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Pest-Smart Practices and Early Warning System under Climate Change

A Manual for Rice and Other Crops

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Photographs on the cover by: Leocadio Sebastian

Pest-Smart Practices and Early Warning System under Climate Change

A Manual for Rice and Other Crops

Centre for Agriculture and Biosciences International - Southeast Asia
CGIAR Research Program on Climate Change, Agriculture and Food Security - Southeast Asia

Foreword

Climate change is triggering existing and new combinations/complexes of pests and diseases (P&D) to spread, and its impacts (drought, flood, salinity intrusion, among others) make P&D management more difficult. These make a great portion of Southeast Asian farmers' rice production at risk because of possible P&D outbreaks. The risk is further aggravated by the inadequate knowledge of farmers to cope with P&D as affected by climate change.

To help Southeast Asian farmers cope with P&D problems, the Centre for Agriculture and Biosciences International (CABI) Southeast Asia with support from the CGIAR Research Program on Climate Change, Agriculture and Food Security in Southeast Asia (CCAFS SEA), conducted "pest-smart" interventions. This project was piloted in three Climate-Smart Villages (CSVs) under CCAFS SEA, such as Tra Hat CSV in Vietnam, Rohal Suong CSV in Cambodia, and Ekxang CSV in Laos.

The Pest-Smart program has enabled farmers, particularly women and marginalized groups, to become resilient against potential P&D outbreaks due to climate change. It has served as a platform in promoting climate-smart agriculture technologies and practices and in building the capacity of farmers to deal with problems concerning P&D.

This simplified manual "Pest-Smart Practices and Early Warning System under Climate Change" is part of the program's vision to develop pest-smart farmers in the region. The manual brings together the relevant information to control and manage various P&D in rice in the context of climate change. This publication has been translated into local languages for wider use by extension workers and farmers.

Lastly, congratulations to the team of experts, led by Dr. Sivapragasam Annamalai, for coming up with this publication.

Dr. Leocadio Sebastian
Regional Program Leader
CCAFS Southeast Asia

Acknowledgements

The authors would like to thank all colleagues who participated and contributed to the completion of this manual: Dr. Leocadio Sebastian for his support (CCAFS SEA); Mr. Eisen Bernardo for the illustrations and book design (CCAFS SEA); our external reviewers - Dr. Ravindra Chandra Joshi (University of South Pacific, Fiji), Dr. Paul Pavelic (IWMI), Dr. Jothiganesh (RIMES, Thailand), Dr. Yumiko Kura and Mr. Eam Dyna (WorldFish, Cambodia); our international partners - Dr. Ho Van Chien, Mr. Bora Soeung, and Mr. Vu Thy Chin (Aphivat Strey), Mrs. Siea Kimnay, Mr. Chhun Hy Heng, and Mrs. Ly Yan (PDA Cambodia), Dr. Hanh Tran and Mr. Loc (SOFRI, Vietnam), Mr. Duong Le Minh (DARD Bac Lieu, Vietnam), Mr. Tiangkham Vongsabouth and Mrs. Pinkham (PPC, Laos); and to all those who help in making this publication possible.

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International Rice Research Institute (IRRI)
Leocadio Sebastian, CCAFS Southeast Asia
Northern Mountainous Agriculture and Forestry Science Institute (NOMAFSI)
Philippine Rice Research Institute (PhilRice)


Photo by Leo Sebastian

About this manual

Climate change affects large areas in our planet due to temperature changes, sea level rise, and increased risk of prolonged droughts or severe flooding. In this regard, this manual was produced to tackle major questions pertaining to climate change and its effects on pests and diseases outbreaks in Southeast Asia.

The present manual is intended to be user-friendly and to provide simple and helpful information to farmers and extension agents; yet it can be read by a larger audience interested in solving pests and diseases issues in the context of climate change.

In the first chapter, we introduce the effects of climate change on agriculture, then second chapter, we detail the effects of climatic factors on the development of pests and diseases. Chapter 3 highlights the importance of an Early Warning System and its use followed by pest-smart interventions and recommendations to alleviate problems due to pests and diseases in the context of climate change.

How to use this manual?

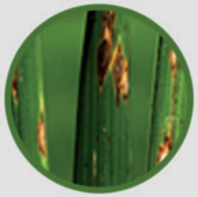
1. Assess the climatic conditions

Understand the consequences of climate change to Pests and Diseases.

Ex: continuous rain

2. Implement an Early Warning System

Assess the pest population and decide whether to take action or not.



Pests and Diseases

3. Decide interventions against Pests and Diseases

Follow Pest-Smart solutions against Pests and Diseases.

Photos by: (a) Eisen Bernardo; and (b,c) IRRI

Table of Contents

1. Introduction

1.1 Agriculture and climate change

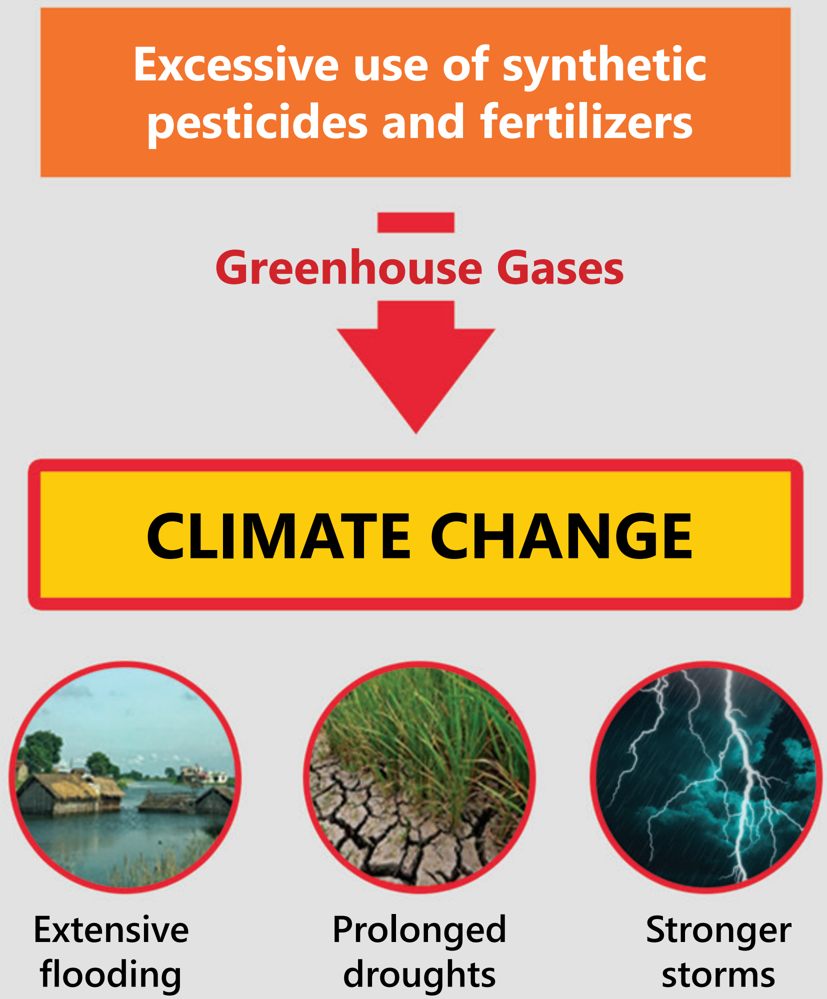
Modern agriculture has helped farmers to increase their yield, but future farming systems need to integrate the concept of sustainability.

Current farmers' practices can have profound effects on our environment due to excessive use of pesticides and fertilizers.

Such practices increase the emissions of greenhouse gases. These gases are known to cause and aggravate climate change.

