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# IPM in Rice

## Enhancing Biodiversity, Ecosystem Services and Pest Management

K.L. Heong

# Rice IPM Development Key points - 1

- **1979 Kiritani/Brader**
  - The implementation of IPM by farmers still remains far behind. To bridge this gap, it is anticipated that many obstacles should be conquered not only in technology but also in socioeconomic sectors.

- **Matteson 2000**
  - The “farmer first” approach of participatory nonformal education in FFS followed by community FFS emphasizing farmer-farmer training and diffusion has had greater success.

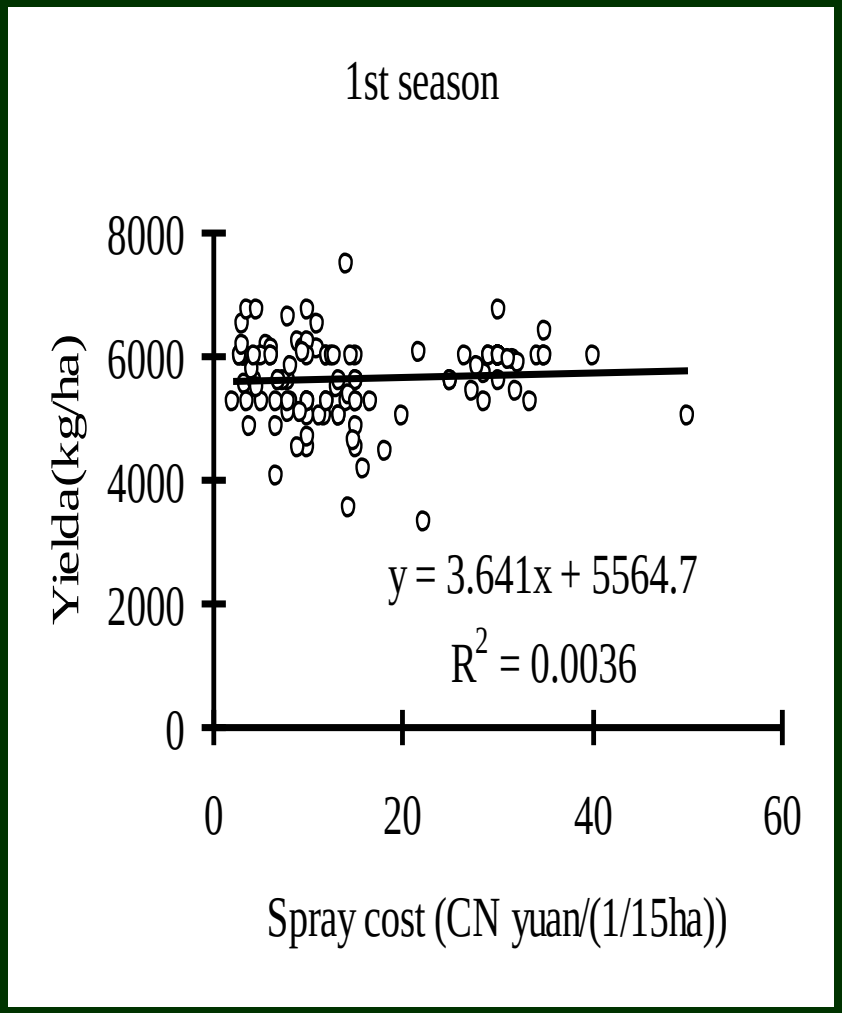
# Rice IPM Development Key points-2

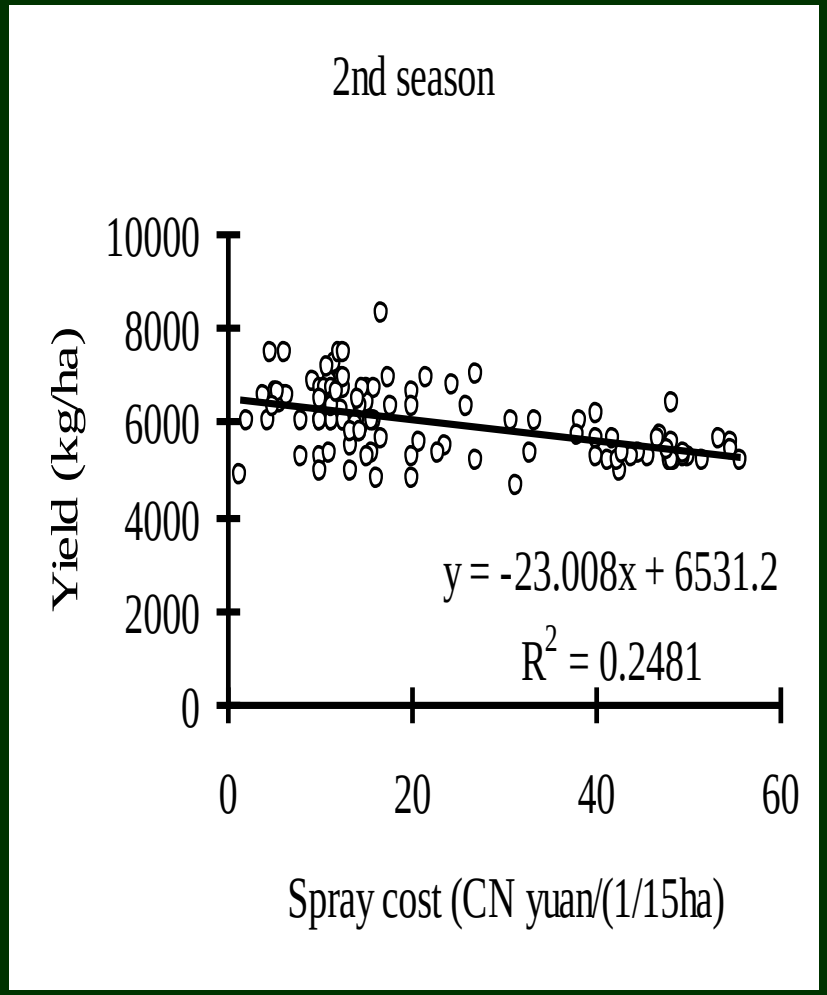
- **1990s and early 2000s**
  - Millions of US$ (both ODA and national programs) spent in IPM-FFS training and community IPM programs and more than 2 million rice farmers trained. Horizontal diffusion expected to spread to the remaining 99%.
- **2000 onwards**
  - Difficulties in horizontal diffusion first pointed out in 1993. In the Philippines there was no diffusion. No diffusion from FFS trained to non trained farmers even in the same village.
  - High training costs and sustainability issues raised.

# Are there any productivity gains from insecticide applications? - 1

- **IRRI economists**
  - Returns lower for farmers applying insecticides on prophylactic basis (Herdt et al 1984)
  - When compared with using thresholds, use of natural control economically dominant (Rola and Pingali 1993)
  - All production benefits from pest manangement overwhelmed by health costs (Pingali and Rola 1993; Antle and Pingali 1994).
  - Pest control without insecticides ranked the dominant strategy and farmers' 2 sprays strategy ranked higher than IPM because of high costs in pest monitoring

# Relationships between farmers' yields and pesticide spending in Jiaxing, China.



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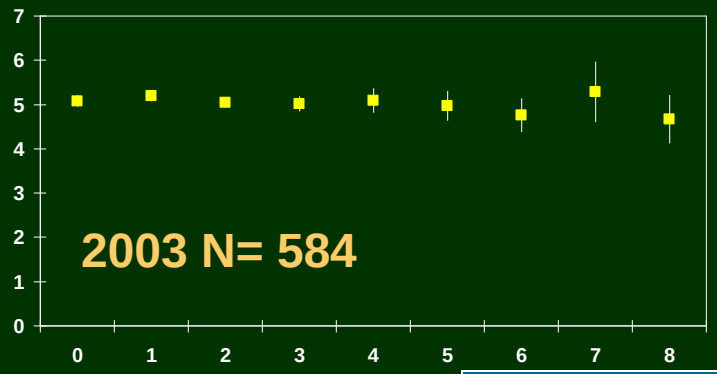
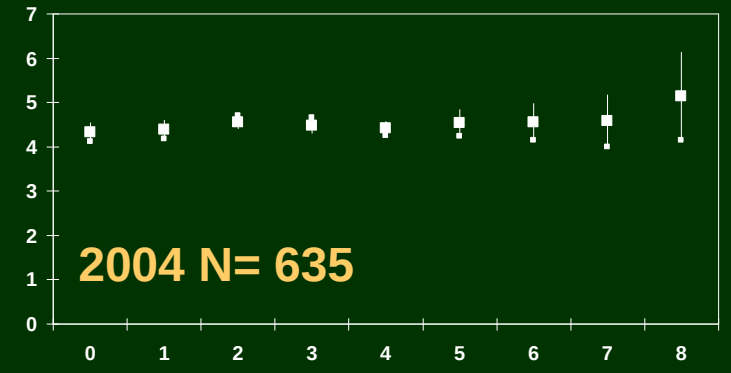
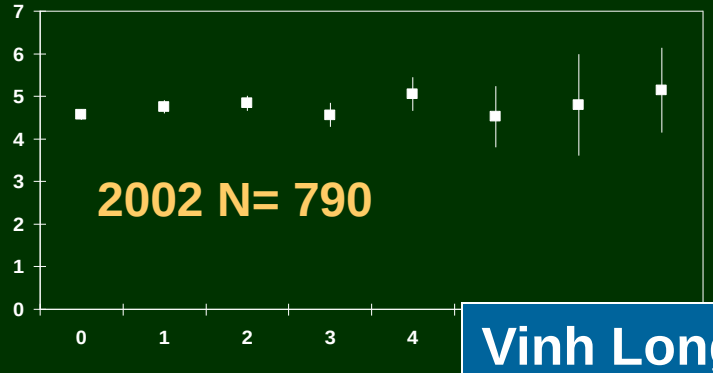
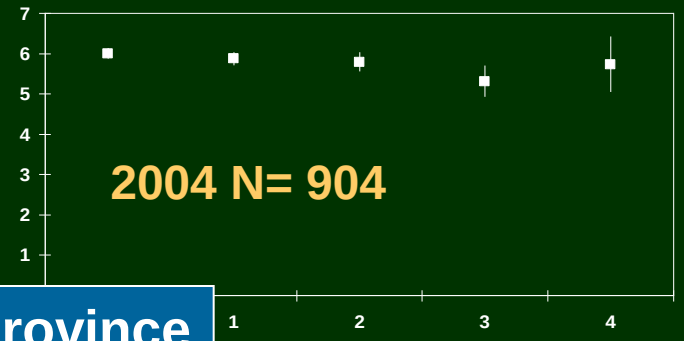
Tiengiang province



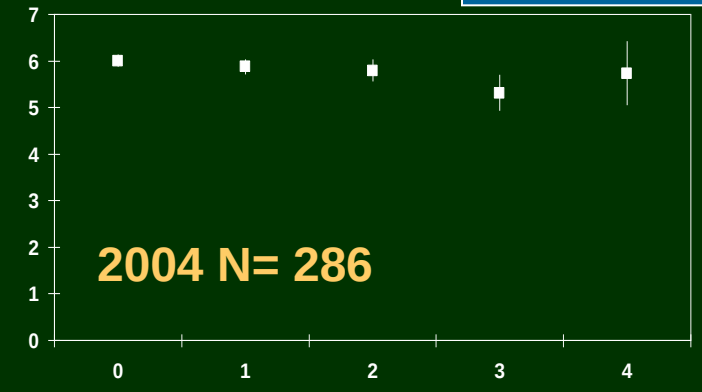



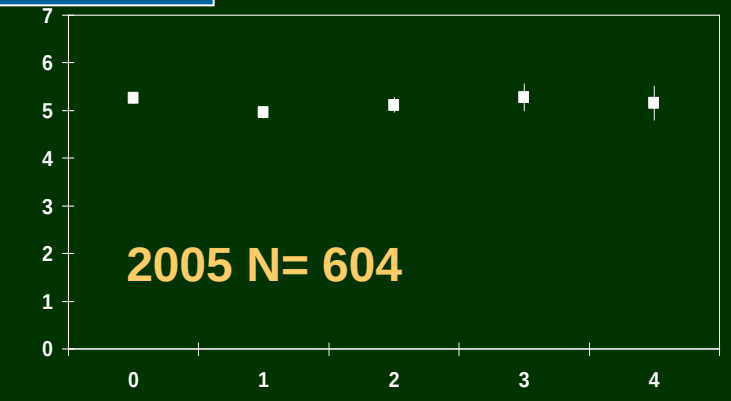

Cantho province




Vinh Long province




Yield in tons

Number of insecticide sprays

# Are there any productivity gains from insecticide applications? - 2

- **IRRI ecologists**
  - Ecological costs - Insecticide sprays bring an additional 4 million herbivores per ha and 1 million fewer predators.
  - Insecticide sprays shorten food chain length from 2.6 to 2.0 favoring pest species.
  - Insecticide sprays especially in the early crops stages (first 40 DAS) disorganized predator-prey relationships rendering predation functions ineffective.
  - Most rice farmers' sprayers have poor delivery and thus less than 10% of the sprays will actually reach pest targets.

