité Fraternité

INVESTIR L'AVENIR

AGENCE NATIONALE DE LA RECHERCHE
ANR

PheroSensor
Early detection of insect pests using pheromone receptor-based olfactory sensors

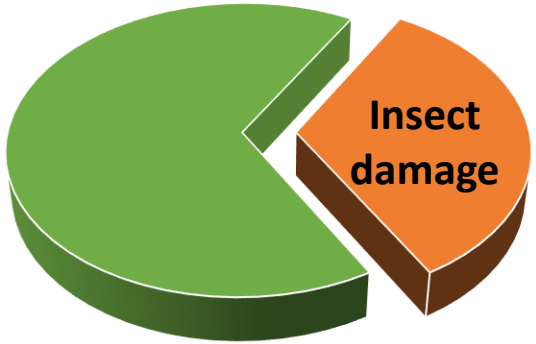
Philippe LUCAS

Kick-off meeting, 23 Septembre 2020



Early detection of insect pests is an urgent challenge

Insects destroy 1/3 of crop production



invasive insects cost
> US$70 billion/year

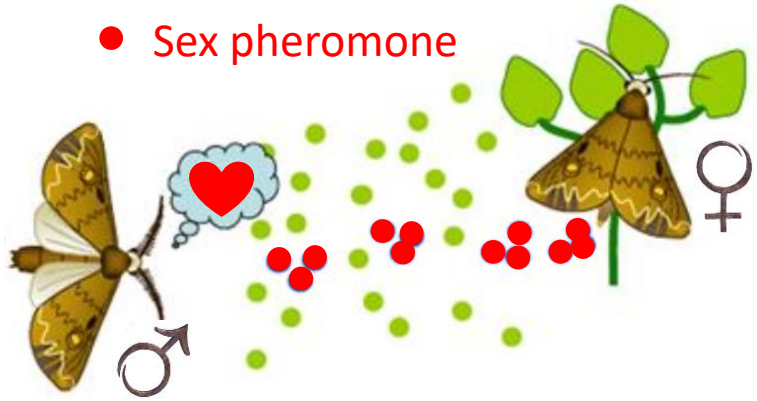
Early detection of insect pests

↓

- optimal action before infestation settles
- targeted biocontrol strategies

Insects communicate with species-specific pheromones

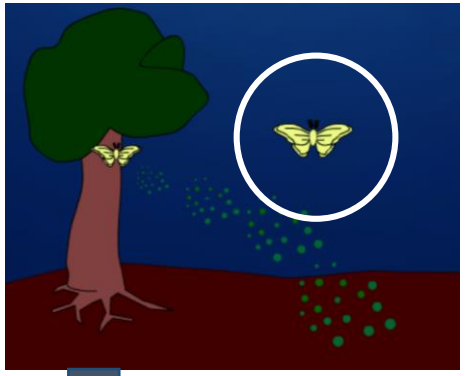
- Pheromones: signals indicating the presence of a given insect species
- Pheromone detection: based on highly sensitive and specific receptors



PheroSensor proposes to design, build and test in the field bioinspired sensors, based on insect pheromone receptors, for the early monitoring of invasive insect pests

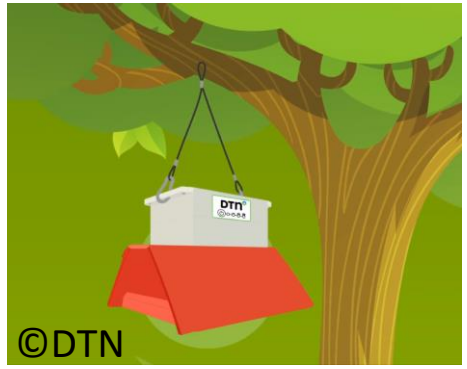
The detection of insect-specific odors
A new strategy to monitor insect populations