Photos by: IRRI

1.1 Agriculture and climate change



Photos by: (a,b) IRRI and (c) Eisen Bernardo

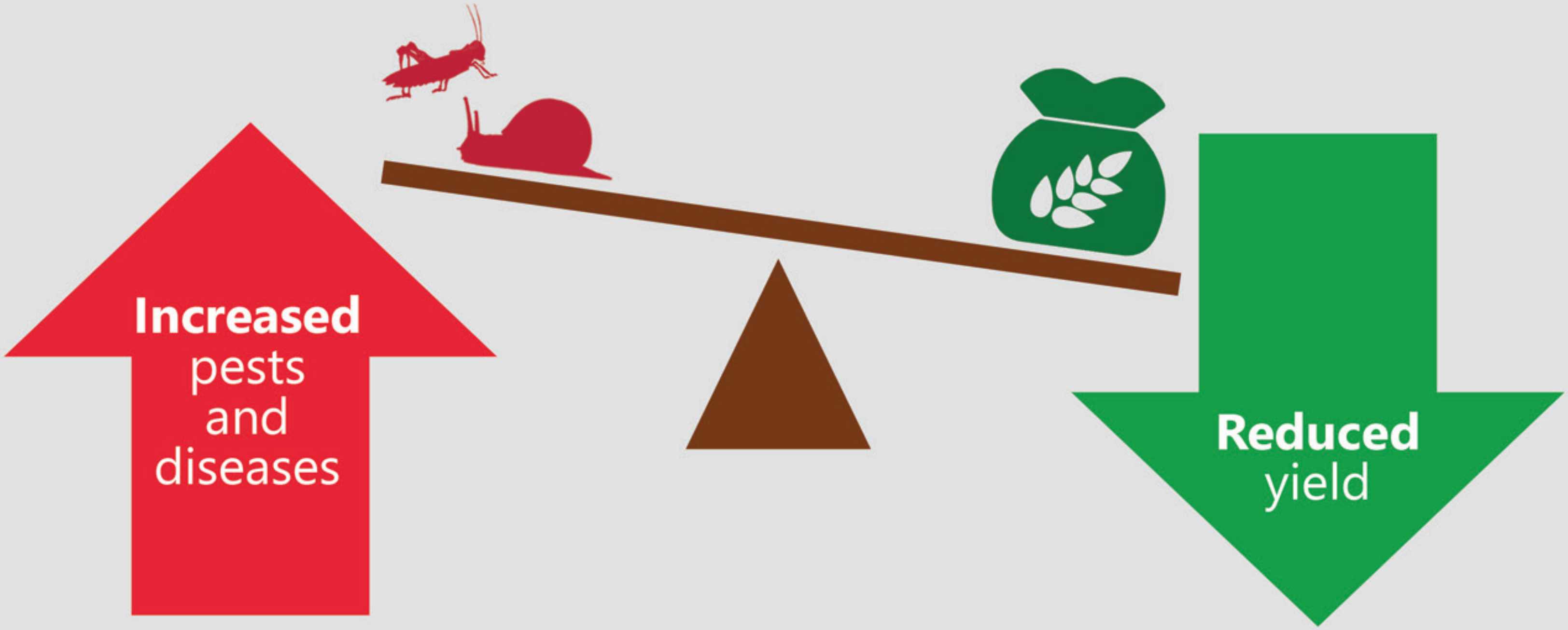
1.2 Abiotic factors affected by Climate Change

Climate change effects		Abiotic factors
	**Change in temperatures**	Higher temperatures or colder temperatures, extreme and unpredictable variations.
	**Stronger storms**	More rain, stronger winds.
	**Extensive flooding**	Higher humidity, repeated /heavy rains Higher salinity with sea water intrusion.
	**Prolonged droughts**	Lower humidity, lack of rain.

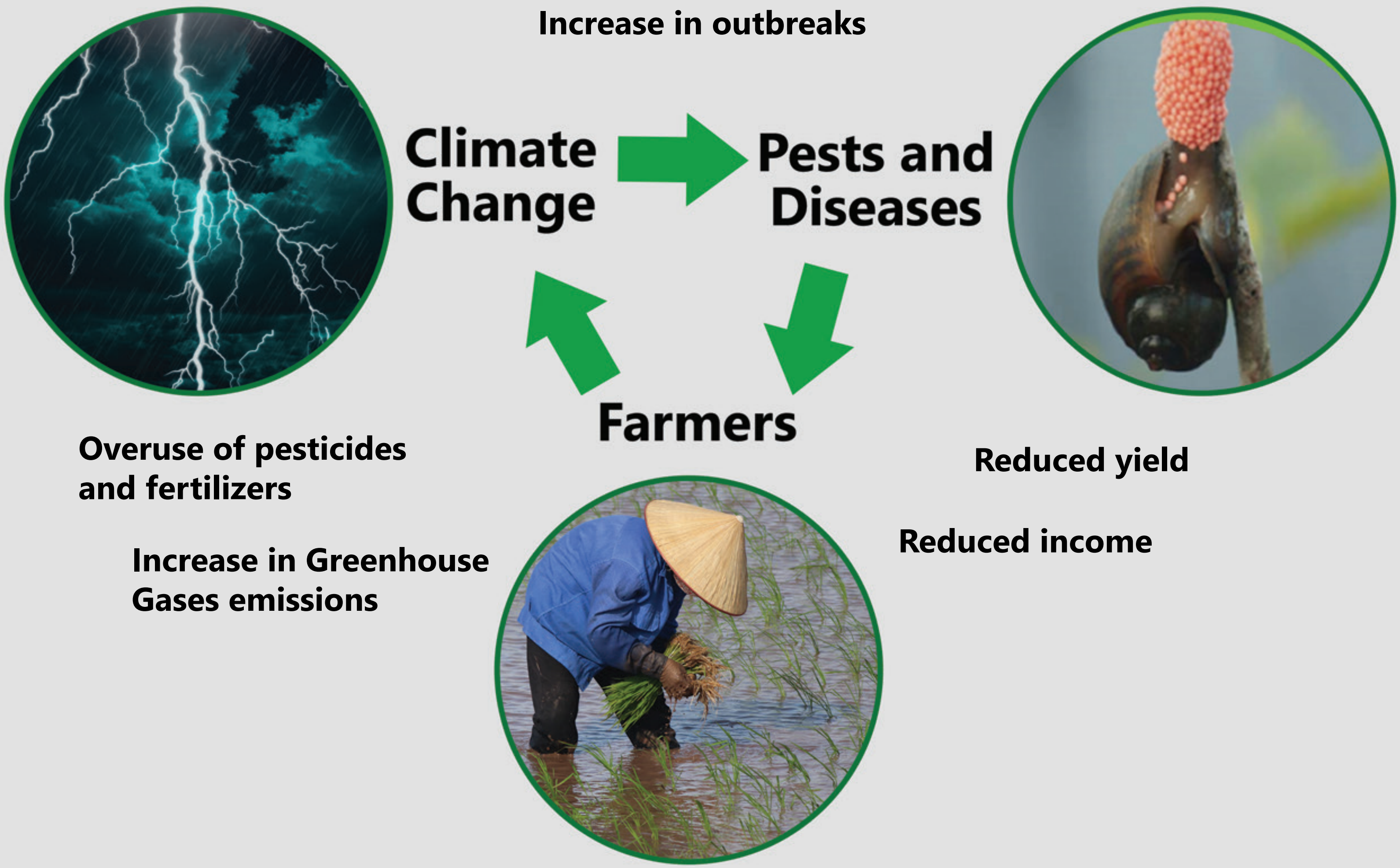
Photos by: (a) Leo Sebastian; (b) Eisen Bernardo; and (c,d) IRRI

1.3 Farmer practices, climate change, and Pests and Diseases

Unpredictable temperatures on Earth due to climate change can reduce crop yields and will **increase the risk of pests and diseases**.



1.3 Farmer practices, climate change, and Pests and Diseases



Photos by: (a) Eisen Bernardo; (b) Leo Sebastian; and (c) CABI

1.4 About Pest-Smart

Why Pest-SMART?

Pest-SMART is the smart way of dealing with pests and diseases; it is a part of the CCAFS programme on climate change.

Pest-SMART aims to mitigate the risk of Pests and Diseases in the context of climate change.