# Early season blanket spraying

Note
Spraying in early crop stages
Spraying on top of the canopy
Use equipment with poor delivery

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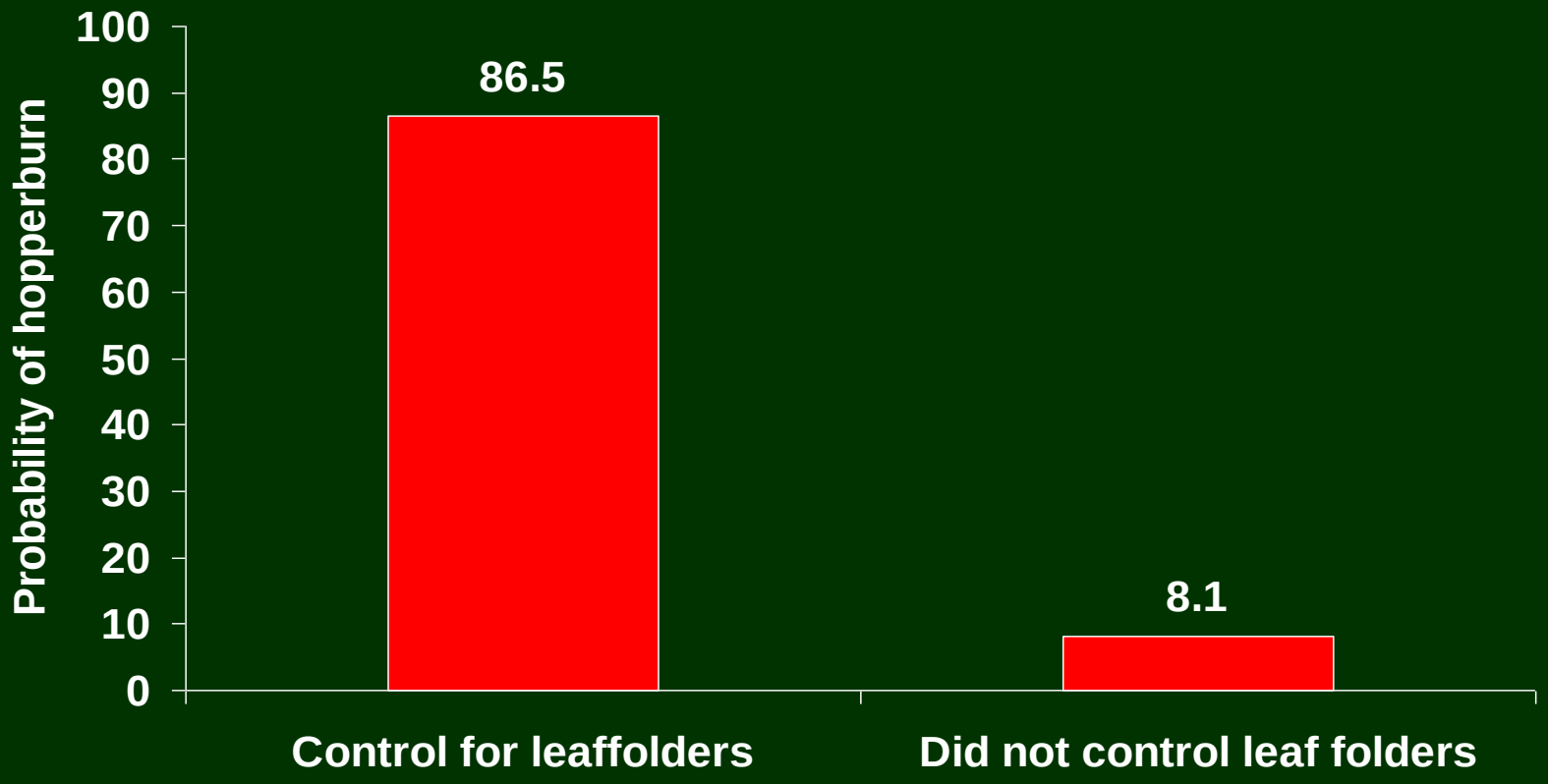
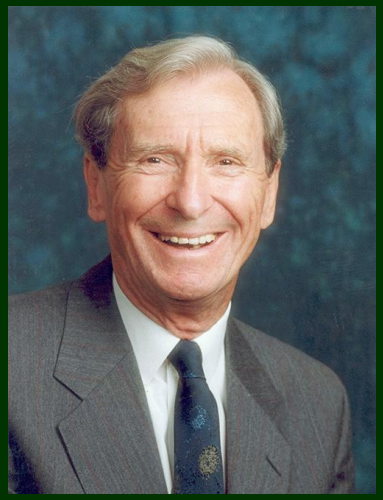
# Sprayed rice fields are like mine fields to predators and parasitoids in search of prey

# Leaf folder control in early crop stages increases vulnerability to hopperburn by 10 folds



# Are there any productivity gains from insecticide applications? - 3

- **IRRI ecologists - Way & Heong (1994)**



" We conclude that IPM in tropical rice should be based on the contention that ***insecticides are not needed*** rather than they are and "pests" should be critically reassessed and ***proven guilty before insecticide use is contemplated***"

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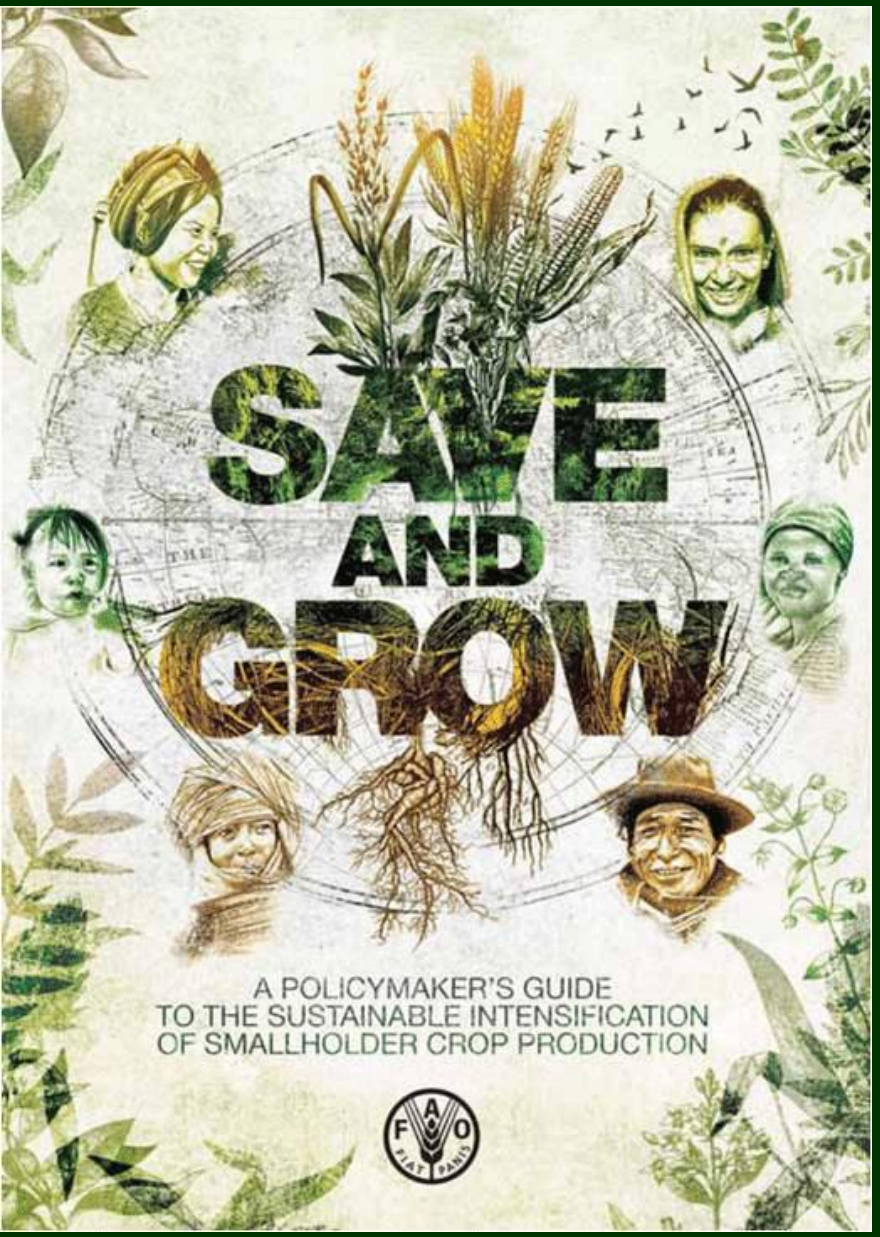



SCPI: Sustainable Crop Production Intensification

FAO 2012:

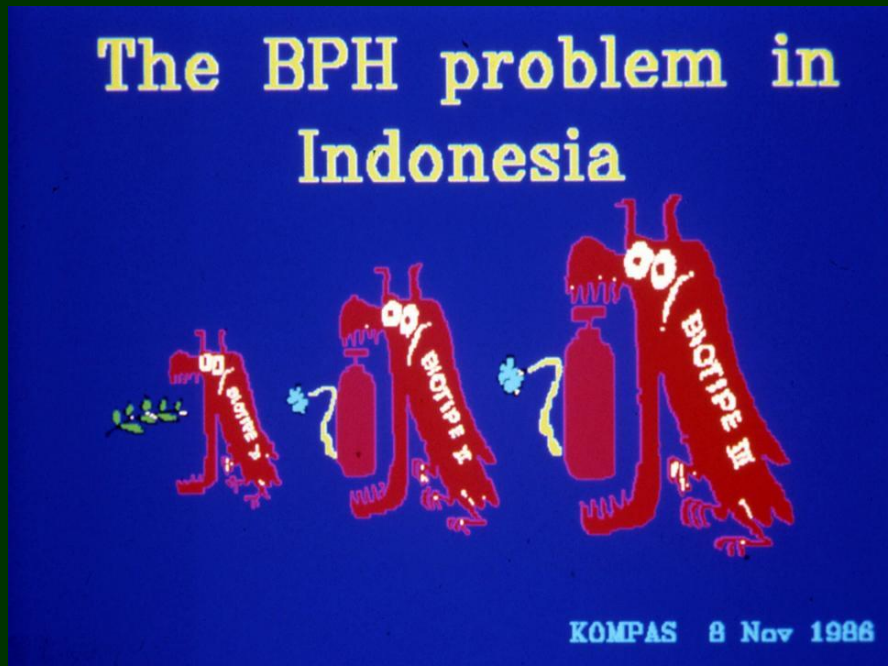
Most tropical rice crops under intensification require

***NO***

insecticide use

# Rice IPM became prominent in Indonesia in 1986

- Rice production threatened by brown planthopper outbreaks
- Farmers were practicing routine prophylactic insecticide spraying.
- These practices were from the Green Revolution ODA funded rice intensification programs, BIMAS
- President banned 57 insecticides for use in rice



