

Food and Agriculture Organization of the United Nations



International Plant Protection Convention

Department for Environment Food & Rural Affairs

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## **Zero Pest Damage**: Potential future alternatives to chemical control

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National Program "Moonshot R&D" GOAL 5 – Creation of the industry that enables sustainable global food supply by exploiting unused biological resources by 2050.



Chemical pesticides sometimes become trade barriers due to differences in regulations by countries.

The purpose of our project is to build a new pest management system with substantially less chemical pesticide use.





- Kyoto University
- NARO (National Agriculture and Food Research Organization)
- Tohoku University
- Osaka University
- Tokyo University of Agriculture and Technology
- Setsunan University
- Jikei University
- Tokyo University of Agriculture

Background



## Pest damage causes crop loss

## Insecticide resistance



After Sharma et al. (2017), Oerke et al. (1994)

Sparks et al. (2020)

#### **Scope – IPM tools**





#### Approach – 3 steps to reduce insect pests



Wide area: migratory pests
Density reduction with symbionts (incompatible insect technique)

Around fields: flying pests

Laser beam shooting

## In fields: minute pests

 Surface irradiation of lasers & biological control agents (BCAs) enhanced





	Symbionts	Laser shooting	BCAs
Initial outcomes	Artificial culture of insect-symbionts in living host insects	Successful prediction of flying path of insects with AI	New <b>genome editing</b> <b>method</b> and RNA interference (RNAi) systems on BCAs
Challenges	<ul> <li>Culture system</li> <li>without living host insects</li> <li>Incompatible insect techniques by symbionts</li> </ul>	<ul> <li>Capturing irregular flying patterns of insects</li> <li>Concerns over safety and reliability</li> </ul>	- Genome information-based breeding and elucidation of BCAs' function



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#### Laser beam shooting technique





Stereo camera 1024x768 pixel, 55 FPS



Spodoptera litura (Adult moth) 15-30 mm length 0.5-1.0m/s flying speed



#### **Prediction of flight position**





- Processing an image takes 0.03 sec (2 frames), and this time lag must be compensated.
- The prediction method provides flight position 2 steps ahead.

#### Laser beam shooting technique: simulation







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#### **Genome editing on Biocontrol Agents**



# Cell Reports Methods

Report

# DIPA-CRISPR is a simple and accessible method for insect gene editing

Graphical abstract





Shirai et al. (2022) Cell Rep Methods

#### **RNAi on BCAs**







## Genome editing RNAi



#### Stronger, bigger eaters'

#### Analysis and control of their behaviour



Orius strigicollis



Nesidiocoris tenuis





Propylea japonica

Neoseiulus californicus



## By 2050, insect pests can be controlled without chemicals

# Reducing the use of chemical pesticides contributes to world trade!





## Thank you for your kind attention

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