Trapping insects



Pheromone traps

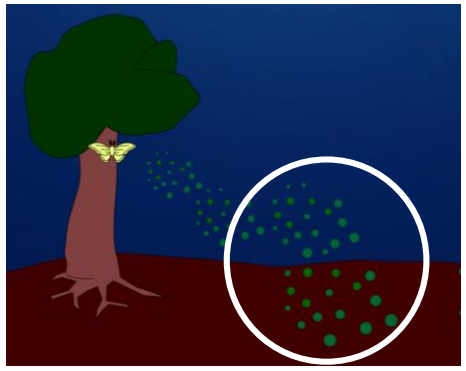
Connected traps



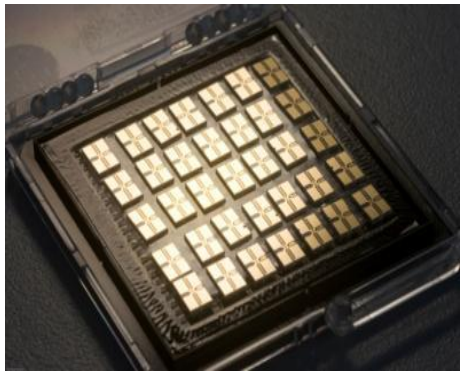
- Diffusion rate and quality of pheromone must remain stable
- Capture identification & counting is an issue

Innovative paradigm

Detecting insect pheromone



Sensors for the remote detection of pheromone

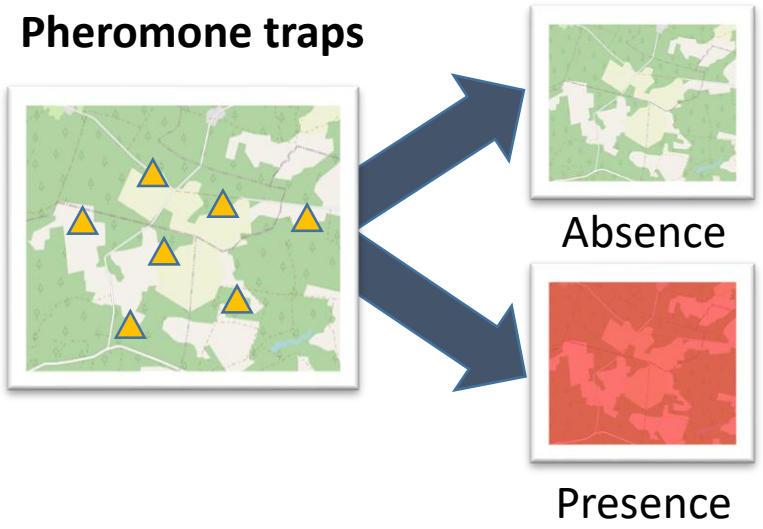


Potential advantages of sensors over traps

- Real-time measure - no insect identification / count
- No issue of pheromone stability and emission rate
- No attraction of pests from neighboring areas
- Not dependent on specific insect behaviors

Sensors should provide more precision to build risk maps
→ Precision agriculture

Pheromone traps



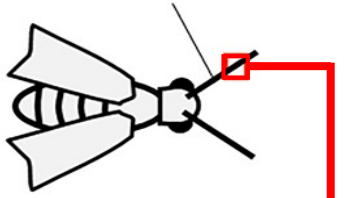
Detection → uniform treatment, even where there are no pests

Pheromone sensors

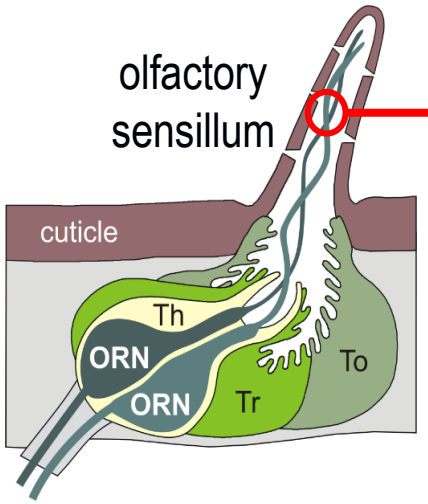
Risk maps → adapt and proportionate treatments to the threat = precision agriculture and drastic reduction of pesticide use

Sensors will be based on insect pheromone receptors

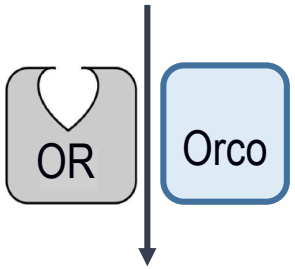
Antenna - sensilla



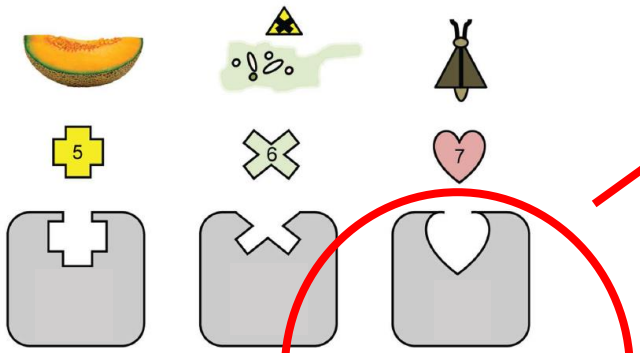
olfactory sensillum



Olfactory receptor (OR)