# Pesticide subsidies, insecticide use and rice production

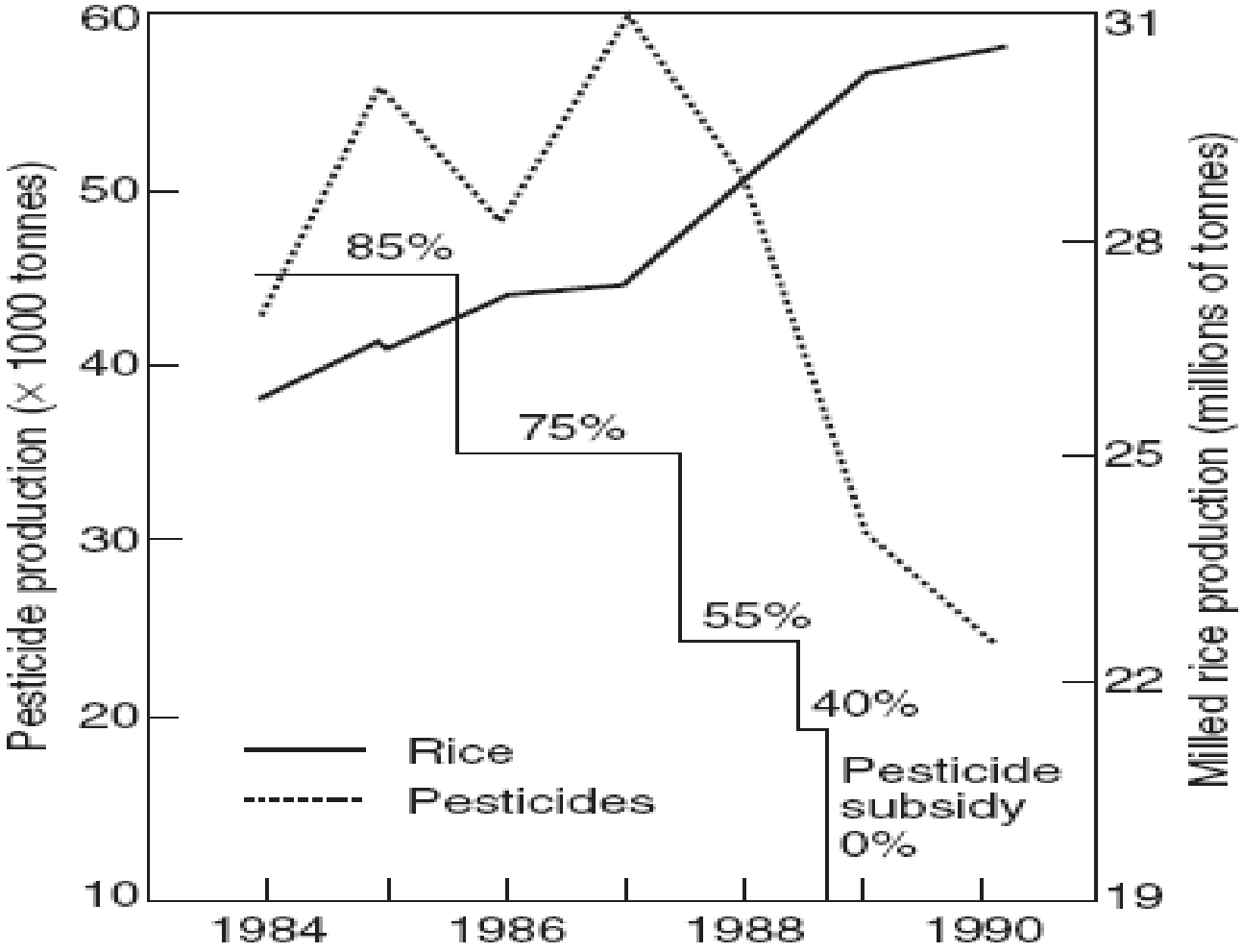
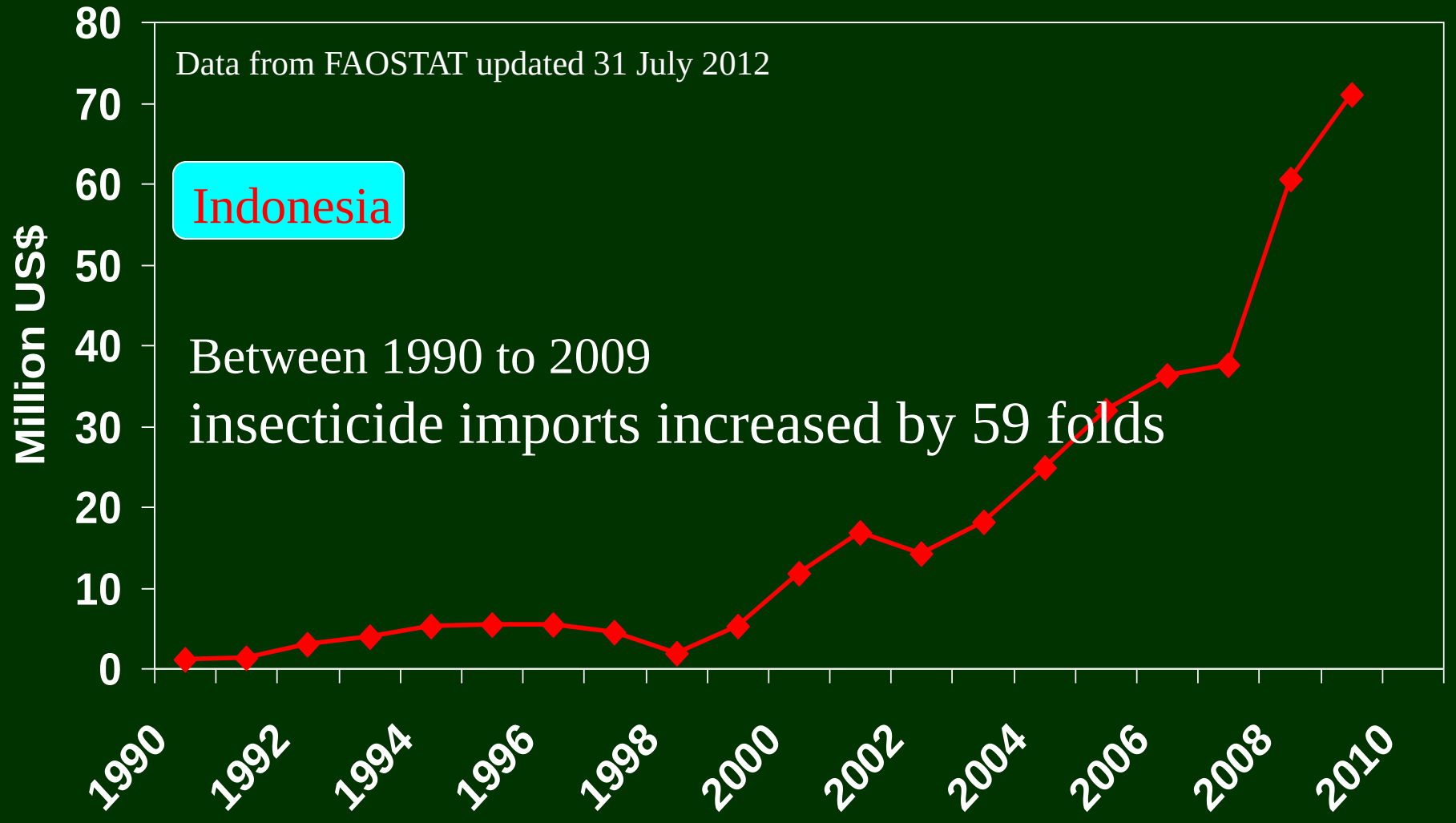
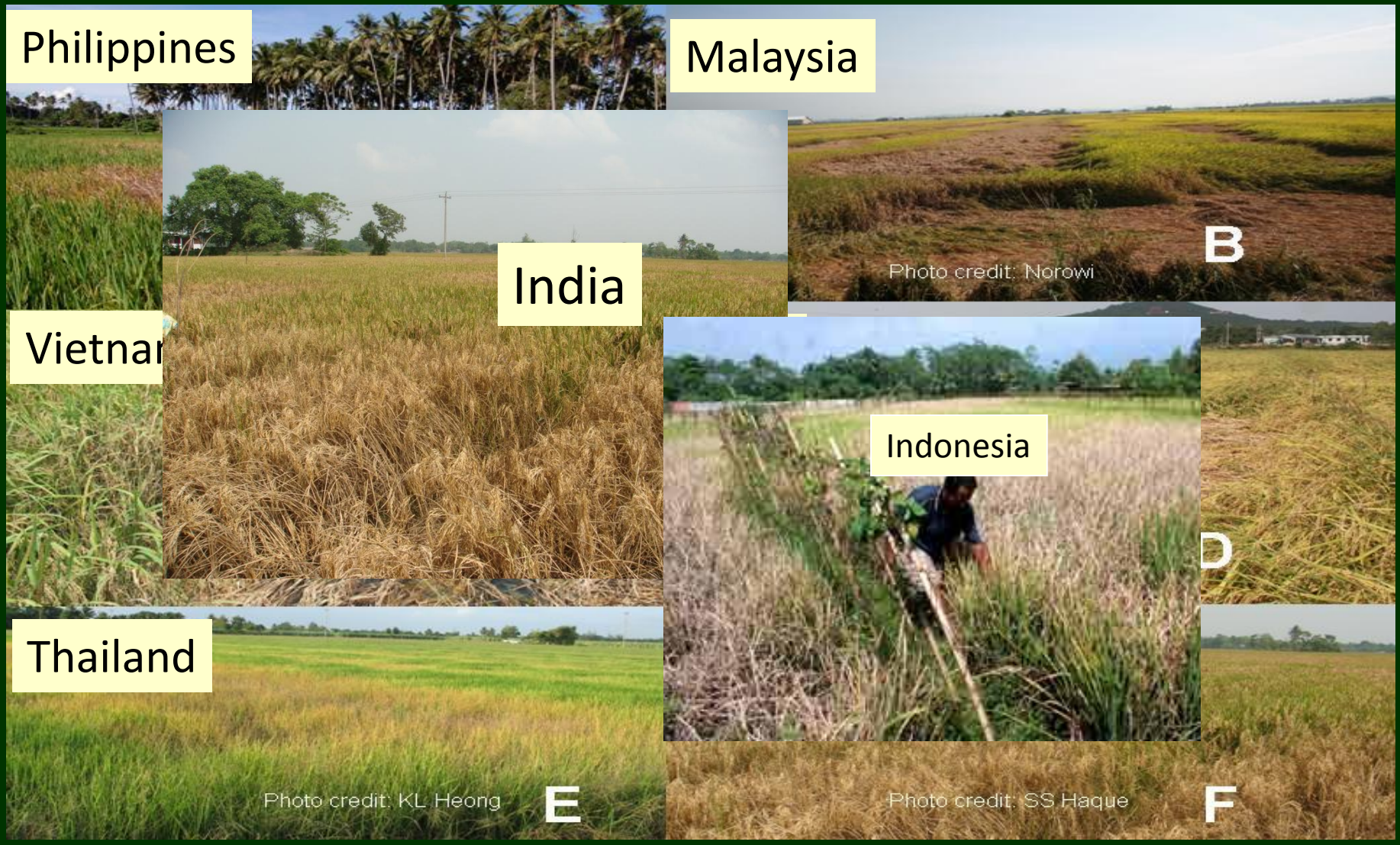



**Fig. 1.1.** Impact of pesticide subsidy on rice production in Indonesia (after FAO, 1990).

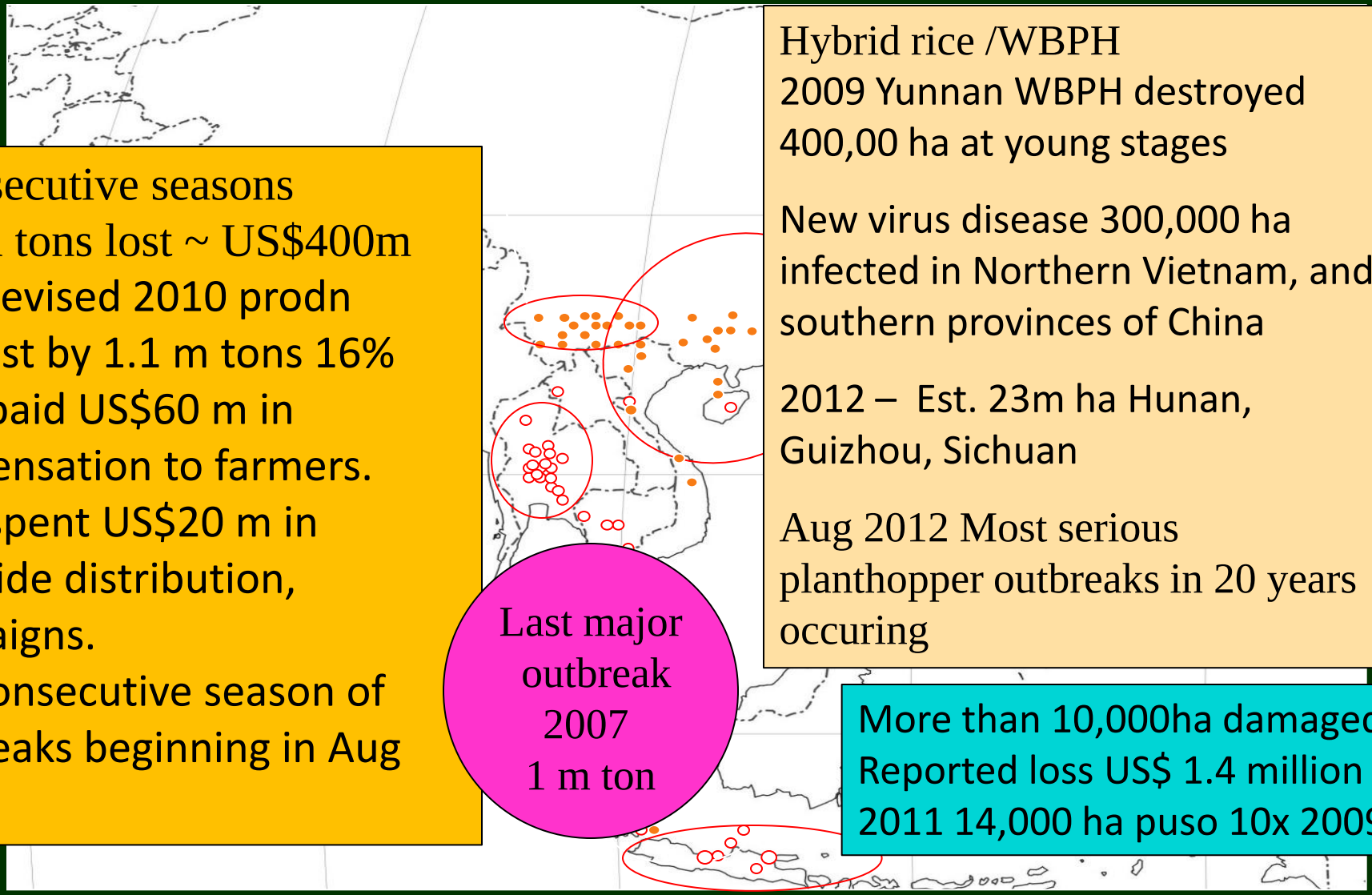
# Insecticide imports in million US$



# Hopperburn occur in patches with ecosystem services disrupted



# Planthopper outbreaks in Asia in 2009/12



9 consecutive seasons
~1.5m tons lost ~ US$400m
Govt revised 2010 prodn forecast by 1.1 m tons 16%
Govt paid US$60 m in compensation to farmers.
Govt spent US$20 m in pesticide distribution, campaigns.
10th consecutive season of outbreaks beginning in Aug 2012

Last major outbreak 2007
1 m ton

Hybrid rice /WBPH
2009 Yunnan WBPH destroyed 400,00 ha at young stages

New virus disease 300,000 ha infected in Northern Vietnam, and southern provinces of China

2012 – Est. 23m ha Hunan, Guizhou, Sichuan

Aug 2012 Most serious planthopper outbreaks in 20 years occuring

More than 10,000ha damaged
Reported loss US$ 1.4 million
2011 14,000 ha puso 10x 2009

# Return of the Green Revolution
# Menace with vengeance

Bottrell and Schoenly 2012

"Resurrecting the ghost of green revolutions past: The brown planthopper as a recurring threat to high-yielding rice production in tropical Asia"

Shepard 2010

History repeats itself

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# Estimated losses in rice production

## Vietnam

- 300,000 ha estimated badly infected with virus in Northern Vietnam predominantly hybrid rice.
- Loss in 2007/2008 estimated to be 1.0 million hectares from hopperburn and virus. Rice exports temporarily halted.
- Hopper burn in patches and low virus infestations from 2010.
- PPD is implementing various programs to curb insecticide misuse like “3 reductions, 3 gains”, ecological engineering.
- Lately PPD issued an administrative order.
- Developed Circular # 18 to manage pesticide marketing. Further instructions to control adverts.

# Brown Planthopper (BPH)

# Virus diseases

## Grassy stunt

## Ragged stunt

Cabauatan et al 2008

# White backed planthopper (WBPH)

# New virus carried by WBPH

- Discovered in Guangdong in 2001.
- Transmitted by WBPH
- Southern Rice Black Streak Dwarf virus (SRBSDV) because of its similarity with the RBSDV carried by sBPH in temperate areas.
- Spreading in southern provinces of China, Northern Vietnam areas.