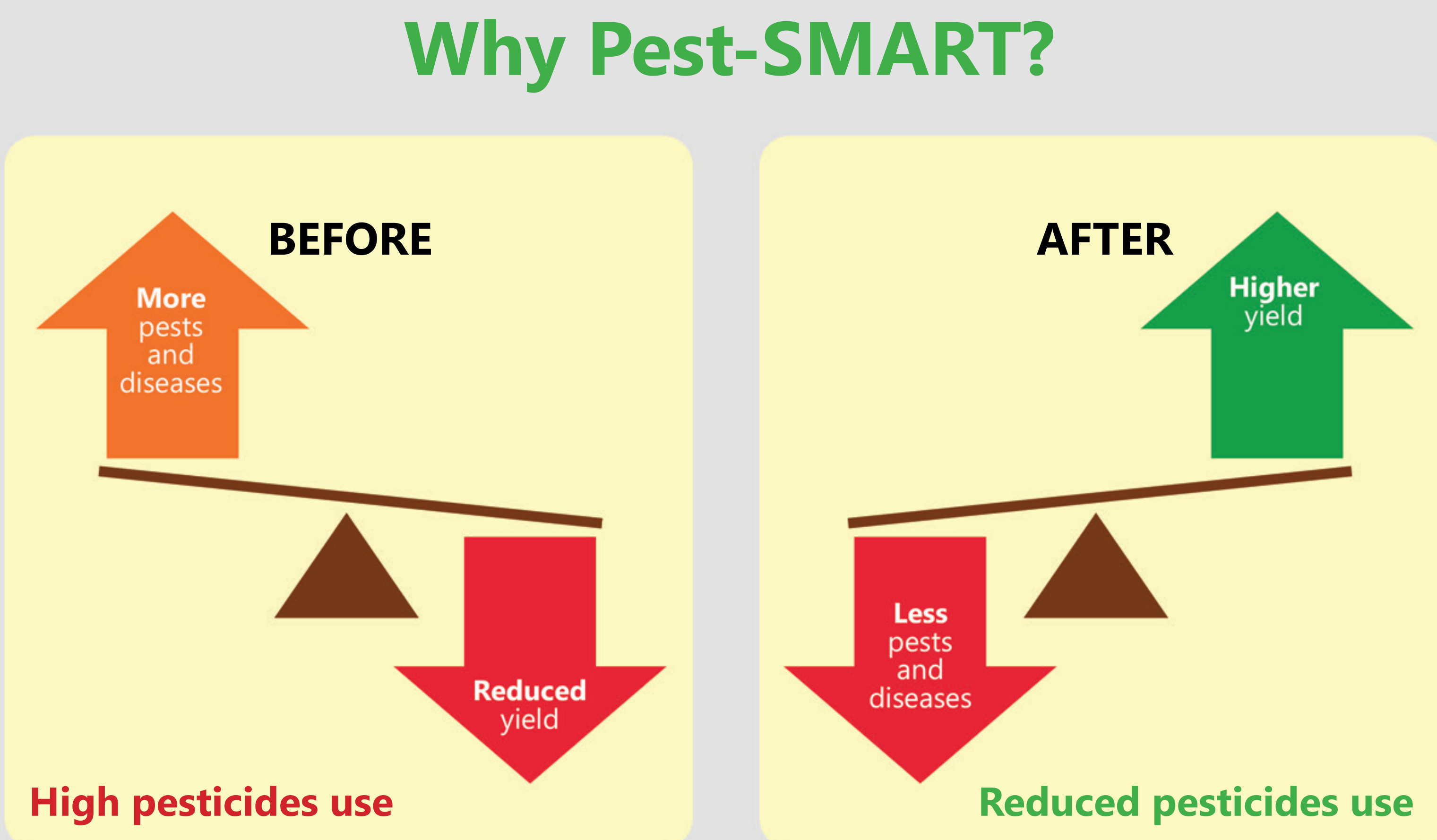
Pest-SMART aims to reduce the use of pesticides and fertilizers by adopting alternative and safer methods.

Photos by: (a,b) Arnaud Costa

1.4 About Pest-Smart

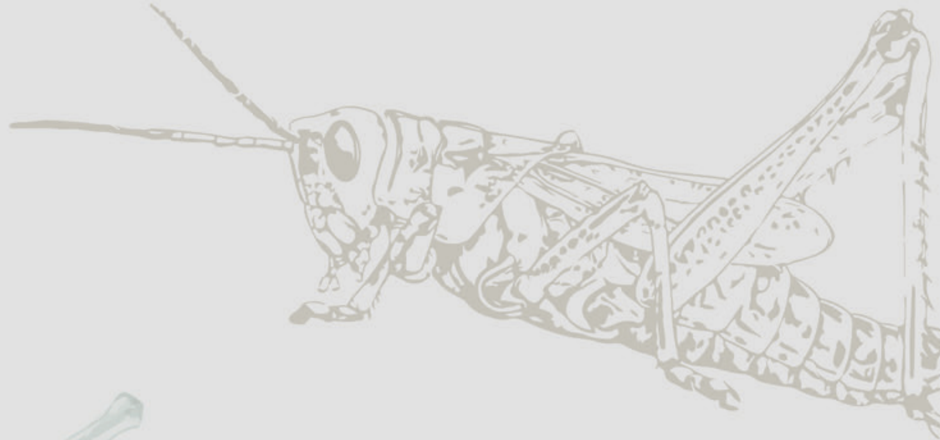
Messages from farmers and advisors

1.4 About Pest-Smart



Before (1) and after (2) Pest-Smart: increased and more sustainable yield.

1.5 Managing Pests and Diseases under Climate Change



2. The Effects of Climate Change on Rice Pests and Diseases

2.1 The effects of climatic factors on the main pests and diseases on rice

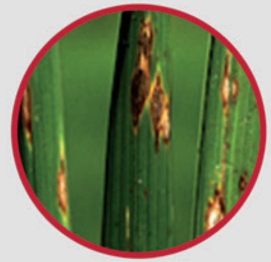
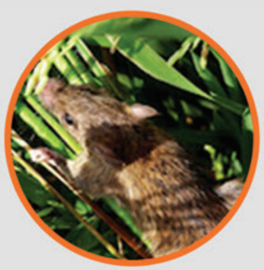
Climate Change increases the risk of pests and diseases, which could reduce farmers' yield.

Rice Pests and Diseases

RICE YIELD REDUCED

Photos by: (a,f) Leo Sebastian; and (b,c,d,e) IRRI

2.1 The effects of climatic factors on the main pests and diseases on rice

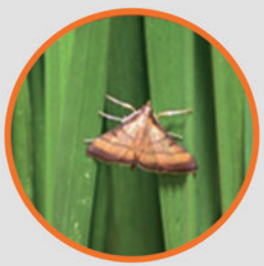
MAIN PESTS		MAIN DISEASES	
	**Brown Plant Hopper** Reproduction and development linked to temperature, highest at 34-38°C		**Rice blast** Most of the severe infection occurs between 22-24 °C and more than 80% of infection severity is reported at 19-28 °C.
	**Invasive Apple Snail** Optimal temperature range between (20-25°C). After drought, can remain buried for up to 10 months		**Sheath blight** Occurs at high temperature (28−32°C), high levels of nitrogen, and high humidity (>85%)
	**Rodents** Different rice planting times can trigger major outbreaks		**Bacterial blight** Commonly observed at 25−34°C, during heavy rain seasons with winds

Photos by: IRRI

2.1 The effects of climatic factors on the main pests and diseases on rice

MAIN PESTS

Grasshoppers
Abundant during drought outbreaks at high temperatures



Leaf folders and Stem borers
At 25-30°C, hatching and development are improved. Higher temperatures slow the growth rate.

Slender rice bugs
With the first rains, they threaten rice crops and feed at temperatures < 30°C.

MAIN DISEASES

Brown spot
Develops in relatively high humidity (>89%) at 27-30°C and infection is favoured by free water on leaf surface.

Red stripe
High leaf wetness and high nitrogen supply favours the spread of disease.

