# INTEGRATED PEST AND DISEASE CONTROL

**Plant Protection Team**
**Indonesian Center for Rice Research (ICRR)**
**Indonesian Agency for Agriculture Standardized Instruments (IAASI)**

**Online Training Course on Rice Plant Management for Africans Countries**
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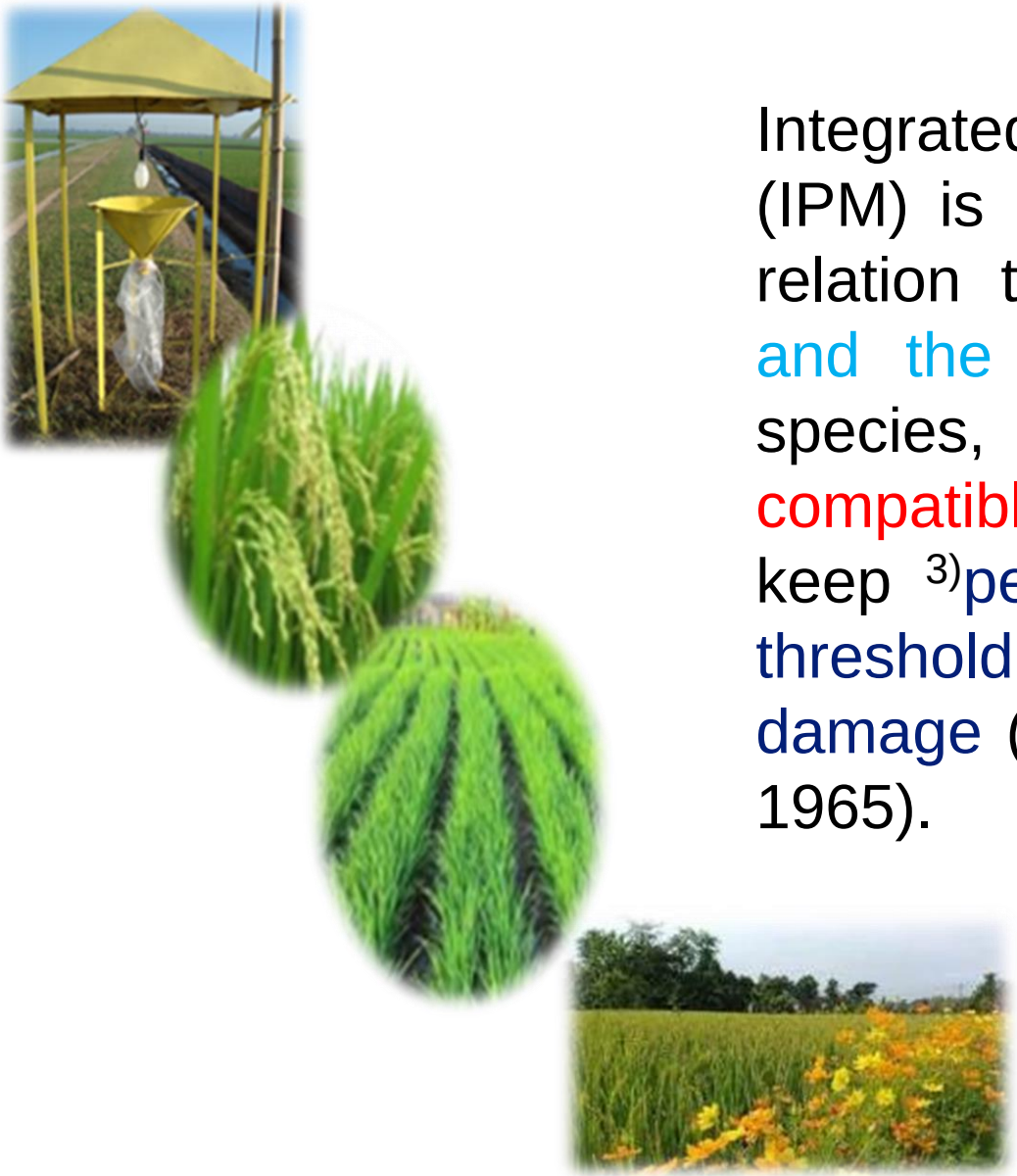
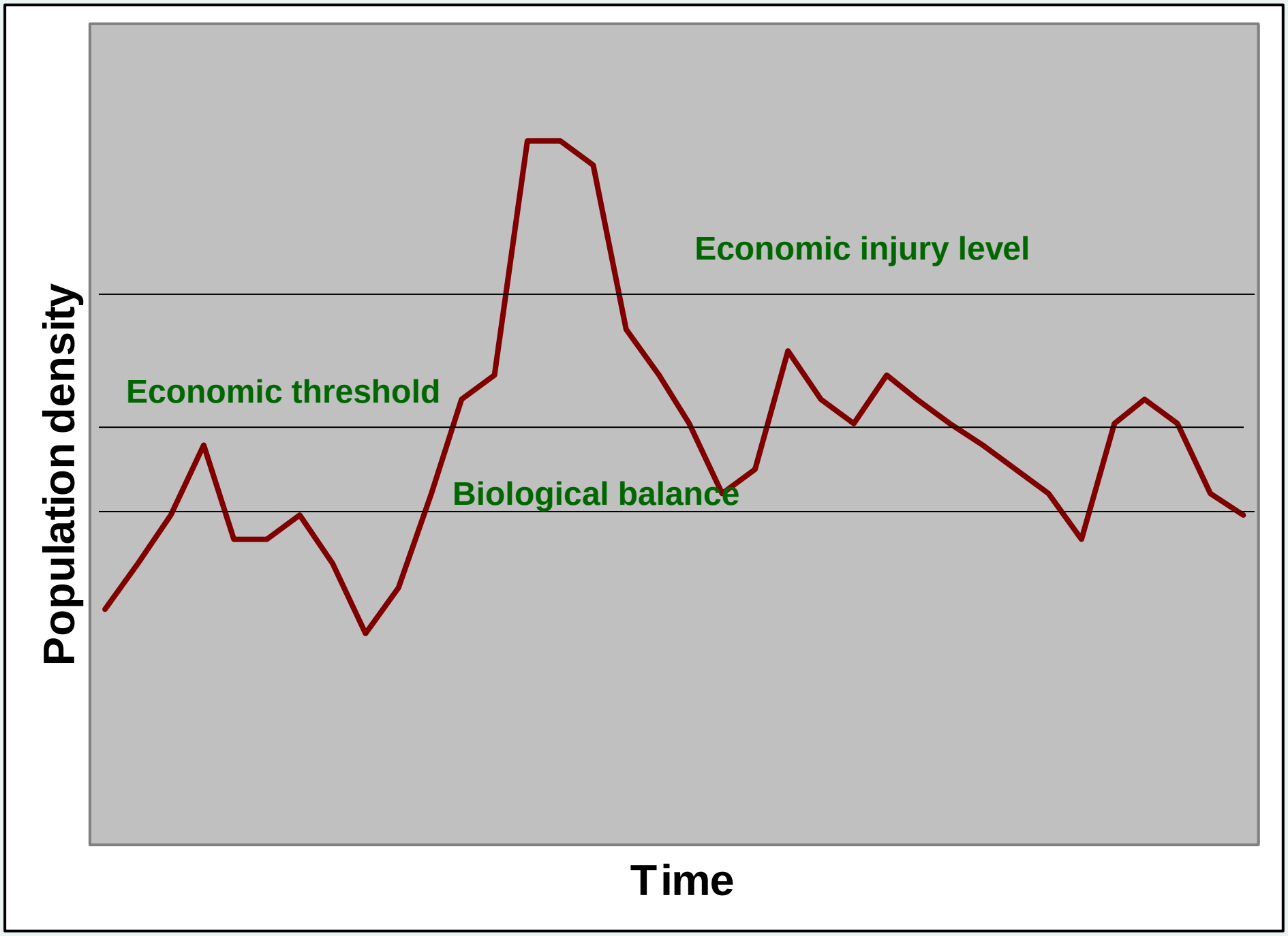
The Non- Aligned Movement Centre of South-South Technical Cooperation