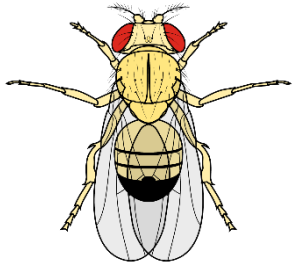
ORs for ecologically relevant odorants are specific



pheromone receptors (PRs)

Biological sensors

Sentinel flies



Electroantennography (EAG)

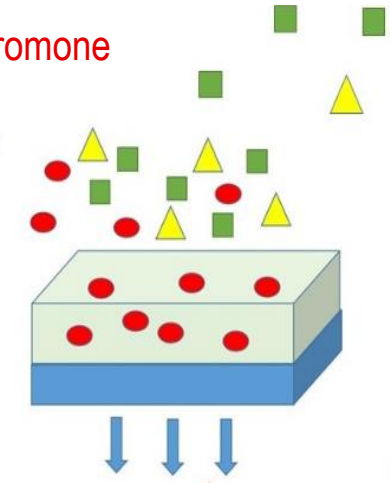
Electrical response

GOLD STANDARD

Physical sensors

pheromone

Sensitive layer
Immobilized PRs
Transducer
Synthetic diamond technology

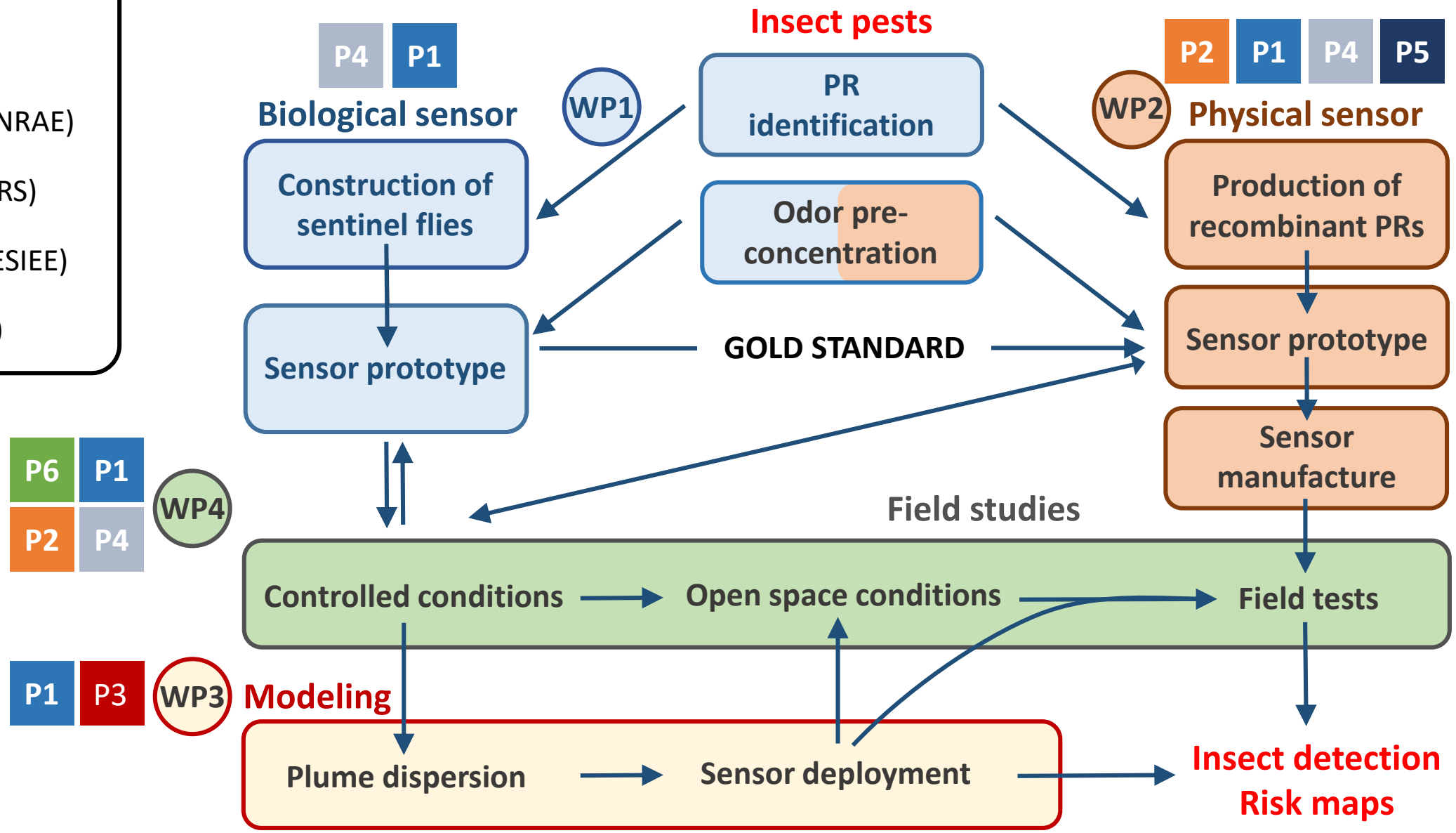


Electronic readout

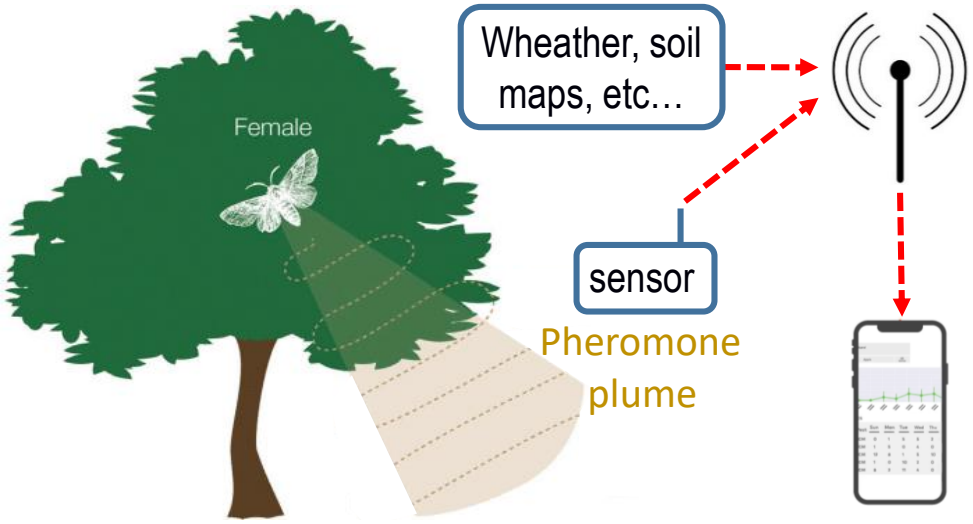
Project workflow

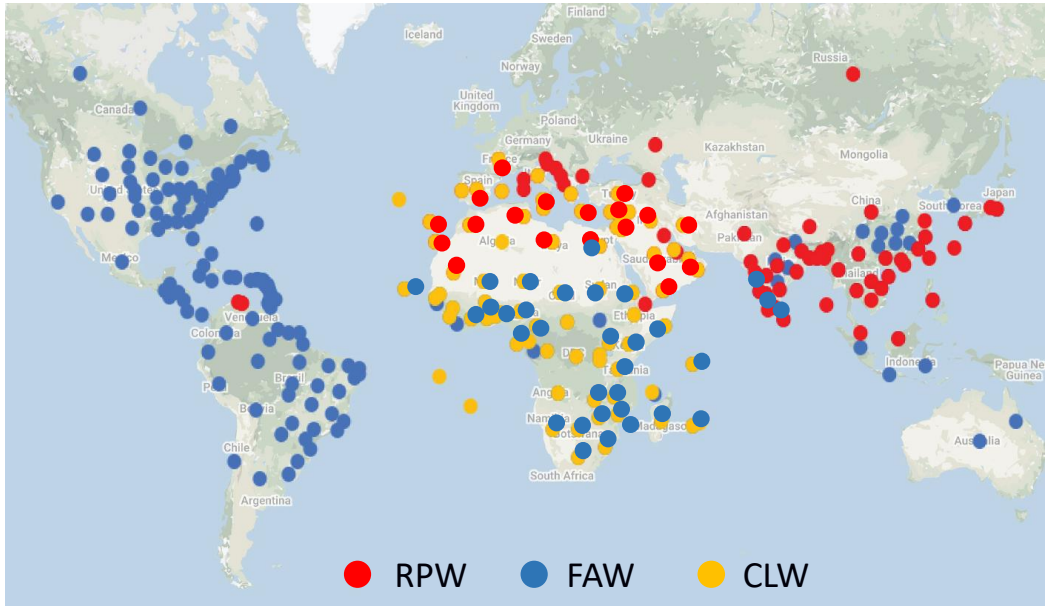
6 Partners / 5 Institutes

- P1 iEES (INRAE)
- P2 LIST (CEA)
- P3 MaIAGE (INRAE)
- P4 LORIA (CNRS)
- P5 ESYCOM (ESIEE)
- P6 EGCE (IRD)