Bacterial leaf streak
Occurs with high temperature and high humidity

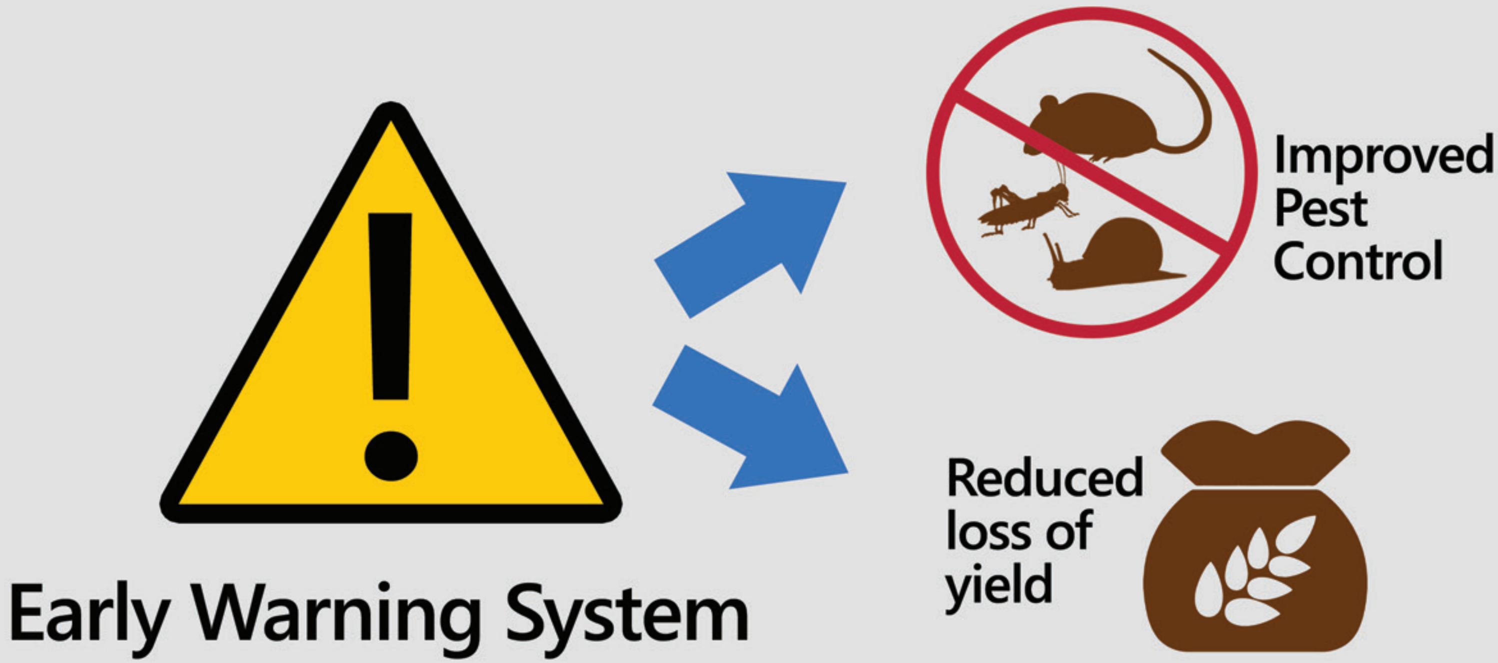
Photos by: IRRI

3. An Early Warning System and Pest-Smart Practices

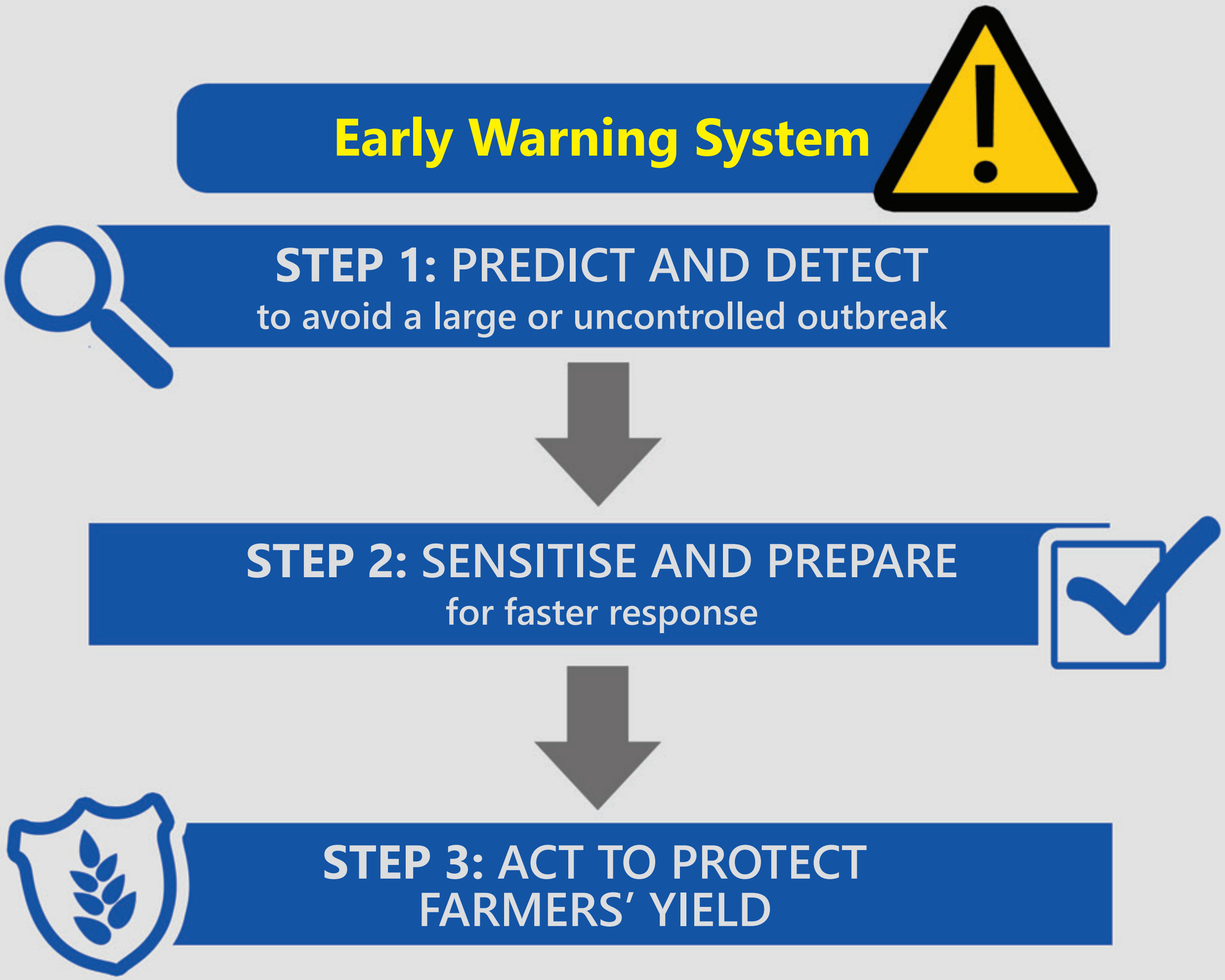
3.1 An Early Warning System

Developing an **Early Warning System** can reduce the effects of climate change on farmers' yield.