# Integrated Pest Management Concept



Integrated Pest Management (IPM) is a pest control system in relation to [1)]population dynamics and the environment of a pest species, using [2)]various compatible control techniques to keep [3)]pest population below the threshold that causes economic damage (FAO Expert Panel, FAO, 1965).


Economic injury level
Economic threshold
Biological balance
Population density
Time

# RICE PEST AND DISEASE MANAGEMENT

## What are plant pest and disease ?

**Plant pests** defined as any animal including invertebrate, insect, mammals, aves, weeds, etc. which their activities can cause damage to crop.

**Plant diseases** defined as a condition which one or more physiological function of plant being disturbed by biotic factor (pathogenic agents such as: bacteria, fungi, virus, nematode, protozoa, etc.) or abiotic (environmental) factor such as: climate, nutrient deficiency, etc. and the disturbances are continuously and expressed as disease symptoms

# The Important of Pest and Disease in Rice

- The total global potential loss due to pests for rice is about 37.4% (Oerke 2006).
- The total potential loss due to plant disease is about 24 – 41% in Asia

**Controlling of plant pest and disease are important things**

# Major Rice Pest and Disease

**Major Rice Pest**

- Brown Planthopper
- Rice Stem Borer
- Rat

**Major Rice Diseases**

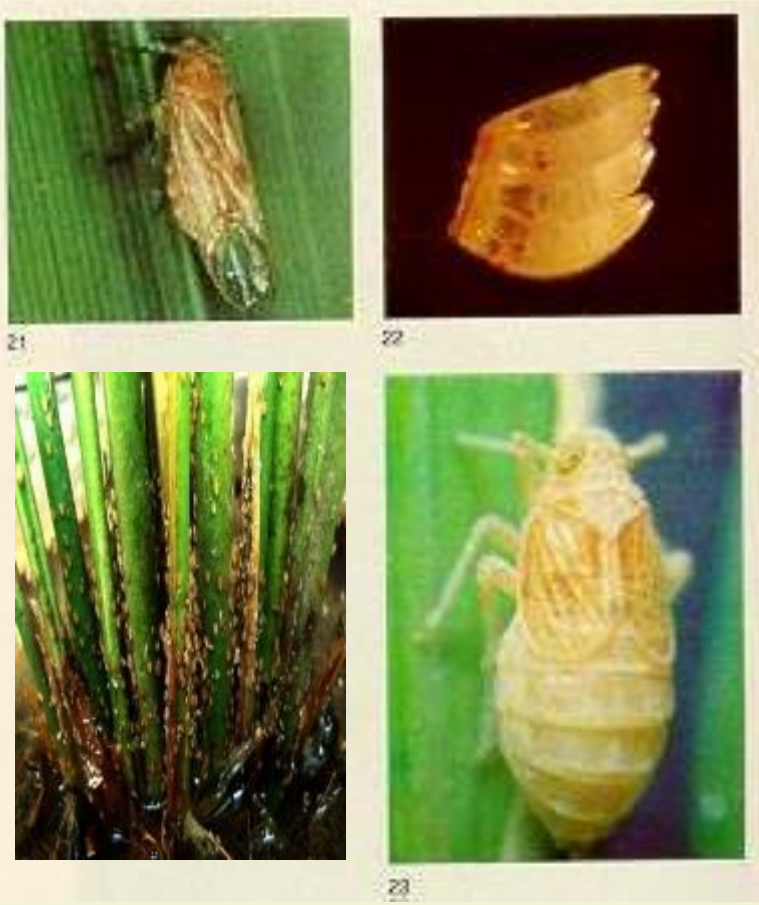
- Bacterial leaf blight (BLB)
- Blast
- Tungro
- Ragged stunt
- Grassy stunt