Active surveillance of three major invasive insect pests





Red palm weevil
4-methylnonan-5-ol
Aggregation pheromone

100s M€ /year
in Europe

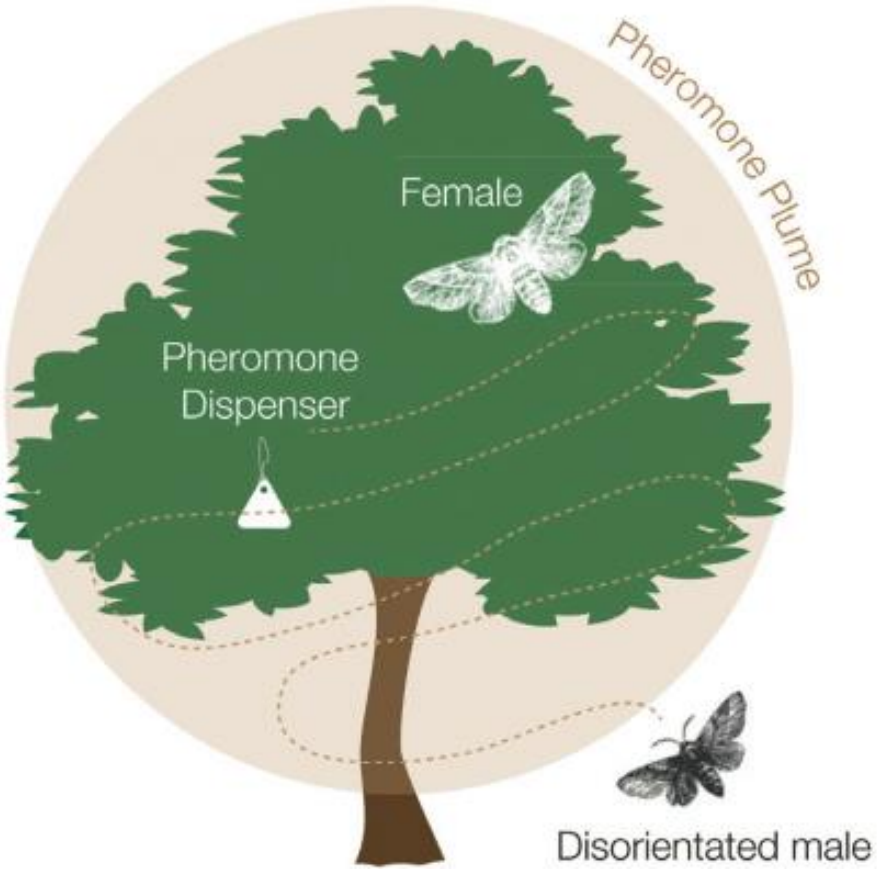
2-5 B€ /year

Fall armyworm
Z9-14:Ac
Sex pheromone

Cotton leafworm
Z9,E11-14:Ac
Sex pheromone

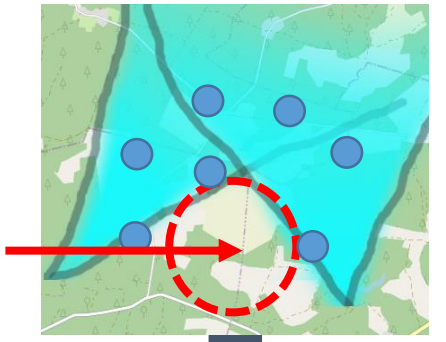
Surveillance of all insects communicating with sex or aggregation pheromones