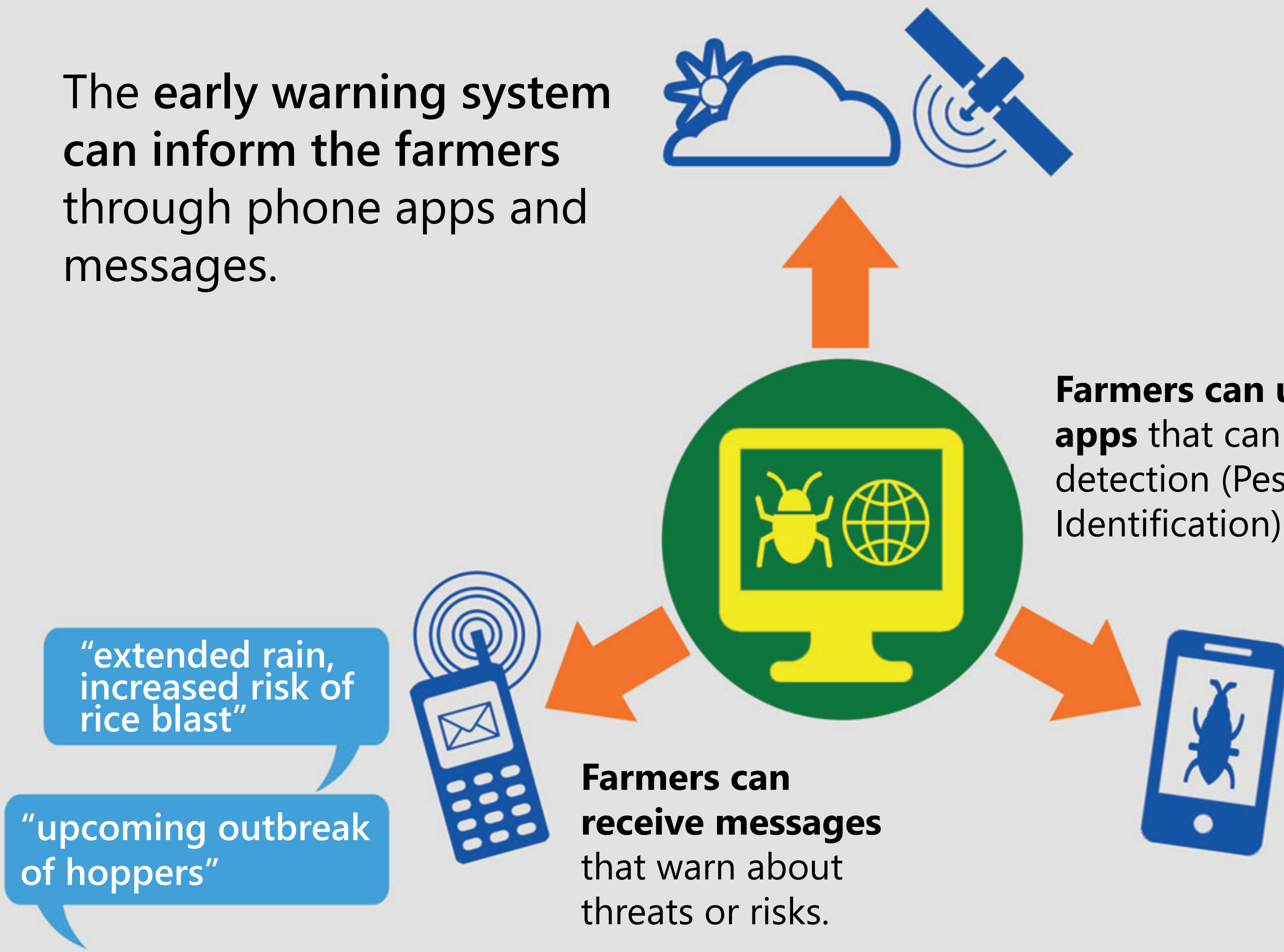
This early warning system is a predictive tool for the farmers to be prepared **prior to pest outbreaks**.



3.1 An Early Warning System



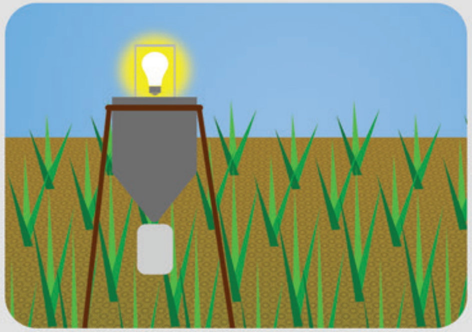
3.2 E-WARS: Developing an online support



3.3 Early detection through insect trapping

To prevent large pests outbreaks...

Monitor and detect pests with early detection tools such as light traps, pheromone traps, and sticky traps.



Light trap

Sticky yellow/blue sheets

Pheromone traps for yellow stem borer

Practice scouting and survey of pests
in rice fields at least twice a week

3.4 Invasive Apple Snail: effect of temperature, increased rainfall

During the dry season, **snail populations are lower** but they **can remain in the rice field by** up to 10 months.

Following rain, snails can invade the flooded fields.

"**Feeding**, activity, growth, and **reproduction increase** with [higher] **temperature**" (Carlsson in Joshi, et al., 2017)

Invasive Apple snails lay their eggs on rice plants and other objects above the water line.

Photos by: IRRI

3.4 Invasive Apple Snail: effect of Temperature, Increased rainfall

INVASIVE APPLE SNAIL: THE PEST-SMART ADVICES

Conduct mass snail and egg collection campaigns, involving the whole community to reduce the snail population.

Trap adult snails that are dormant in the soil **using tapioca, cassava, and papaya leaves** set at the edge of the rice field.

Prevent snails movement by setting various strainers (ex: woven bamboo screen) at irrigation inlets/ outlets to keep them from entering your field.

Ploughing during the off-season kills the dormant snails in the soil.