# *Common Pest in Paddy Field*

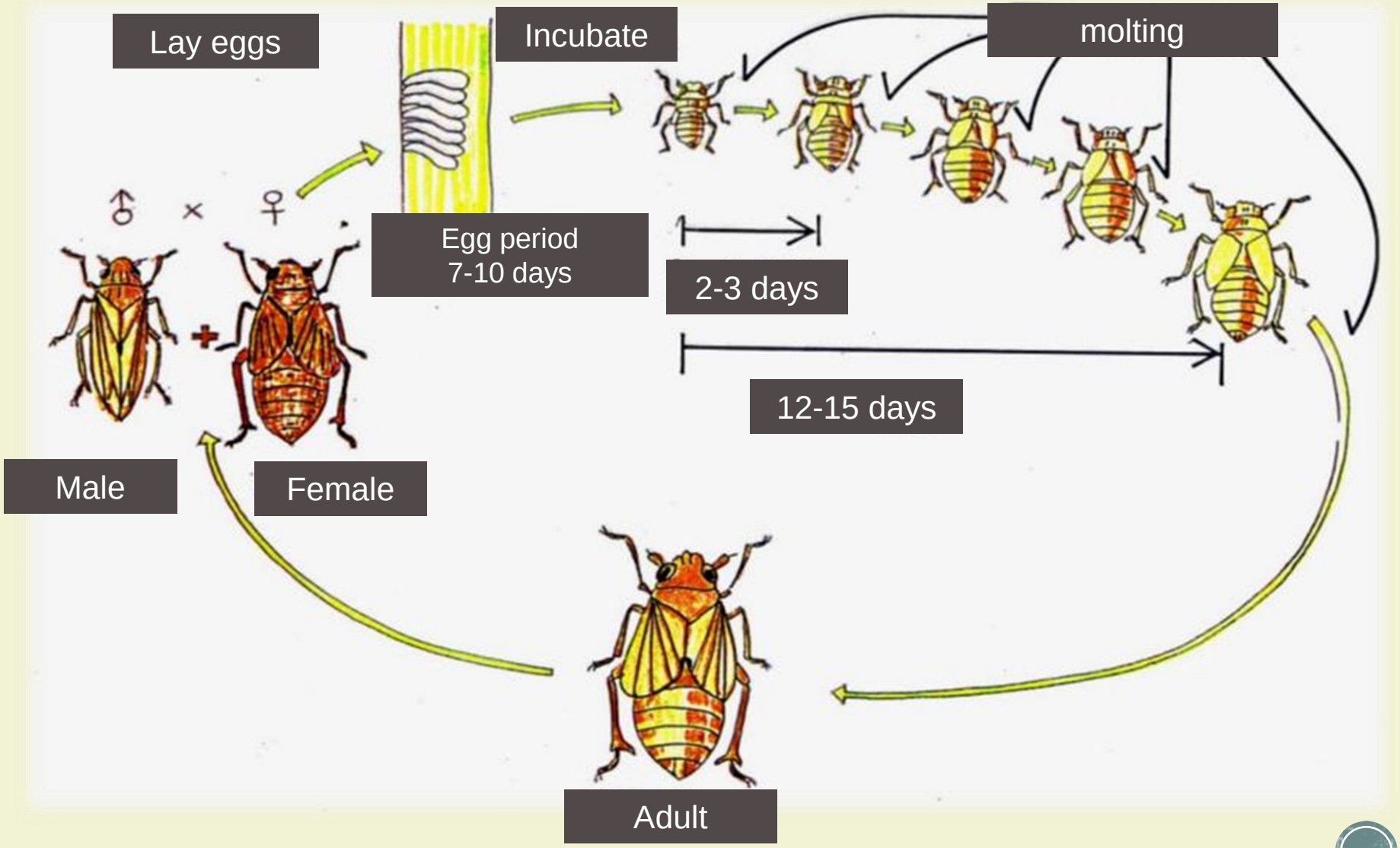
# Brown planthopper (BPH)

**Morphology**

- Adult insects form long wings and short wings,
- Eggs are laid in the leaf sheath or leaf bones,
- The eggs group like banana combs and hatch within 7-9 days, becoming BPH nymph,
- There are 5 instars,
- Nymph period 12 – 15 days



# The life cycle of the brown planthopper



## Adult insects and nymphs

- Attacking the stem
- Symptoms of BPH in individual clumps can be seen from the yellowing of the leaves, then the plant dries quickly (like burning). This symptom is known as hopperburn.
- As a vector of grassy and ragged stunt viruses

# How to control Brown Planthopper ?

- **Plant rice simultaneously in a large area**
- **Use of resistant varieties** : Inpari 13, Inpari 31, Inpari 33, Inpari 47