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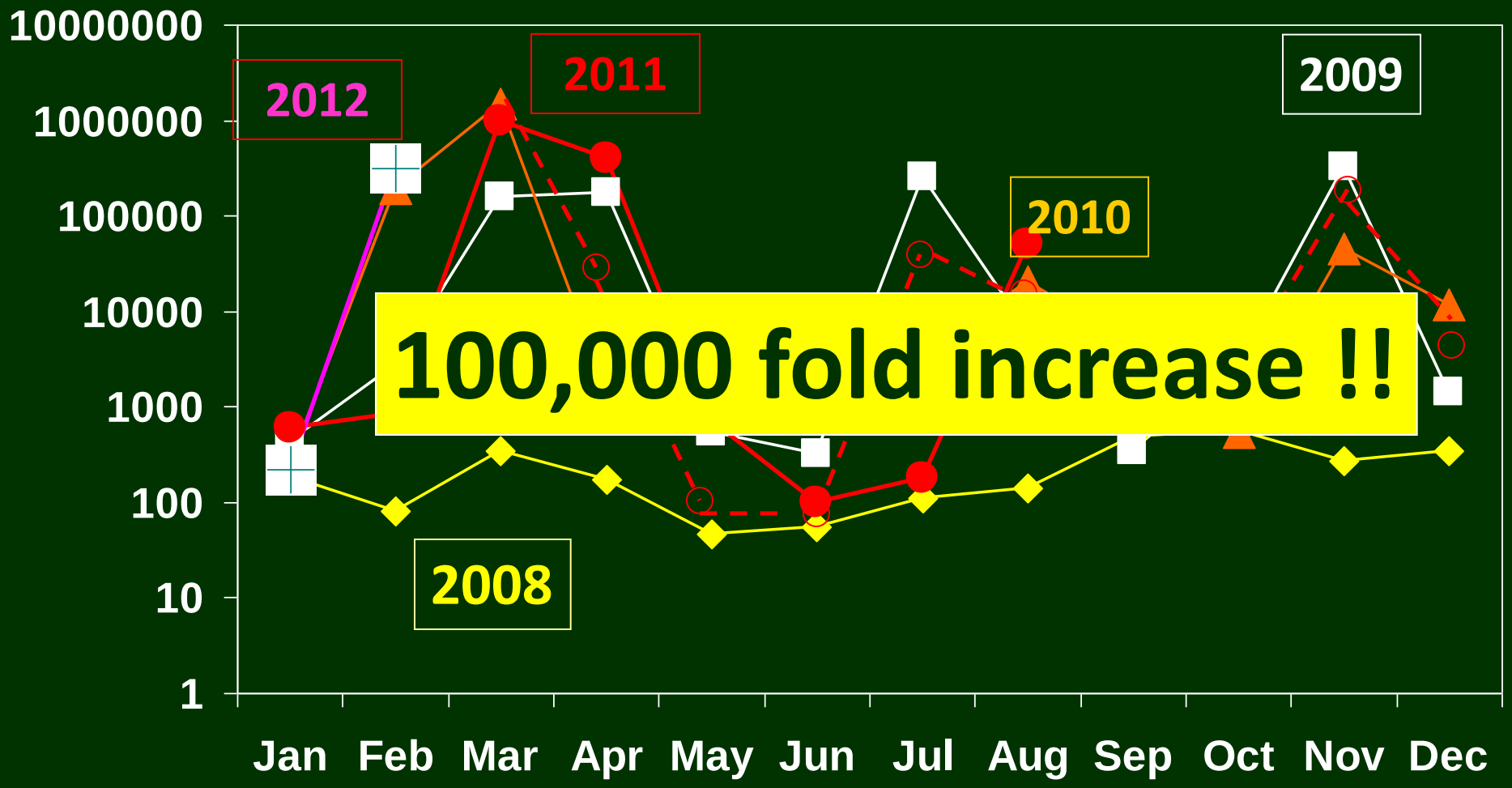
# Light trap records in Chai Nat Thailand



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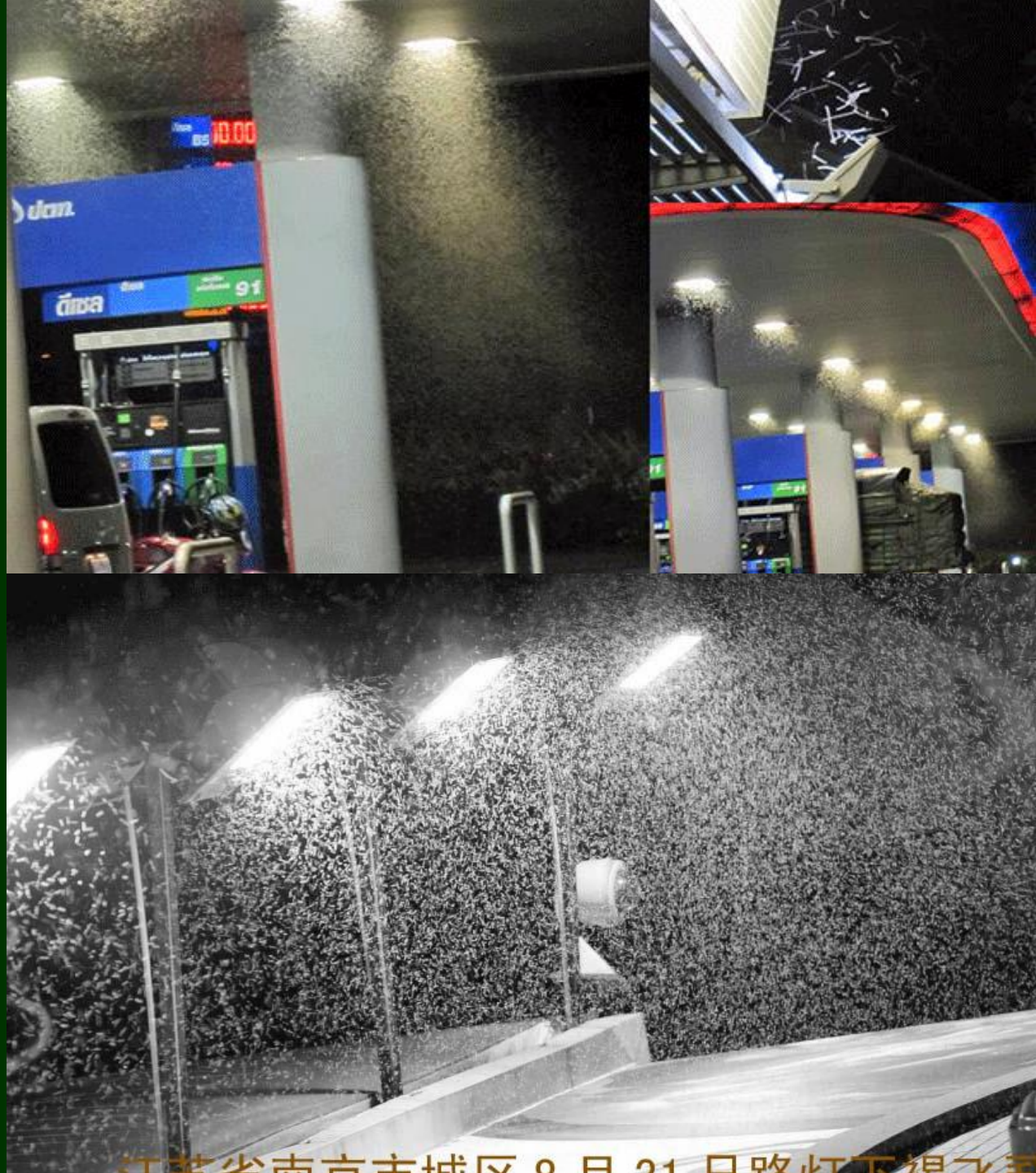
# Pest storms in

Thailand

China

Indonesia



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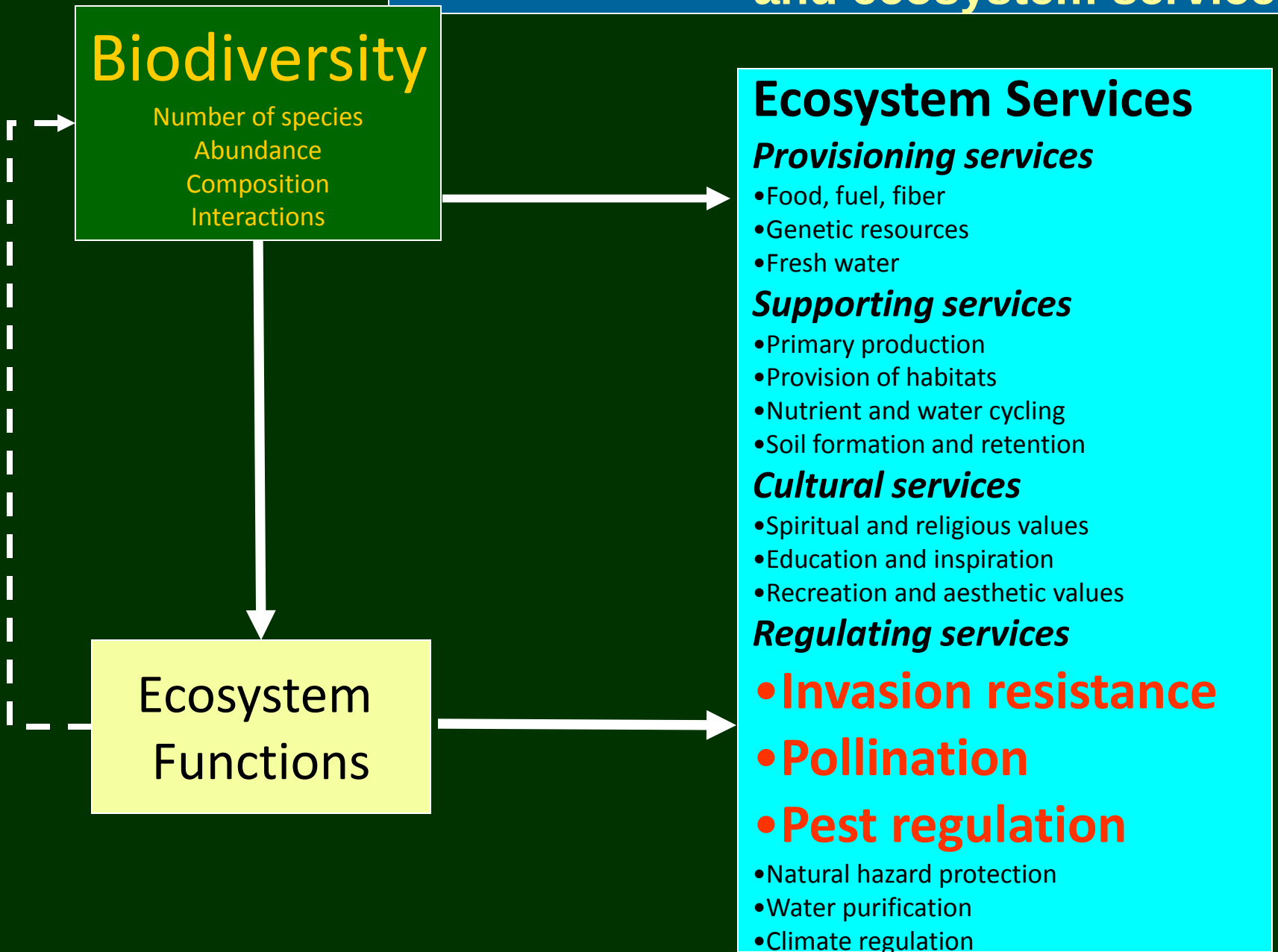
# Biodiversity, ecosystem functioning, and ecosystem services



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# Biodiversity, ecosystem functioning, and ecosystem services

## Biodiversity

Number of species
Abundance
Composition
Interactions

## Ecosystem Functions

## Ecosystem Services

*Provisioning services*

- Food, fuel, fiber
- Genetic resources
- Fresh water

*Supporting services*

- Primary production
- Provision of habitats
- Nutrient and water cycling
- Soil formation and retention