Photos by: (a,b,c) H. Yahaya, et al.; and (d) Arnaud Costa

3.5 Temperature: main effects on Pests and Diseases

3.5.1. Insect pests and the effect of temperature

Hot spots (hopper-burn) in a rice field

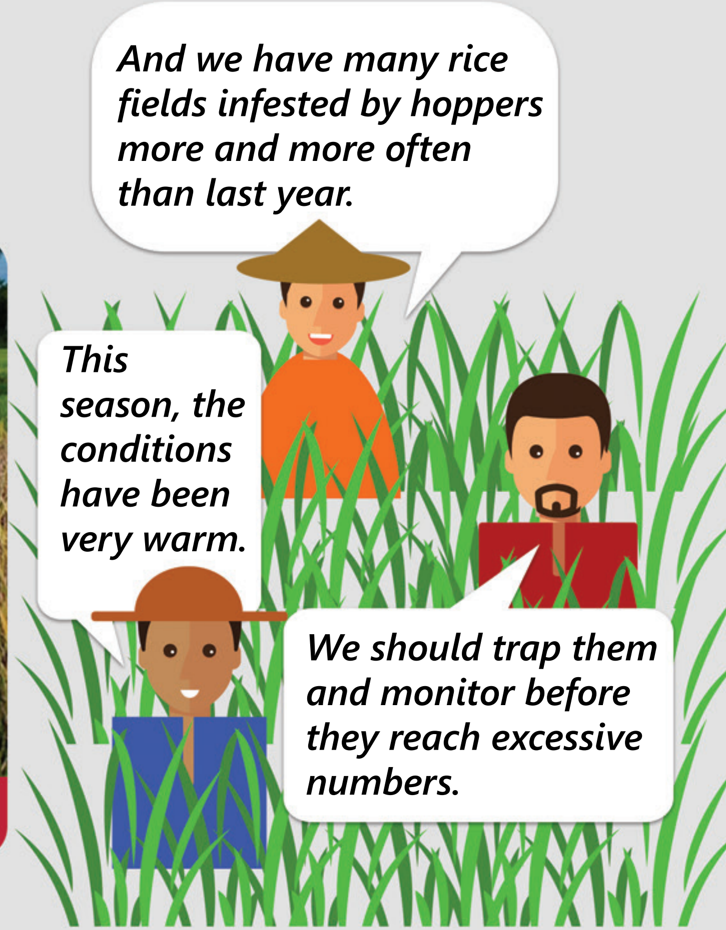


Photo by: IRRI

3.5.1. Insect pests and the effect of temperature

RICE HOPPERS: THE PEST-SMART ADVICES

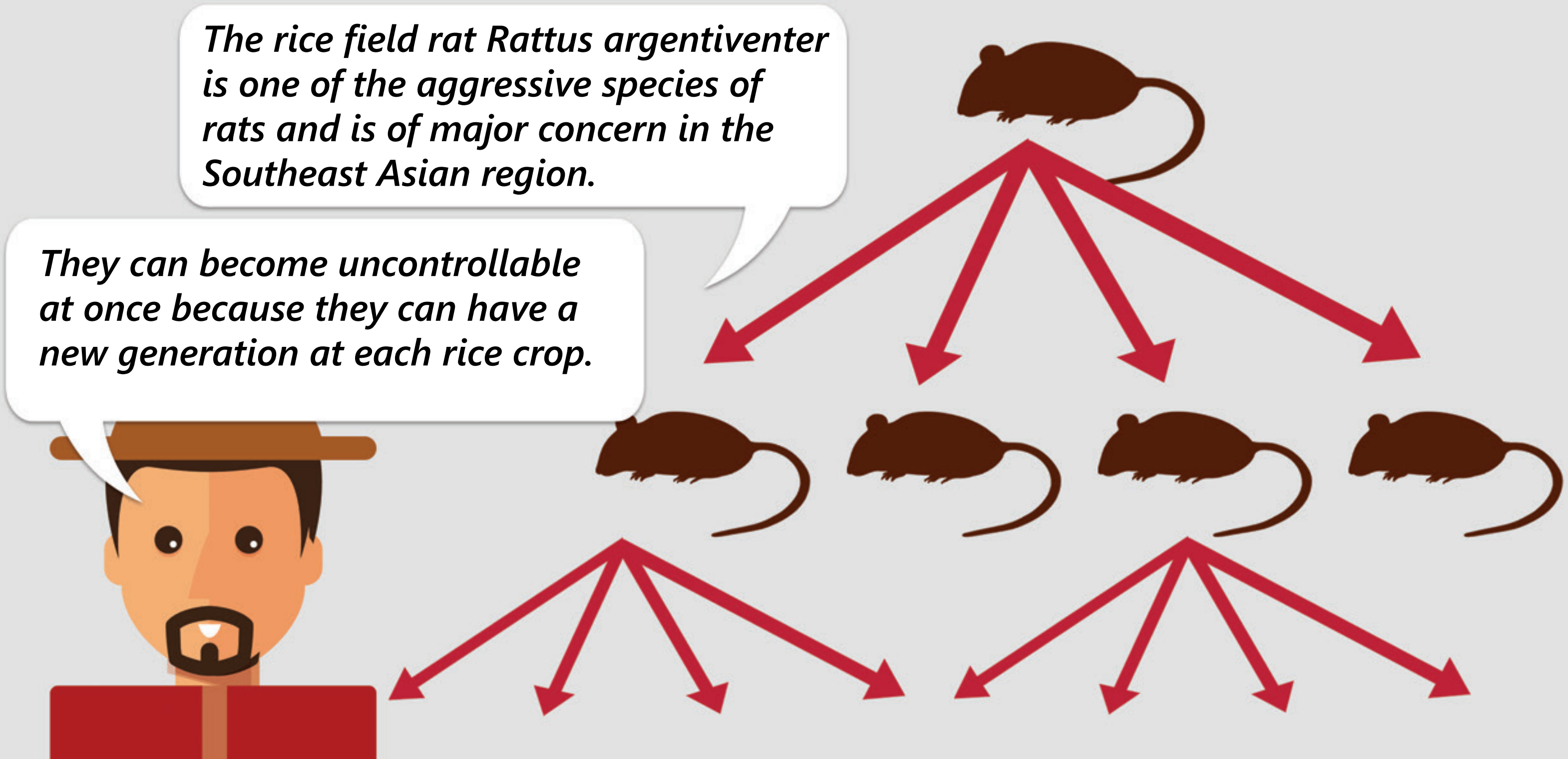
Do not spray insecticides in the rice field during the first 40 days; they have no effects on hoppers but they kill beneficial insects.

Reduce the use of insecticides that hoppers already show resistance against.

Attract farmers' friends using rice bunds with flowers (*see page 39*).

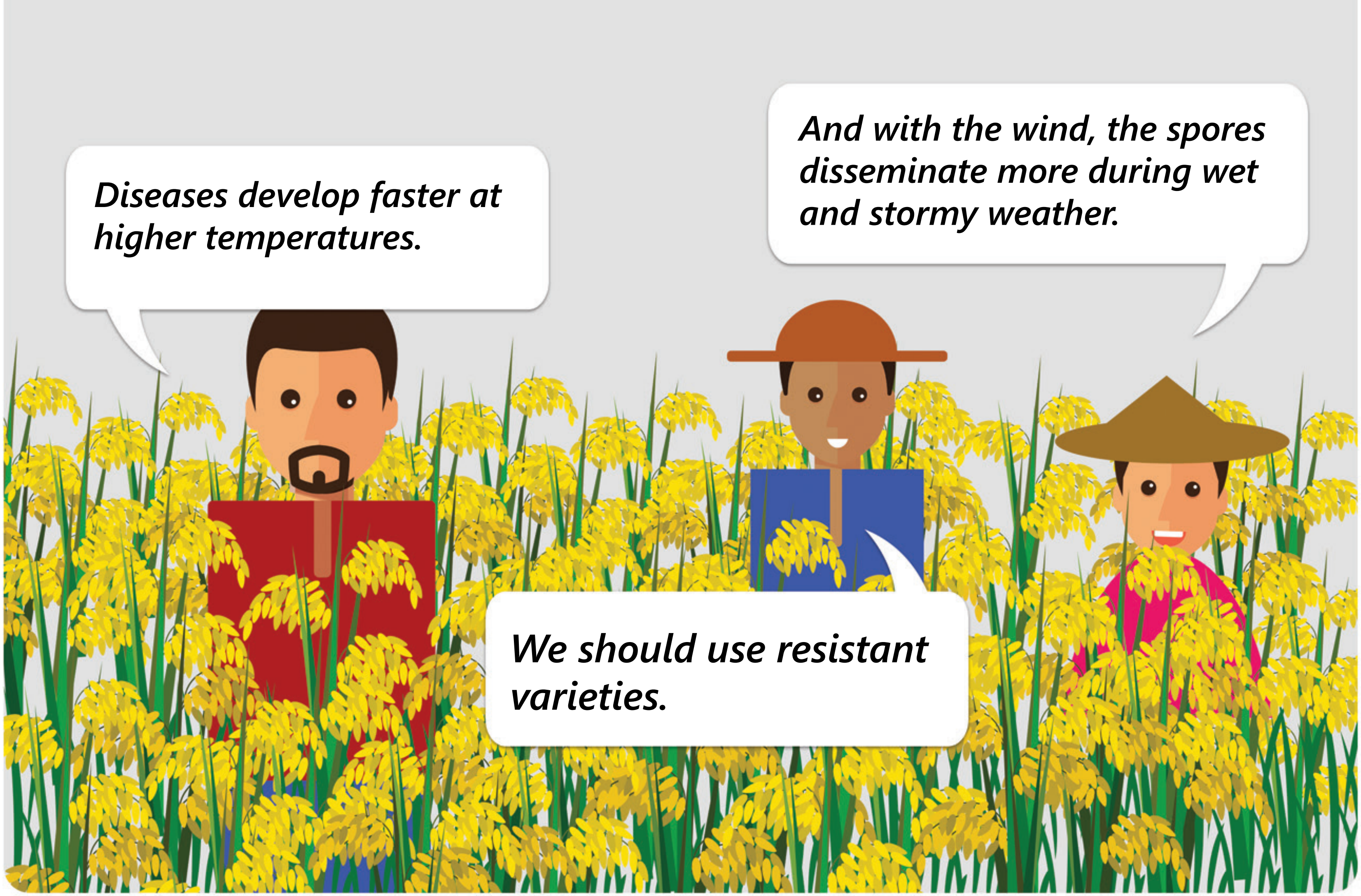
Use pest-resistant rice varieties against hoppers (*see page 34*).

3.5.2. Rodent pests and the effect of temperature



Rats can affect a whole area and management should be done at the community level.