# ➢ Use of light traps

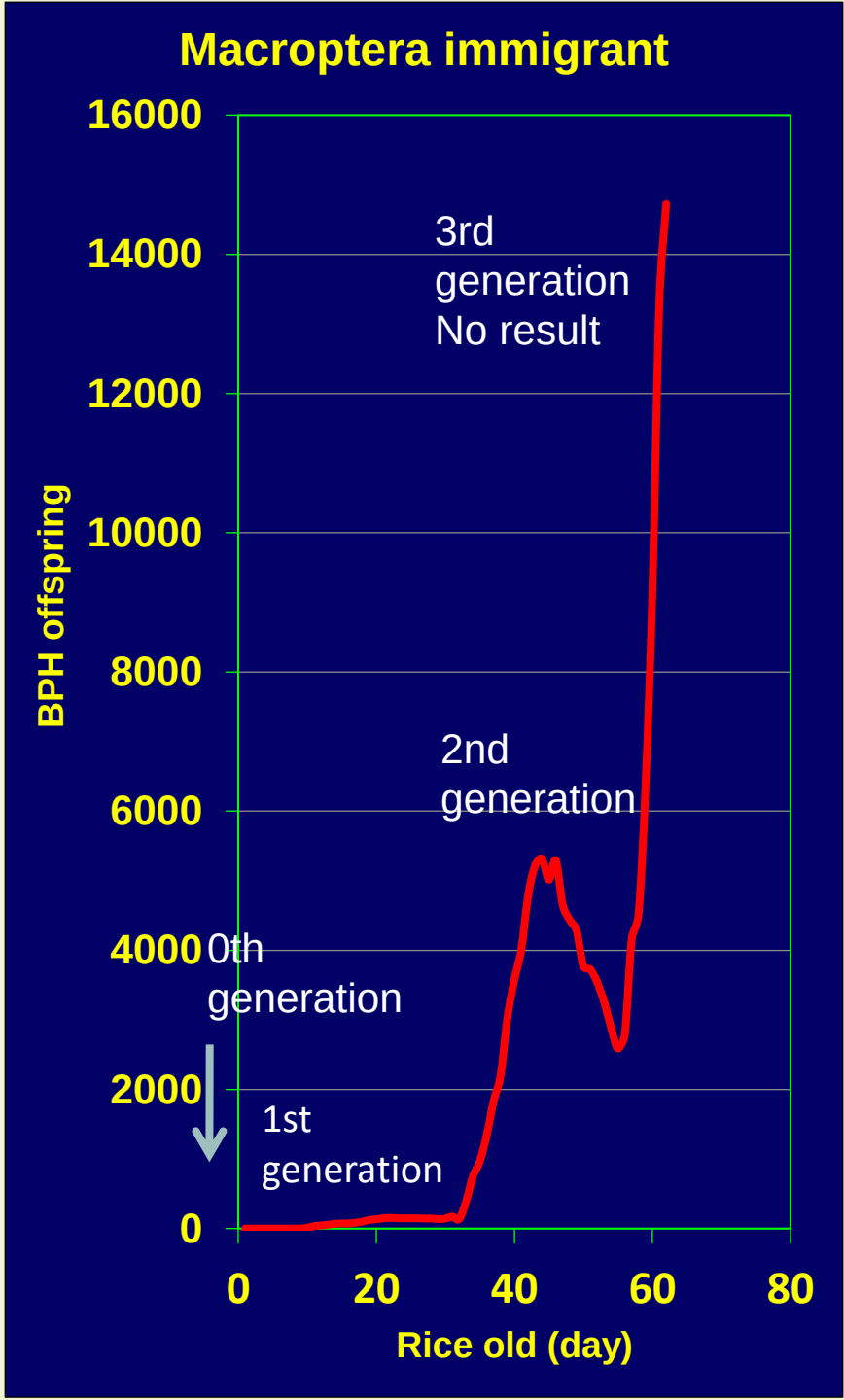
- Light trap can be used to monitor the presence of immigrant brown planthoppers
  - ✓1 light trap with 160 W lamp can cover: 200-500 ha
- Physical and mechanical controller for the brown planthopper
- Light trap can reduces brown planthopper

- ***Determination of rice seedling time based on catch on light trap***
  - ✓ Seedling should be done 15 days after the peak of immigrants (if not overlapping generations)
  - ✓ Seedling should be done 15 days after the 2nd immigrant peak (if overlapping generations)
- ***Appropriate timing of chemical insecticide application based on catch on light trap***
  - ✓ The peak population of early immigrant = G0
  - ✓ 25-30 days later = imago G1
  - ✓ 25-30 days later = imago G2
  - ✓ 25-30 days later = imago G3