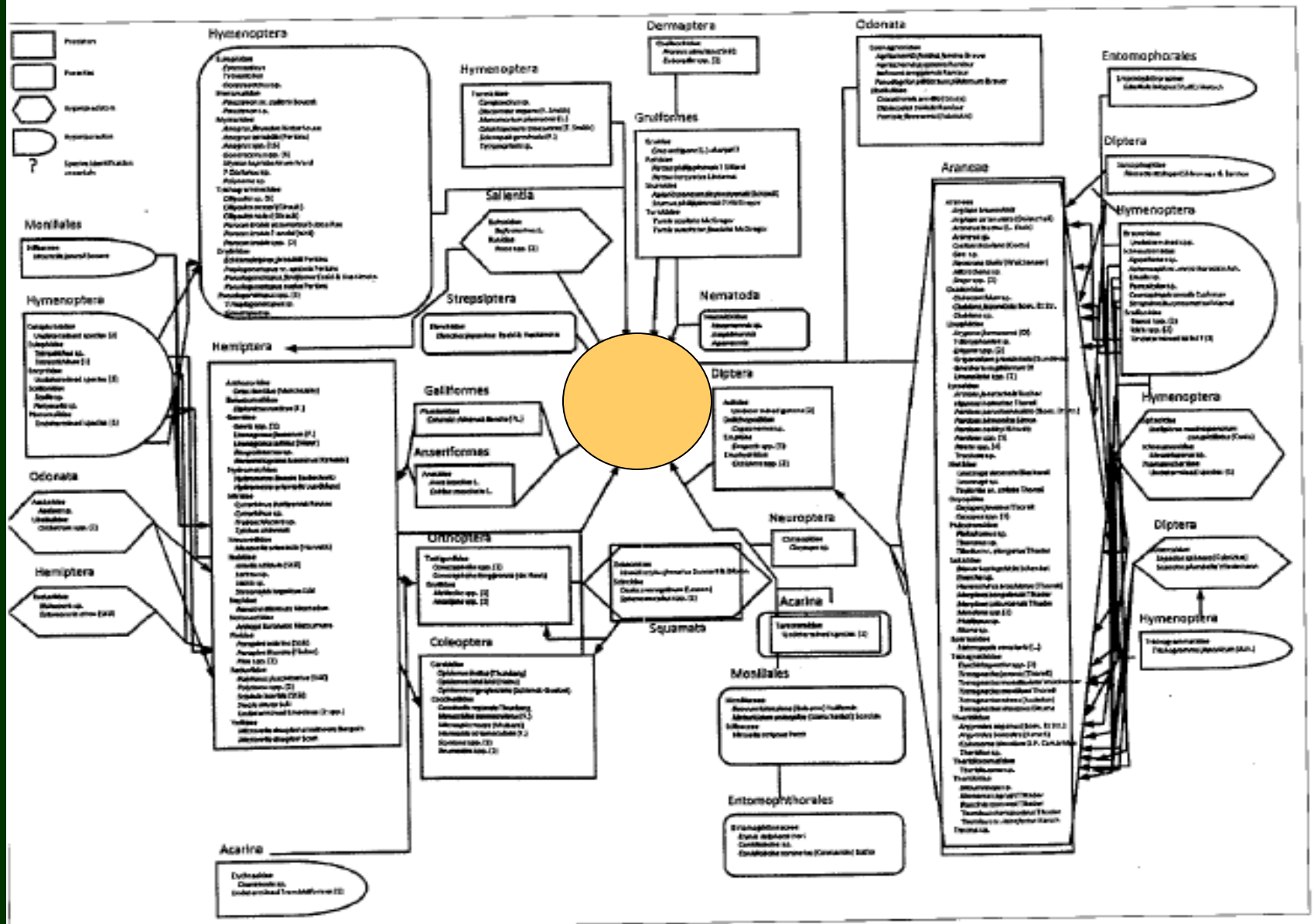
*Cultural services*

- Spiritual and religious values

## *Regulating services*

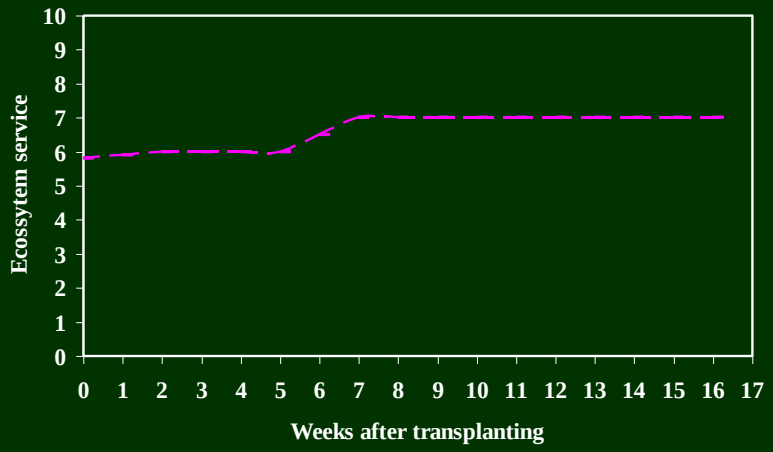
- **Invasion resistance**
- **Pest and disease regulation**
- Climate regulation
- Natural hazard protection
- Water purification

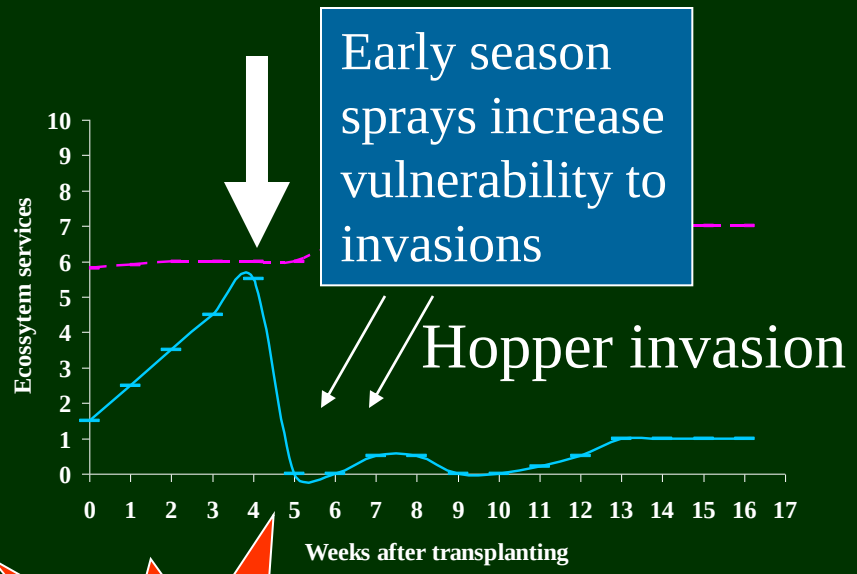
# Planthoppers' food web

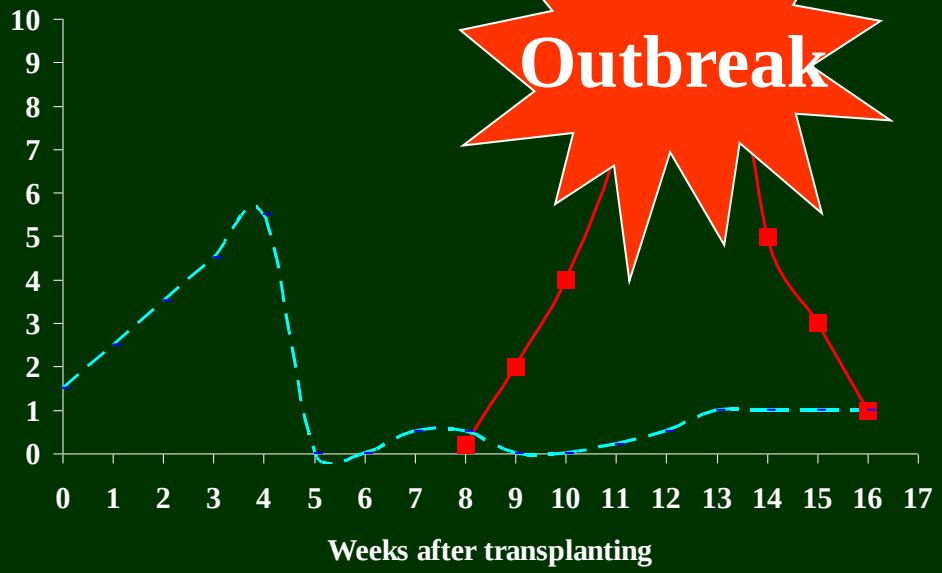


# Effect of early season sprays on ecosystem services

Ecosystem services



# Why do planthopper outbreaks continue to threaten rice production in Asia?

*Vulnerability factors*

- ***Low genetic biodiversity***
  - Many rice areas grown with few or closely related varieties.
  - In Central Thailand 72% of farmers grew 2 varieties, Chainat1 and Pathumtani1.
  - In the Muda area 2005, 2 varieties MR219 and MR220 covered 75% of the area.
  - Season 2008/09 the same 2 varieties grown in 95% of rice areas in Malaysia.
  - Hybrid rice – narrow range of parental lines.

- ***Low habitat biodiversity***
  - Large area rice monocrops with no other habitat. Low flora and resources for natural enemies
  - Double and triple cropping of rice and lack non rice habitats.

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# Why do planthopper outbreaks continue to threaten rice production in Asia?

*Vulnerability factors*

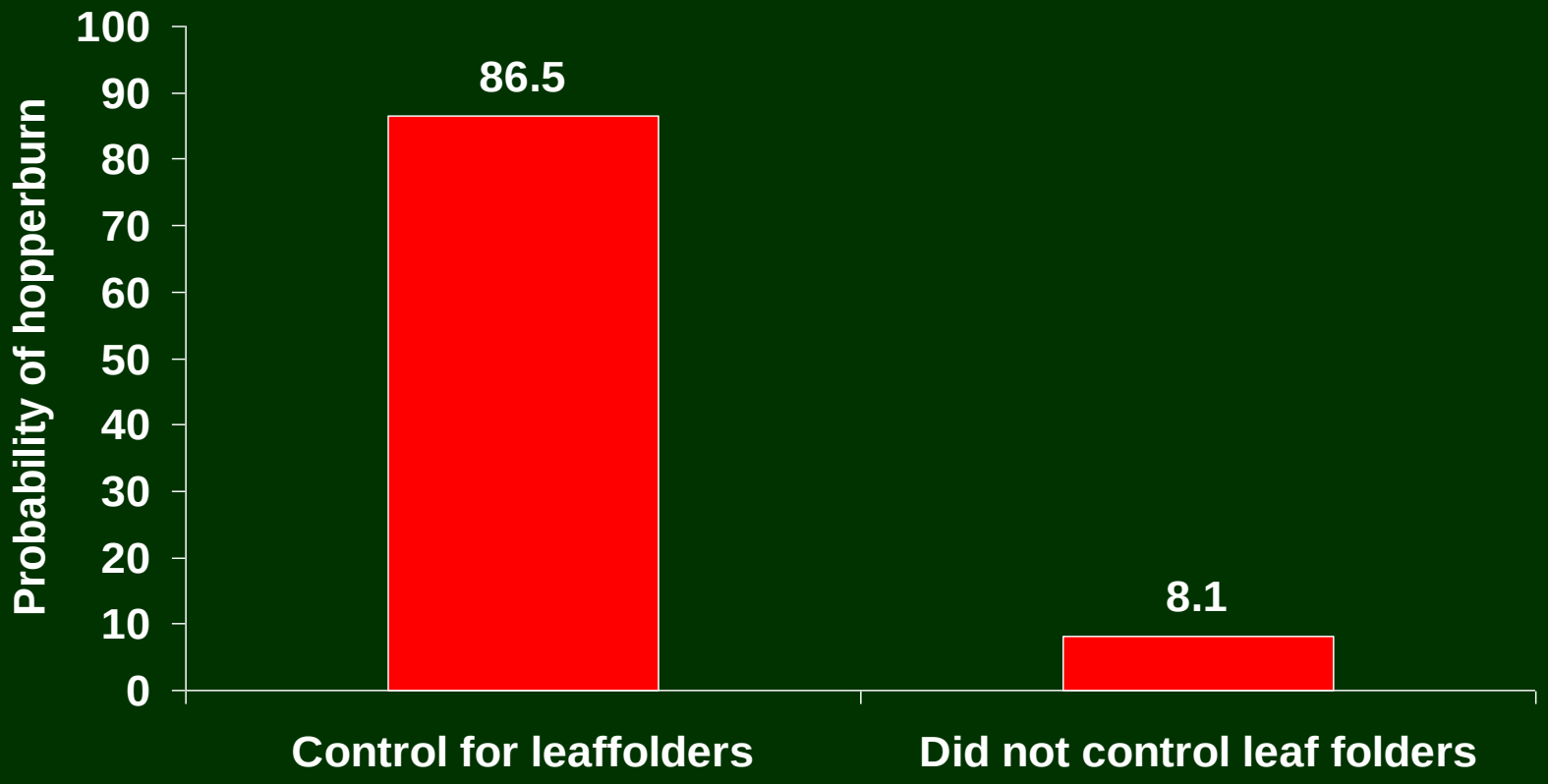
- ***Low biodiversity in parasitoids and predators***
  - **Lack habitat and food resources for natural enemies. Bunds sprayed with herbicides.**
  - **High insecticide pressure – farmers often apply 3 to 10 prophylactic sprays.**
  - **High use of insecticides toxic to parasitoids and predators.**
  - **Poor equipment used – low efficacy to pests, high efficacy to non targets esp. aquatic fauna.**
  - **High use of cocktails that broaden the "kill" spectrum.**
  - **Prophylactic spray (pre emptive strikes); mixed with herbicide sprays.**

# Hopperburn along spray paths – Suphan Buri, Thailand

# Hopperburn occur in parallel rows of the sprayer booms

## Malaysia

# Leaf folder control in early crop stages increases vulnerability to hopperburn by 10 folds

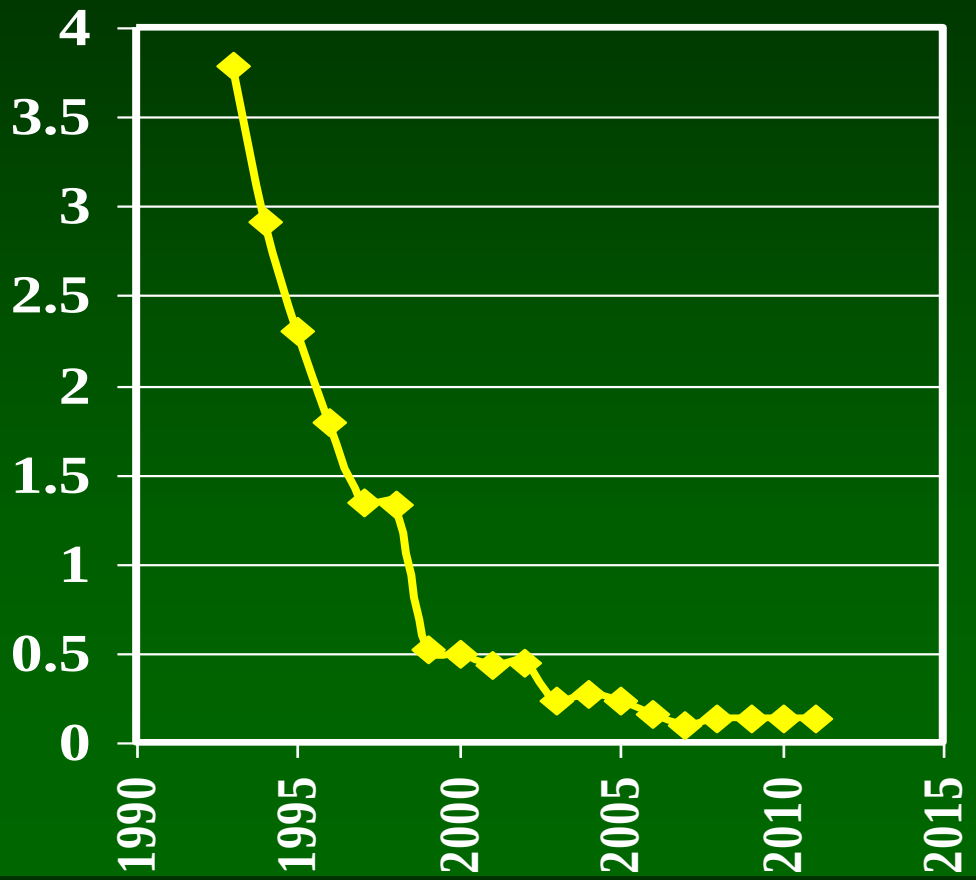


# Insecticide sprays have no effect on hopper – Only few specialist species for egg mortality

Youtube

# Total insecticides used in IRRI farm

1993 - 2011



# Comparison of arthropod communities between 1989 & 2005 in IRRI

Using rarefaction method after Gotelli and Entsminger. (2001)

| Species richness $S_r$ | 1989 | 2005 |
|---|---|---|
| Herbivores | 13.6 | 36 |
| Predators | 37.6 | 65 |
| Parasitoids | 17.1 | 38 |
| Detritivores | 5.6 | 30 |
| All arthropods | 75 | 169 |