3.5.3 Rice diseases and the effect of temperature



3.6 Humidity and rainfall: main effects on Pests and Diseases

3.6.1. Insect pests and the effect of Humidity/Rainfall

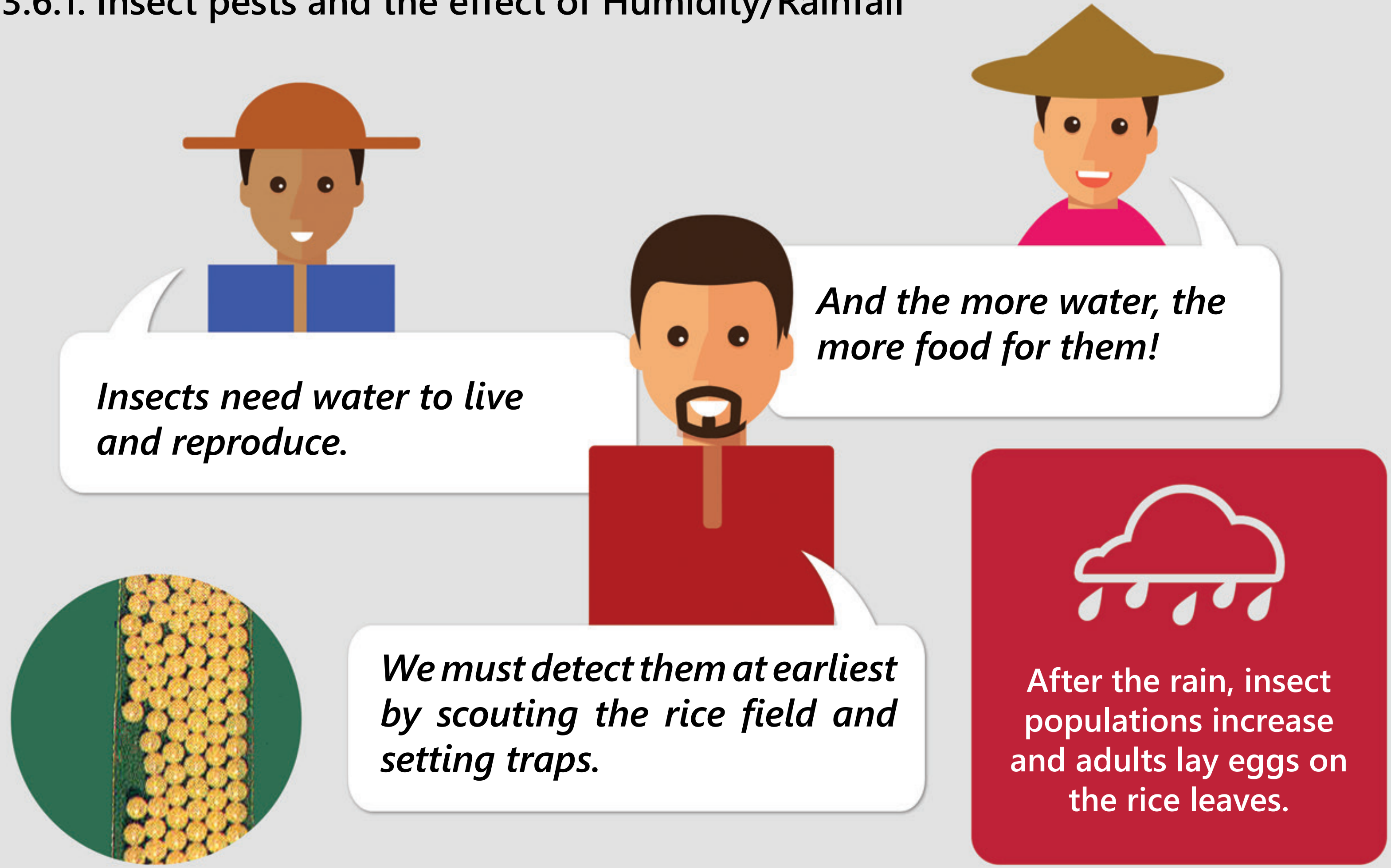
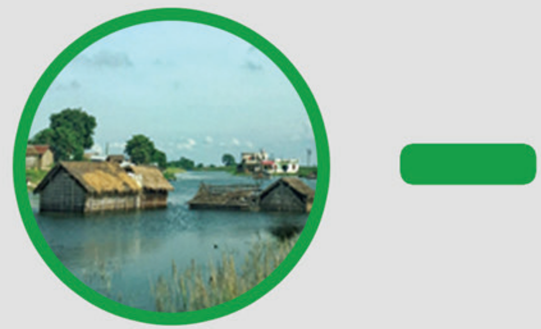


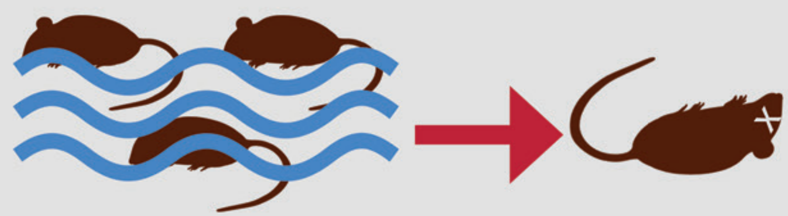
Photo by: IRRI

3.6.2 Rodent pests and the effect of humidity/rainfall

Rat numbers increase with more rainfall due to more food and water available for growth.



Rat nests and shelter can be affected by flood and excessive water levels among rice fields.



Photos by: (a) Eisen Bernardo and (b) IRRI

3.6.2 Rodent pests and the effect of humidity/rainfall

RODENTS: THE PEST-SMART ADVICES

Rats can reproduce quickly and once many rats settle, they can be devastating.

Trap adult rats to keep them from entering a whole area; organise campaigns to reduce rats populations. Use the Trap Barrier System (TBS).

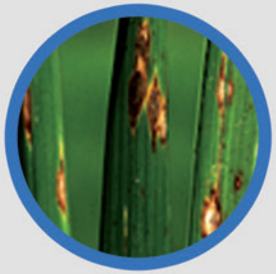
Destroy rat burrows and nests in the field, such as straw heaps.

Clean spilled grain at harvest.

Photos by: (a,b,d) IRRI; and (c) Badrulhadza Amzah

3.6.3 Rice diseases and the effect of humidity/rainfall

Humidity and rainfall: main effects on Rice Diseases



Rice blast

Sheath blight

Bacterial blight

Most diseases spread quicker with warmer temperatures, higher humidity, and repeated rainfalls.

- **Fungal germination**
- **Increased infection**
- **Spores spread through water**

Strong winds and rain cause the bacteria to easily spread through droplets on lesions of infected plants.

Photos by: IRRI

3.6.3 Rice diseases and the effect of humidity/rainfall

RICE DISEASES: THE PEST-SMART ADVICES

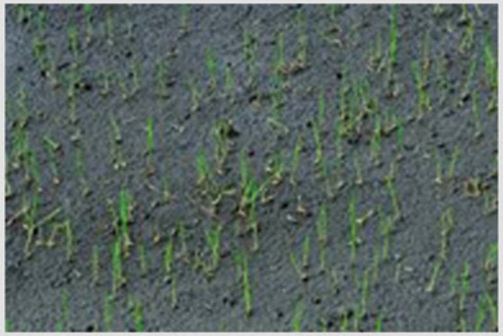
Adjust crop density and spacing

Ensure good drainage of the rice field

Observe the field to practice early sanitation by removing infected leaves

Destroy infested parts to limit sources of diseases

Let fallow fields dry up to reduce spores of diseases in the soil



Photos by: IRRI

3.7 Drought: main effects on grasshoppers and leafhoppers

Grasshoppers and leafhoppers are often major pests of rice.

During drought, the stress increases rice susceptibility to grasshoppers' feeding.

Grasshoppers and leafhoppers are likely to increase in numbers when drought persists for more than a week.

GRASSHOPPERS: THE PEST-SMART ADVICES

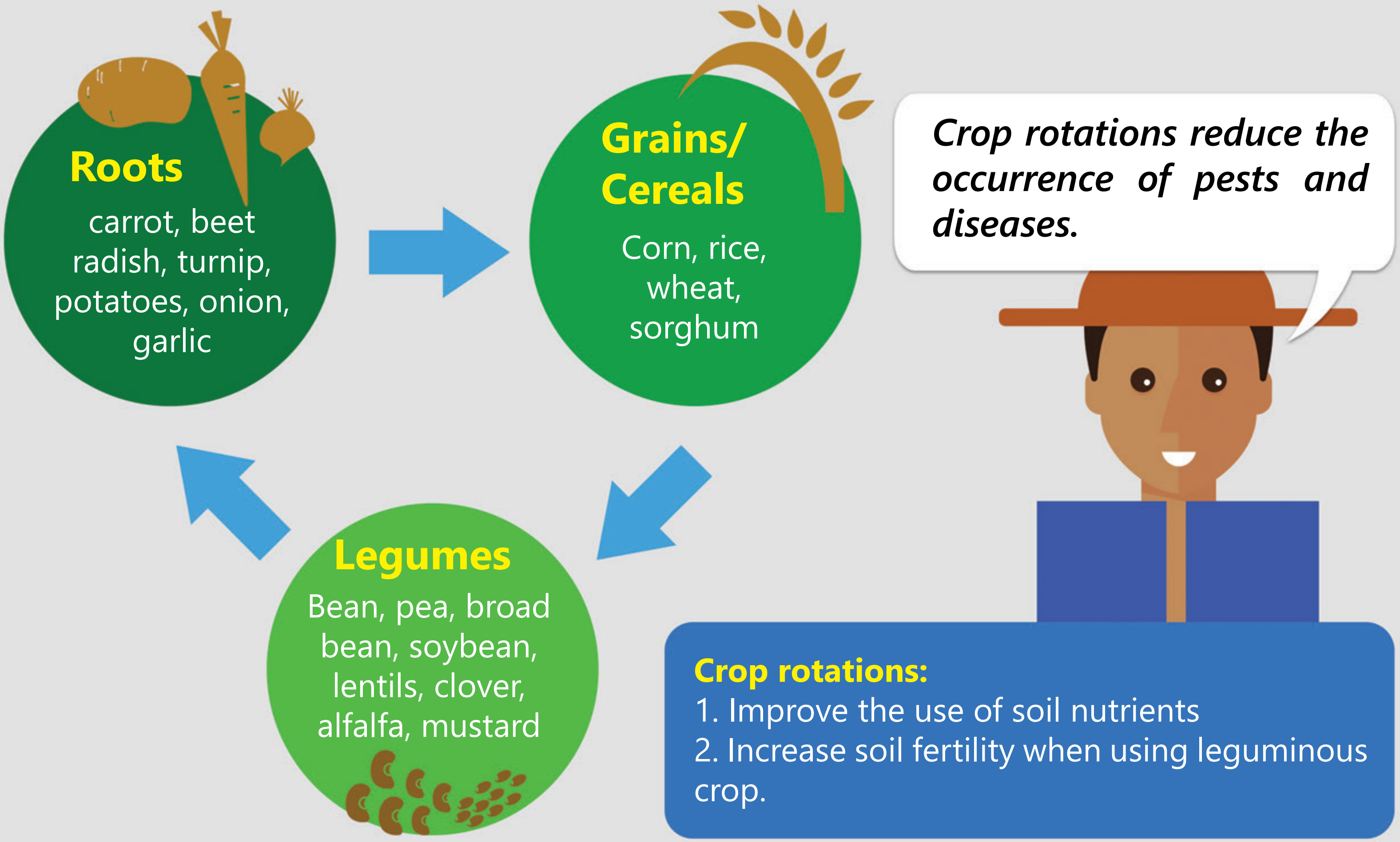
Avoid sowing alternate host plants near the rice crop.