## Best control :

- ✓ at G0 and G1
- ✓ at the latest in the 2nd generation (G2)

Control during the 3rd generation will not work



## ➢ Use of insecticides

- Dry the crop before application
- Apply when there is no dew: 8-11 hours
- The right dose and the right type:
  - ✓ Denatifuran (concentration 1 g/ltr)
  - ✓ Pymetrozine (concentration 0.5 gr/ltr)
  - ✓ Appropriate water solvent 350-500 liters of water/ha

## ➢ Observation of brown planthopper (BPH) in the plantation

- Observations are carried out once every 1-2 weeks
- If the observations show that the BPH has reached the economic threshold, control measures must be taken immediately
- The economic threshold for BPH in rice plants:
  - ✓ aged less than 40 days after planting is 3 individual
  - ✓ aged more than 40 days after planting is 5 individual

# Rice Stem Borer

## Rice stem borer species

*S. incertulas*

*S. innotata*

*C. suppressalis*

*S. inferens*

# Rice Stem Borer

Deadheart Whitehead

## Symptom

- This pest can damage plants at all stages of growth, both at the time of the nursery, growing phase, and flowering phase.
- If the attack occurs in the nursery until the tiller stage, this pest is called deadheart and if it occurs during flowering, it is called whitehead

# The life cycle of yellow rice stem borer

1 egg mass consist of 50 – 150 egg

- Imago will continue to laying egg until died at 5th day
- 1st & 2nd day egg will generate >50 larvae

**Egg**
7 days

**Imago**
5 days

**52 days**

**Larvae**
30 days

**Pupae**
10 days

**Instar 1-5**
6th instar only found in rice crop in highland area

# Rice Stem Borer Control

## A. Endemic attack area

### 1. Cropping pattern settings

- Simultaneous planting: food sources for rice stem borer can be limited
- Crop rotation with non-rice crops so as to break the life cycle of pests.
- Nursery grouping is intended to facilitate efforts to collect rice stem borer eggs in bulk.
- Timing of planting is based on flight of moths. Planting should not coincide with the peak of the moth's flight. Planting can be done before or after the peak of the moth flight.