# Microvelia – attack invaders and BPH that fall into the water

# Ecological Engineering techniques

## Restore Biodiversity

Planting nectar flowers on bunds
Crop diversification
Increase diversity of varieties

## Conserve Biodiversity

Stop early season (first 40 days) insecticide use
Avoid using insecticides toxic to bees and hymenoptera

## Species Biodiversity

Parasitoids, Predators, decomposers

## Ecosystem functions

Pollination, parasitism, predation

## Ecosystem Services

Pest invasion resistance,
Pest and disease regulation
Pollination

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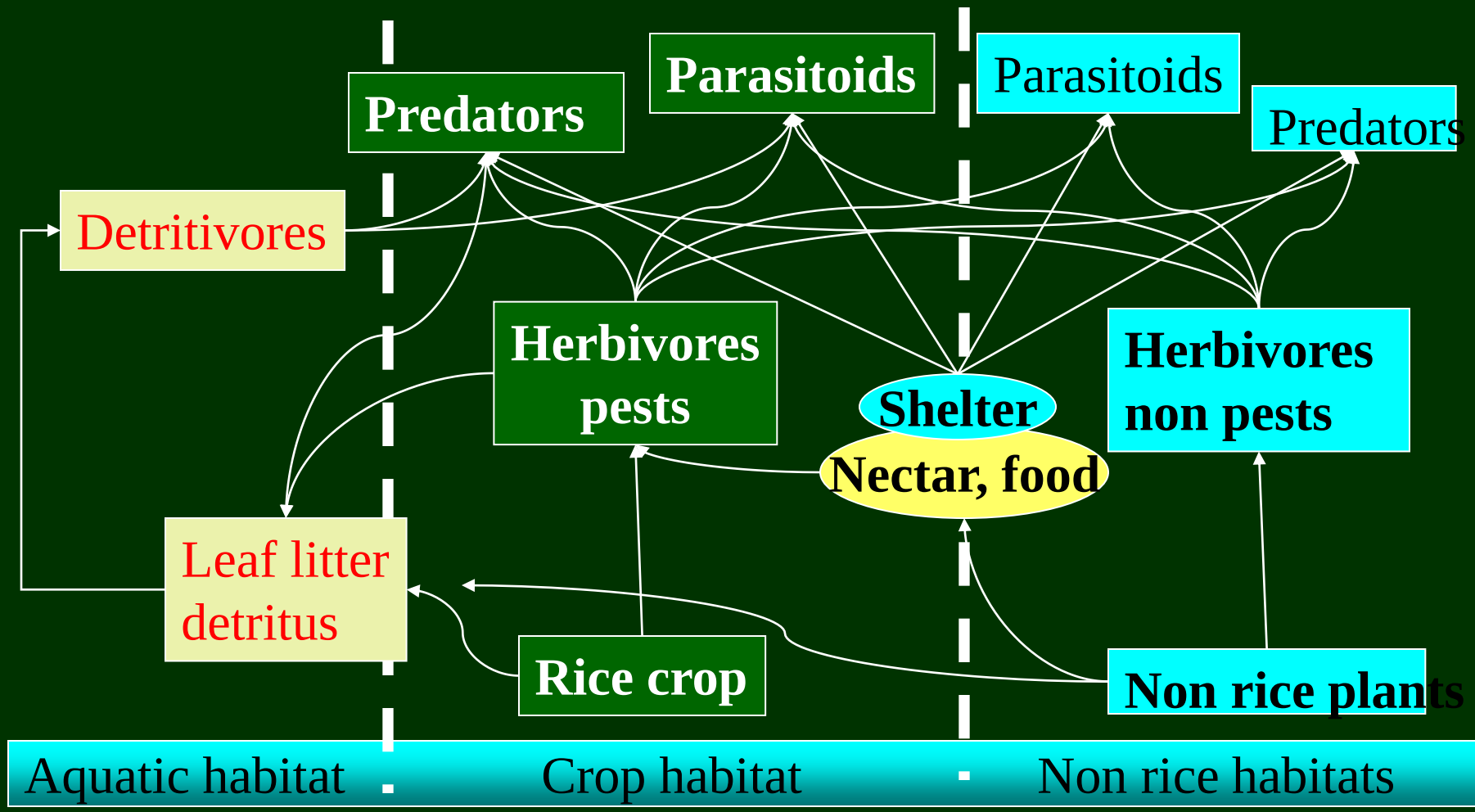
# Rice ecosystem food web



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# Key Resources Provided by Ecological Engineering

- **SNAP**
  - **S**helter
  - **N**ectar
  - **A**lternative Host/Prey
  - **P**ollen

# Ecological Engineering
## Australia

**Buckwheat (*Fagopyron esculentum*) used in Australian vineyard to promote biological control of caterpillar pests.**

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# California

## Conservation biological control of the lettuce aphid in organic lettuce

Syrphid larvae (top right) feed on the lettuce aphid and other aphids. Organic growers enhance the activity of these natural enemies by providing nectarresources (nectar and pollen) to adult syrphids (bottom right) in lettuce fields with in-field plantings of alyssum (below) and other insectary plants.

Photo: W.E. Chaney

Photo: W.E. Chaney

Photo: H.A. Smith

Prof Steve Wratten,
Lincoln University,
New Zealand

# Ecological engineering in Jin Hua

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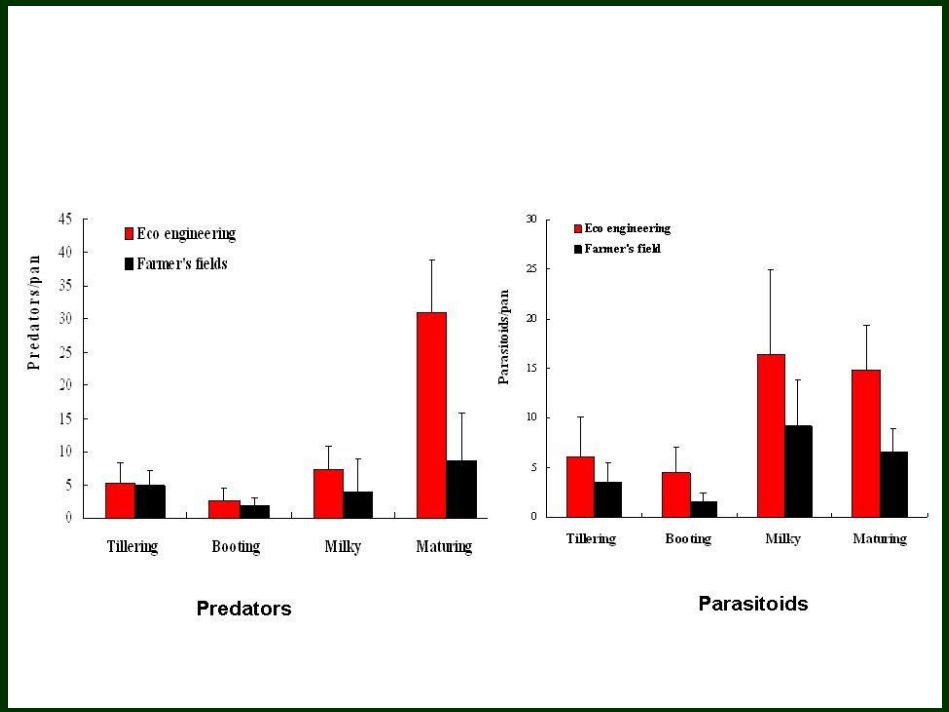
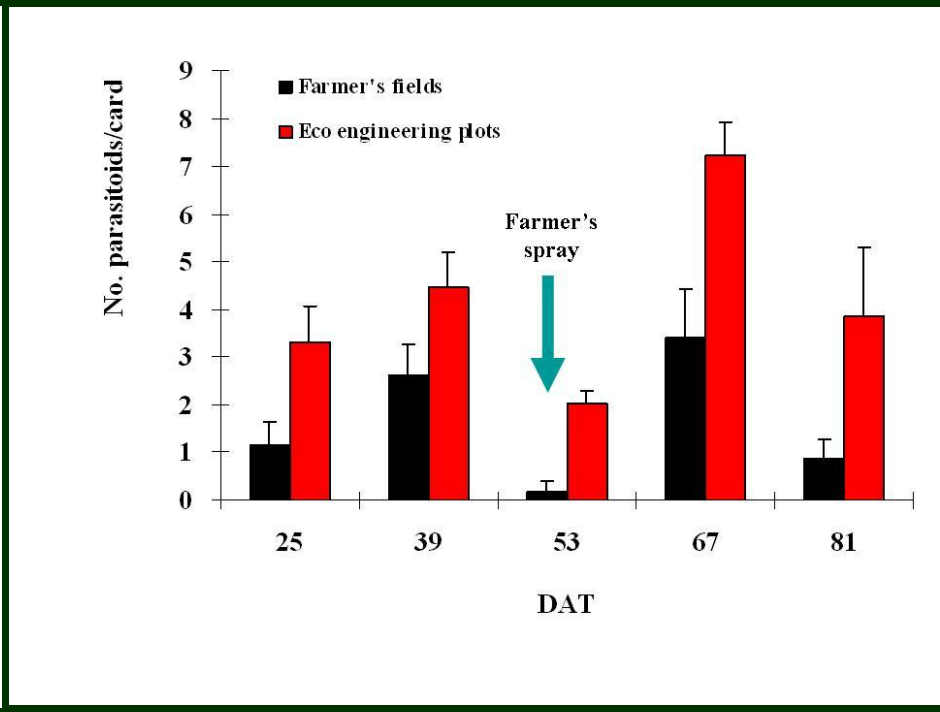
# Nectar plants – sesame (*Sesamum indicum*)