Pheromone sensors can improve mating disruption



Plume detection

white
zone



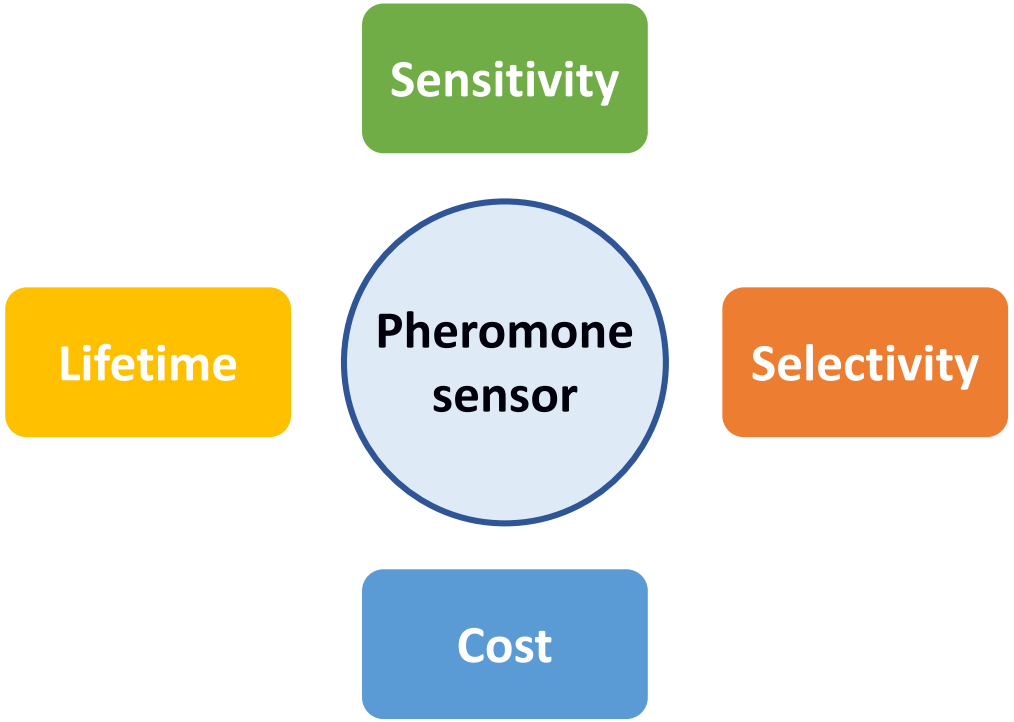
Detection of "white zones" during mating disruption

Optimal positioning of pheromone dispensers

Indicators of success

Innovative technology

- **Properties of the sensors**
- **Economic viability for pesticide reduction**



Bioinspired sensor

Pheromone receptors are THE receptors designed by Nature to be highly sensitive and specific to the odors of interest

Cost

☹ Large investments for the demonstrators

but reduced costs in the long term

☺
- Pheromone receptor production optimized
- Low cost achievable for diamond thin films
- Diamond surfaces can be reused indefinitely
- Electronics mass produced → cheap electronic readout

Impacts

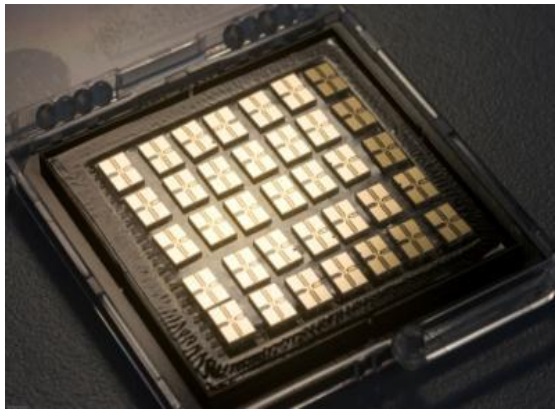
Short term (5 years): dissemination on the sensor properties and optimal conditions of their use (papers, softwares, patents, …)

Long term (>20 years): integration of sensor use on pest management routines, return on investment (patents)

Insect OR-based sensors have many other potential applications

Agriculture
Food industry

Medical
Health care



Environment

Security

Insect olfactory receptors are unique in terms of structure and diversity
They detect many other volatile compounds than pheromones

PheroSensor: 6 Partners from 5 Institutes

1. **iEES (INRAE) – Versailles**
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3. **MaIAGE (INRAE) – Jouy-en-Josas**
   Simon LABARTHE (simon.labarthe@inrae.fr) WP3 leader

4. **LORIA (CNRS) – Nancy**
   Dominique MARTINEZ (dominique.martinez@loria.fr) WP1 leader

5. **ESYCOM (ESIEE) – Marne-la-Vallée**
   Gaëlle LISSORGUES (gaelle.lissorgues@esiee.fr)

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