Favour predators and parasites that naturally control grasshoppers and leafhoppers.

Monitor for plant hoppers every week.

Photos by: IRRI

3.8 Crop rotations



3.9 Sanitation and cultural methods

To prevent diseases...

Rice blast

- Adjust planting time
- Examine plants in several locations of the field to detect leaf lesions

Bacterial blight

- Adjust crop density and spacing
- Ensure good drainage of field

Sheath blight

- Weed control to remove alternate host plants
- Establish wider plant spacing

3.10 Resistant varieties

Varieties have been developed by **IRRI** to resist several diseases, overcome excessive salinity, and adapt to drought or flooding.

Sheath blight
Despite screening of 30,000 rice lines, not yet available

Resistant varieties reduce the need of pesticide treatments and **reduce farmers' costs**.

Rice blast
Variety: Makassane

Bacterial blight
Varieties: NSIC Rc142, NSIC Rc154, PSB Rc82

BPH
Varieties: BG379-2, Bg 366, Bg 300, Bg 360, Ld 408

Photos by: IRRI

3.11 Safe alternatives to pesticides

Predators

Small water striders

Spiders
Consume various pests, 1 Lynx spider can eat 2-3 leaf folders/day

Mirids

Damselflies and Dragonflies
Damselflies hunt leafhoppers, stem borers and leaf folders

Ladybirds
Are generalist that eat larvae, nymphs of hoppers and eggs of pests

Ground and Rove beetles
Ground beetles eat leaf folders and planthoppers nymphs

Photos by: IRRI

3.11 Safe alternatives to pesticides

Beneficial wasps

Trichogramma are wasps that are farmer's friends: they lay eggs inside the pests, which kill them later.

Trichogramma wasp

A small parasitic wasp against moth eggs.

Botanical extracts

Plant extracts can treat several pests and diseases.

Neem oil (3%) against rice blast – pure against snails.

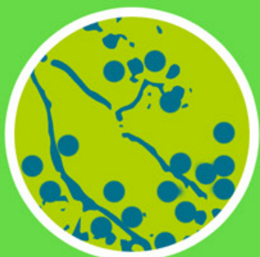
Chili-Ginger-Garlic extract, to treat against hoppers.

Using **botanical extracts instead of pesticides** can help destroy pests and reduce toxicity exposure of farmers.

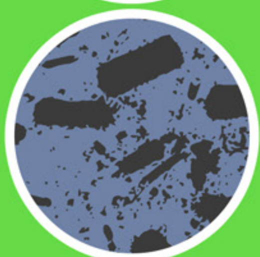
Photos by: (a) CABI; (b) Kevinsooryin WikiCommons; and (c) Freepik.com

3.11 Safe alternatives to pesticides

Biopesticides



Fungi
Beauvaria, Metarhizium
to control rice hoppers, caterpillars, and beetles.



Viruses
Viruses such as NPHV to control leaf folders, caterpillars, and worms.

Bacteria
Bacillus thuringiensis to control leaf folders, stemborers, and fly worms.

3.11 Safe alternatives to pesticides

Against rice diseases...

Bacterial blight

Treatment of rice seeds with *Bacillus spp.* before sowing can control disease up to 59%, and it increases plant height and grain yield.

Rice blast and Sheath blight

Can be treated using ***Pseudomonas fluorescens***. It is also active against other diseases such as sheath rot.

Sheath blight

Trichoderma spp. can increase efficiency of plant growth and it can reduce rice diseases such as sheath blight by foliar spray or seed treatment.

Photos by: IRRI

3.12 Managing pests and diseases at the landscape level

Favor habitats that protect farmers' friends to reduce pest numbers.

- Plant hedges that can be sources of food and refuges for beneficial insects.
- Use crop rotations and within the same season, diversify your cropping system.
- Ecological Engineering can increase local biodiversity and attract beneficial insects in rice field.

Photos by: (a) NOMAFSI; and (b) IRRI

3.12 Managing pests and diseases at the landscape level

Ecological Engineering

Ecological Engineering can increase local biodiversity and attract beneficial insects in rice field.

Why Ecological Engineering?

To protect the farmers' crops with less pesticides

What benefits for the farmers?

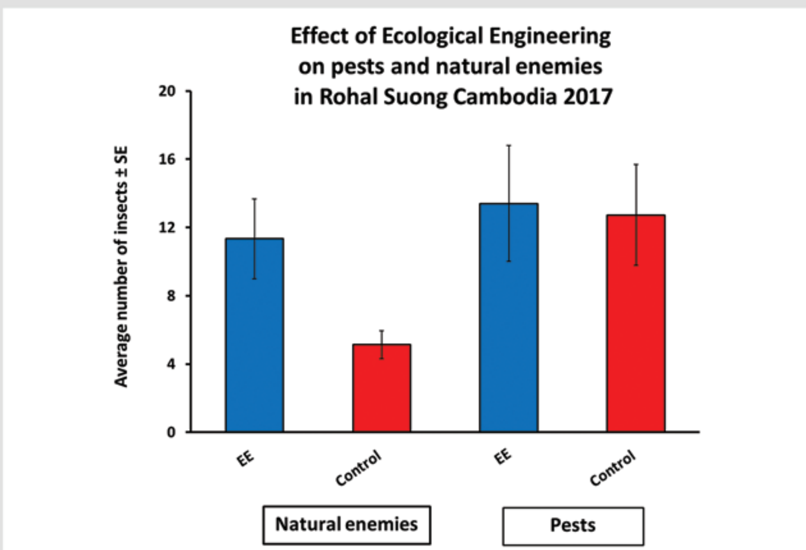
To reduce the costs of cultivation

Photos by: (a) A. Sivapragasam; and (b) Arnaud Costa

3.12 Managing pests and diseases at the landscape level

Ecological Engineering

Reduction of pesticides costs
(no insecticides during the first 40 days of rice crop)



Attraction of beneficial insects
(natural enemies and pollinators)

More beneficial insects can be found on fields with Cosmos and sunflower (EE).

Photos by: Arnaud Costa

Conclusions

Climate change will likely increase the risk of pests and diseases in the future.

To protect your rice crop and ensure a good yield:

- **monitor the field** to detect new threats;
- adopt **ecologically-sound management** using resistant varieties, early trapping, and controlled irrigation;
- organize **mass trapping campaigns** to reduce outbreaks at their earliest; and
- increase local natural enemies (**ecological engineering**, intercropping).

Using locally-adapted early warning system will help you achieve high productivity at the same time achieve pest- and disease-resilience. **Be a Pest-Smart farmer now!**

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