# Increase in parasitoids in rice field with sesame and no insecticide use

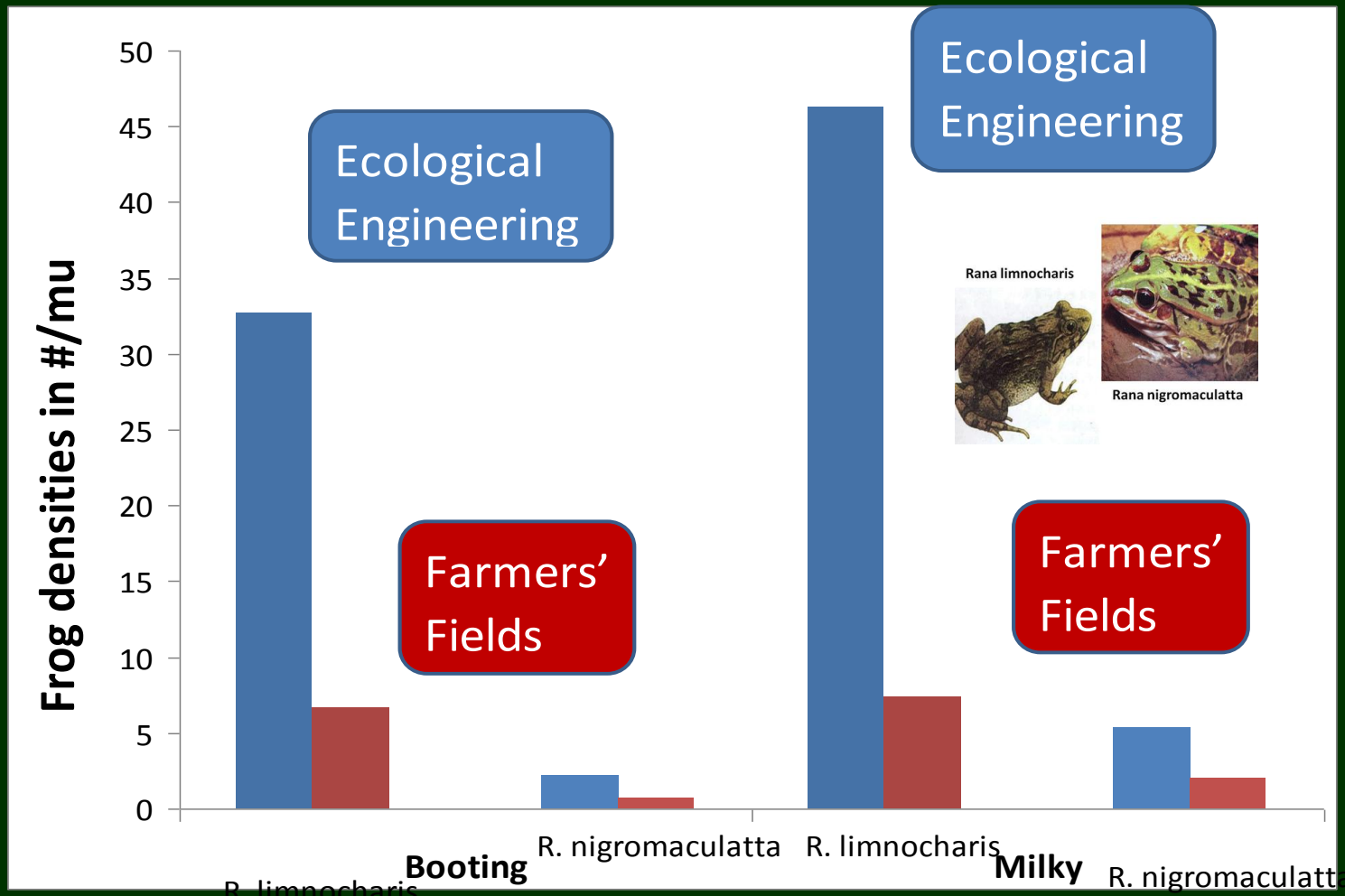
**Jin Hua, Zhejiang**




Lu et al 2009

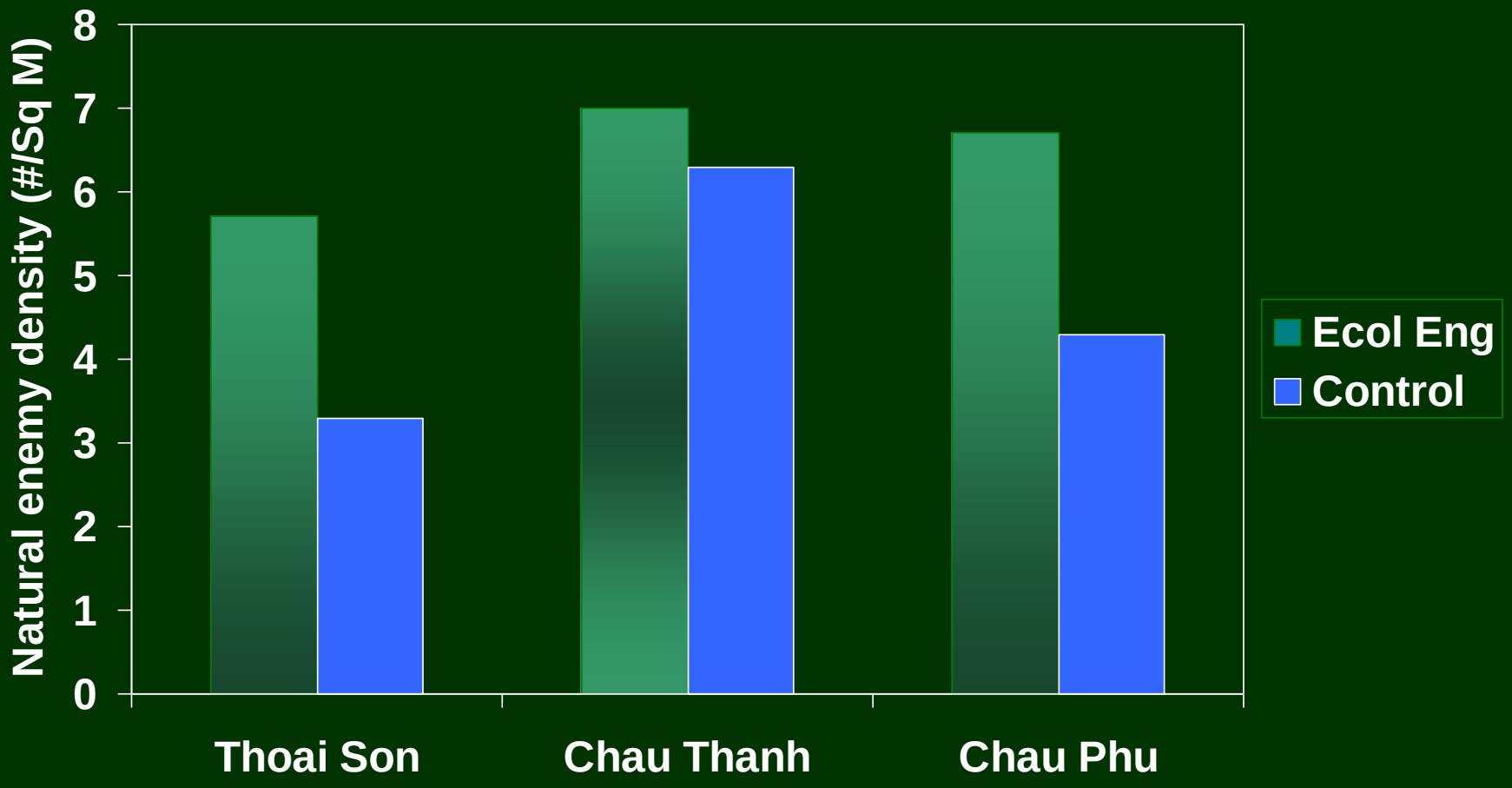
# Frog densities increase in eco eng fields



# Ecological engineering village in Vietnam

# Landscape transformation in many Vietnam provinces

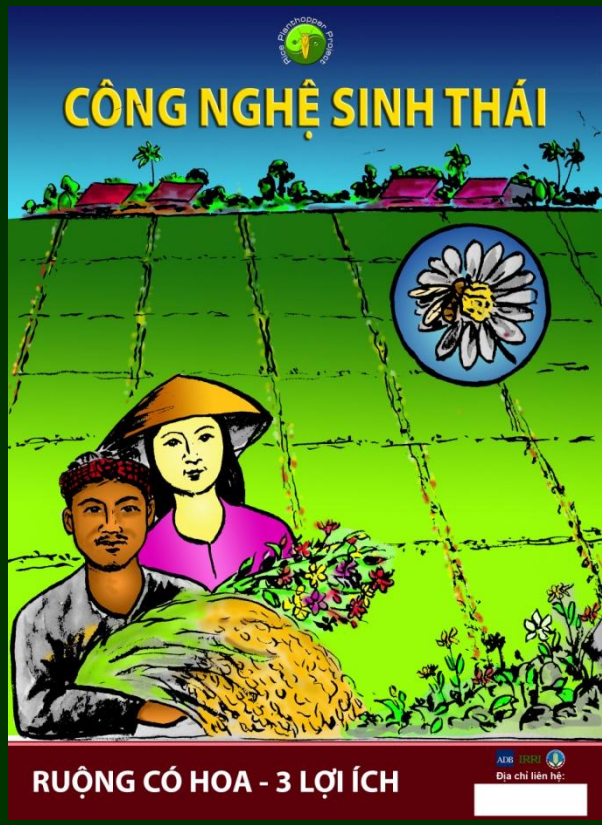

# Natural enemies increase



# Egg predatory bug increase

# Multi media campaign in Vietnam to motivate rural communities to restore biodiversity, increase natural biological control, reduce pesticides and increase their profits





# TV series with popular comedians

THVL
ĐÀI PHÁT THANH - TRUYỀN HÌNH VĨNH LONG

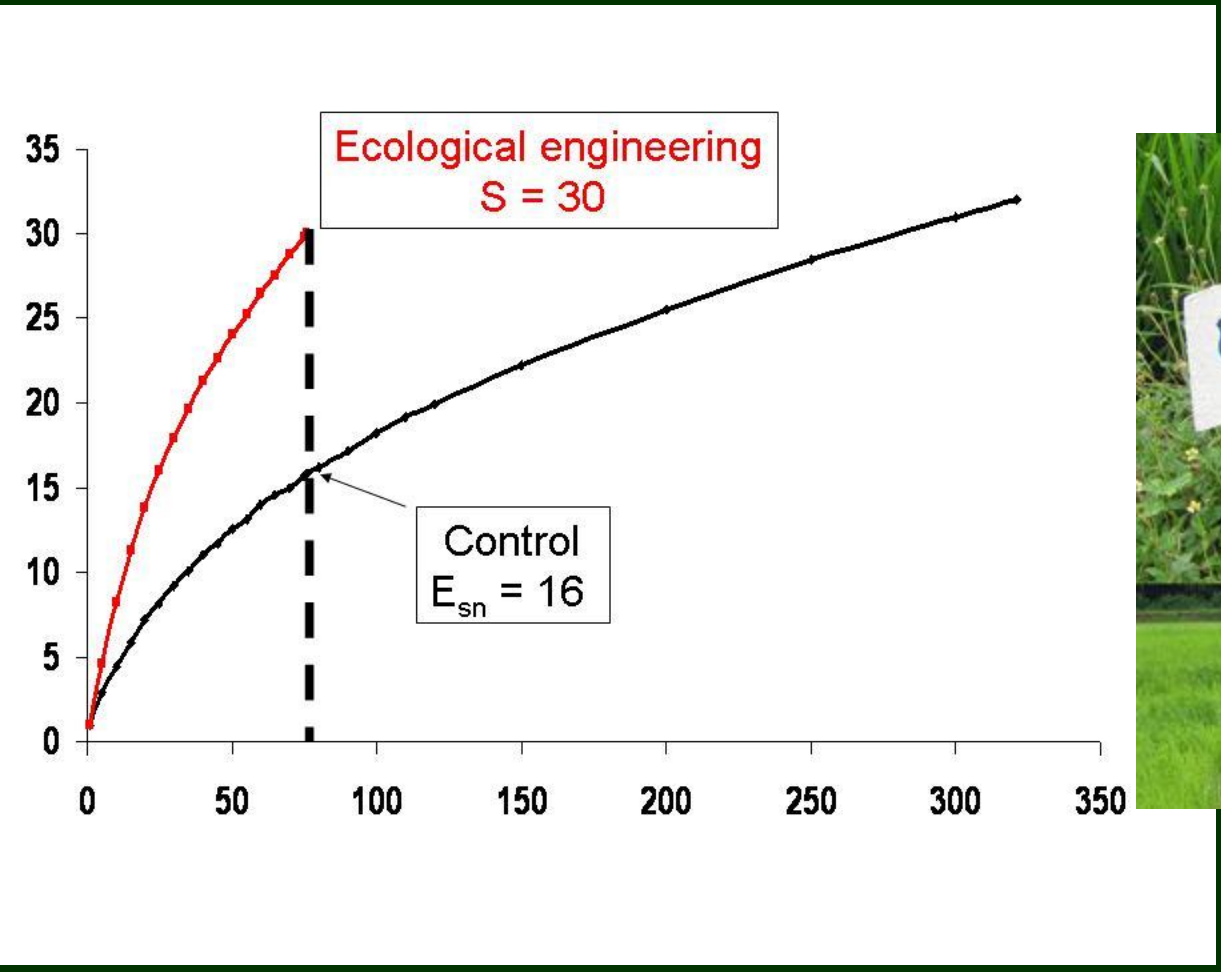
# Thailand

## Pitsanuluk

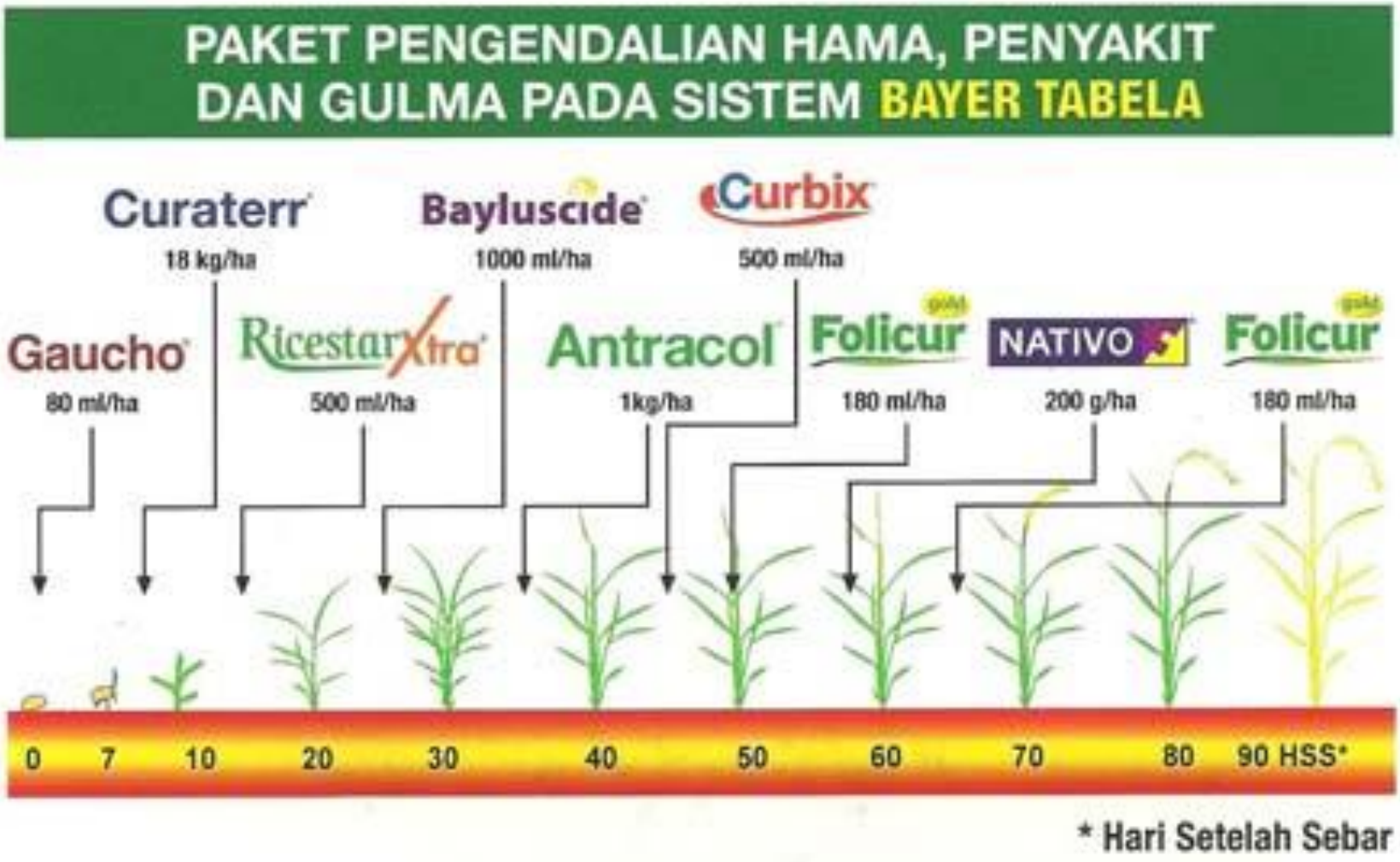
## Nakhon Nayuk

# Parasitoid Species Richness

## Rarefaction curves




# Today's IPM is prophylactic spraying



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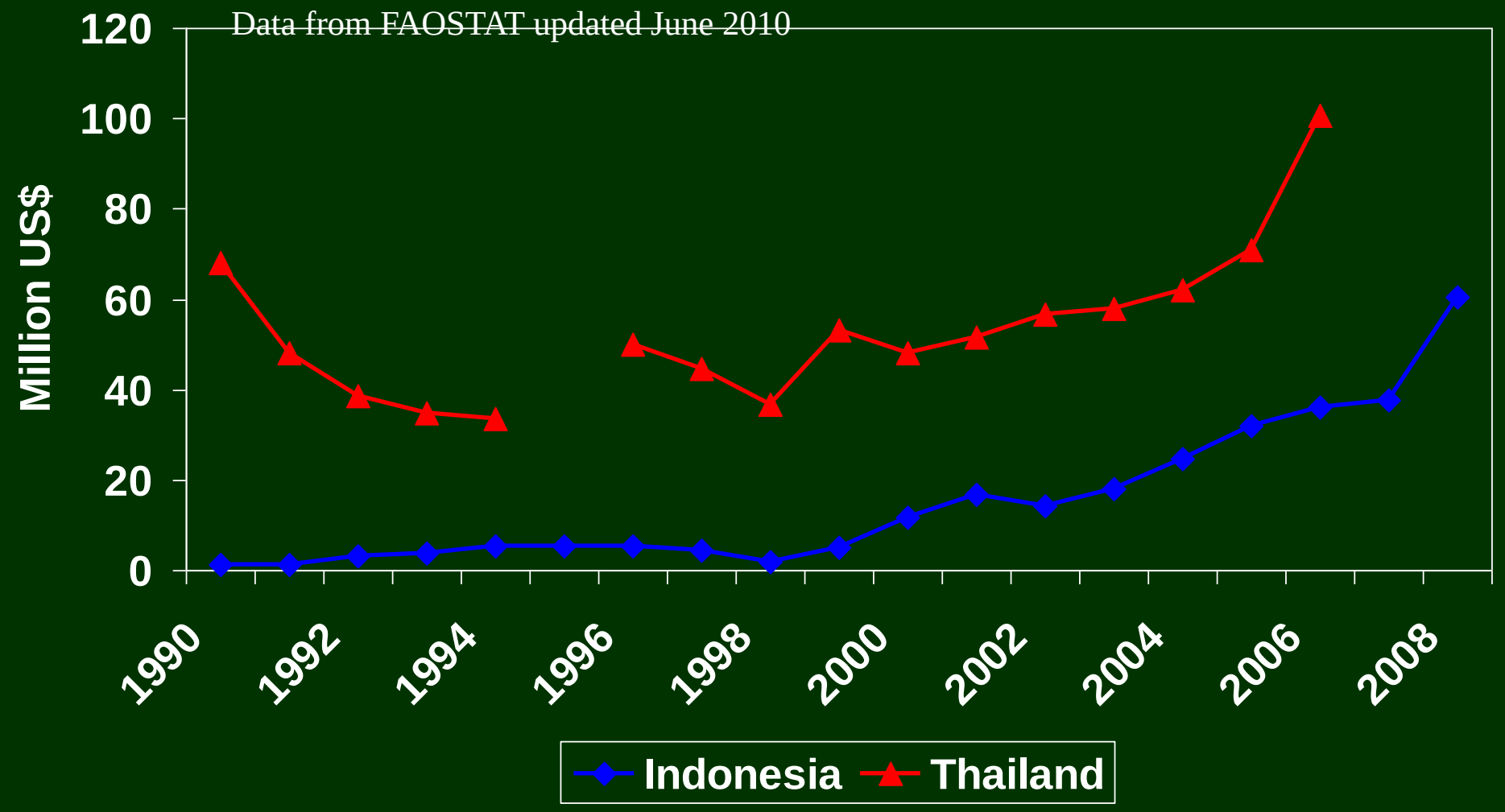
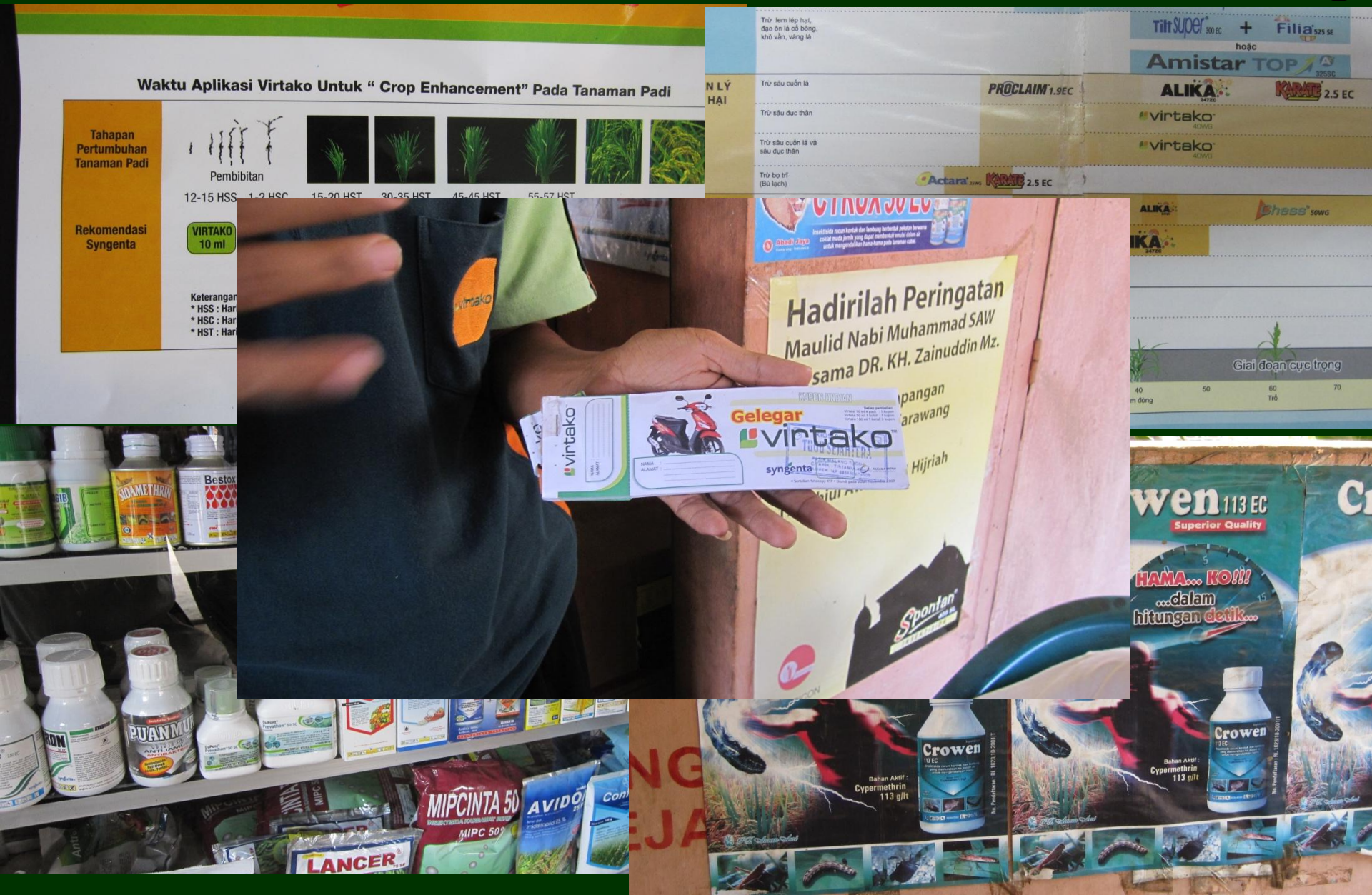
# Spray program ******* Pada Padi


Today's IPM is prophylactic spraying

# Insecticide imports



# Pest management today and Pesticide Marketing



# Multi tier marketing through downline tertiary sub retailers

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## Other sales p mance inc clude:

- Washing machines
- CD players
- TVs
- Cookers
- Free t al tourists' destinations
- Free international destinations
- To Mecca to perform the Haj.

Violations of FAO Code of Conduct on Pesticide distribution

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# FMCG

## Fast Moving Consumer Goods

| Insecticide use based on IPM | Insecticide use based on FMCG |
|---|---|
| **Driven by rational decision making skills.** | **Driven by product packaging, brand names, attractiveness, recalls.** |
| **Need to use knowledge on pests, natural enemies, predation, insecticide actions. Judicious use.** | **No thinking needed. Calendar applications. Mixing several ingredients together to "make sure" of kill.** |
| **Maximize value of knowledge** | **Maximize value of sales**<br>**Knowledge unimportant** |
| **Based on economic rationale** | **Based on emotions viz status, desire, fear, perceptions, attitudes, sense of power, price.** |

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# Hands up those who get their pest management advice from the local pesticide retailers

# Wife of secondary pesticide retailer advising farmers to mix cypermethrin with herbicides

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# Don’t blame me blame the shop keeper for selling me the wrong medicine

# House with No Roof

# Current system favor YIN

## Negatives

Pesticide promotion by private and Public sectors
Govt subsidies, free distributions
ow costs of pesticides
ticide misuses

## Positives

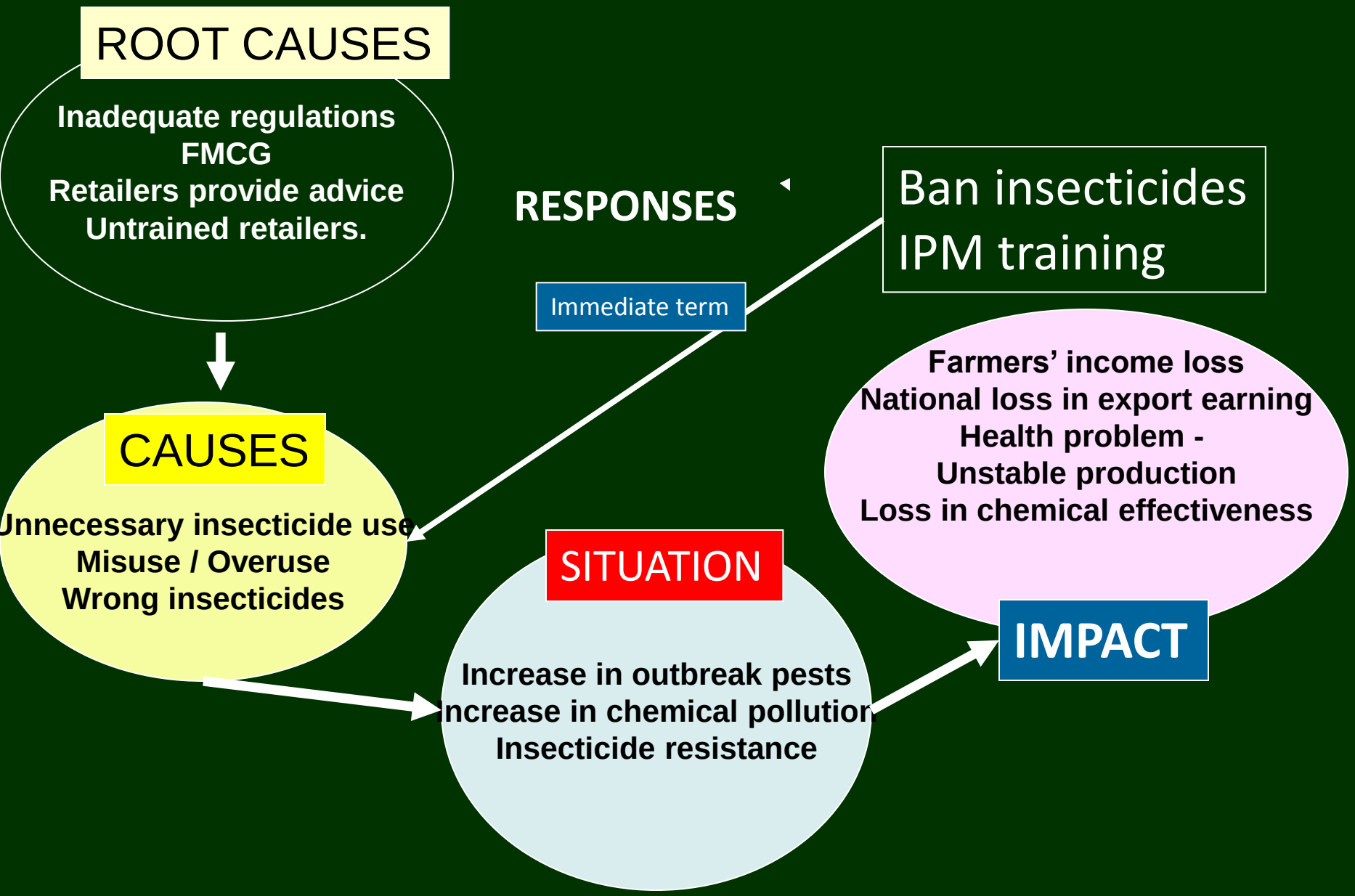
Ecological research
Resistant varieties
Ecological engineering
IPM training
Insecticide reduction programs

## Structures/Policies favoring Negatives

Inadequate pesticides regulatory system
Ecosystem services not factored into policies
Incentives for short term profit gains
Lack incentives for sustainable practices
Access to emergency pesticide allocations


Pesticide Tsunami
Resistant varieties, IPM,Biological control, Biodiversity, Ecological Engineering

# Root Causes of Planthopper problems




การประชุมวิชาการข้าวและธัญพืชเมืองหนาว
องในโอกาสวันข้าวและชาวนาแห่งชาติ ครั้งที่ 2 ปี
างวันที่ 3-4 มิถุน 2554
หยุด การระบาด
เพลี้ยกระโดด
สีน้ำตาล
ในนาข้าว
ห้ามใช้
อะบาเม็กติน
ไซเพอร์เมทริน
ทำลายศัตรูธรรมชาติ และทำให้เกิดการระบาด
เพลี้ยกระโดดสีน้ำตาล
ด้วยความปรา
กรมการข้าว

# Restore biodiversity and resilience

Revise pesticide marketing regulations. License retailers Implement eco eng appr

ROOT CAUSES

Inadequate regulations
FMCG
Retailers provide advice
Untrained retailers.

Medium/Long term

RESPONSES

Ban insecticides
IPM training

Immediate term

CAUSES

Unnecessary insecticide use
Misuse / Overuse
Wrong insecticides

SITUATION

Increase in outbreak pests
Increase in chemical pollution
Insecticide resistance

IMPACT

Farmers' income loss
National loss in export earning
Health problem -
Unstable production
Loss in chemical effectiveness

IRRI


# http://ricehoppers.net/