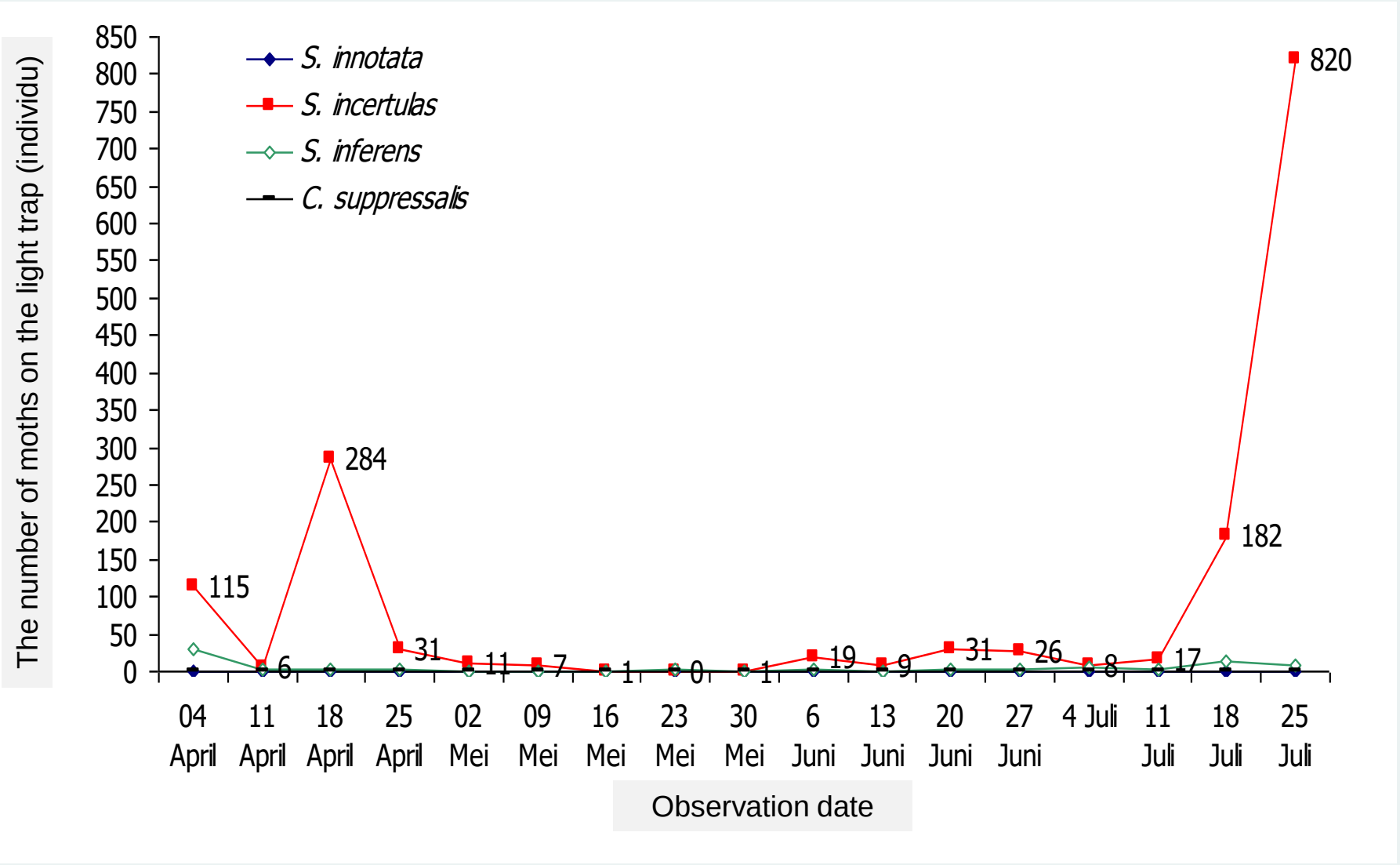
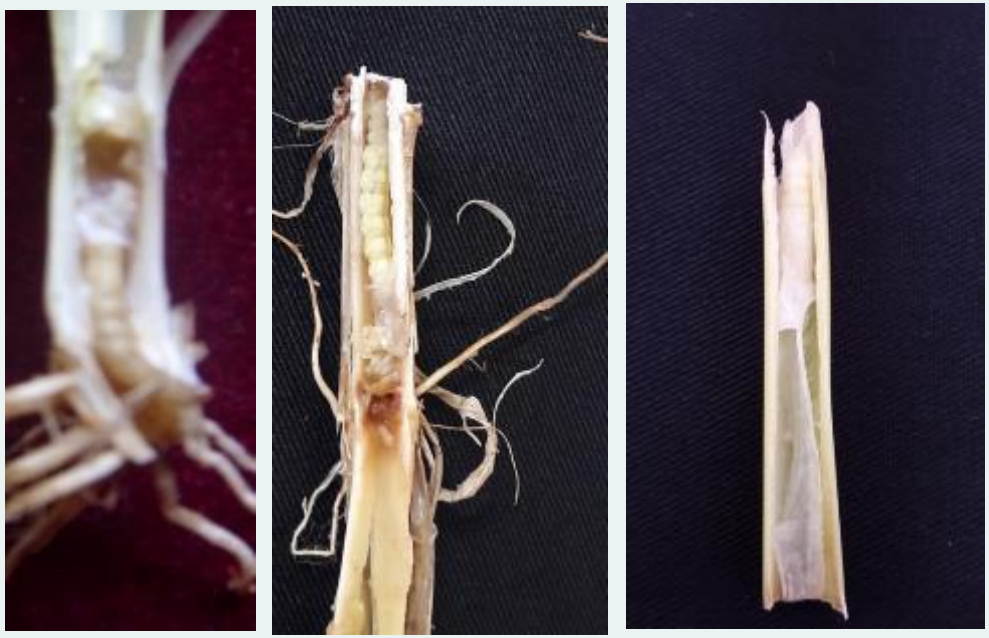



Figure 1. Number of rice stem borer moths caught on light traps. Sukamandi, 2011

## 2. Physical and mechanical control

- Cutting plants as low as possible to ground level at harvest.
- This effort can also be followed by flooding as high as 10 cm so that the straw or the base of the straw rots quickly so that the larvae or pupae die.



- Using a singkal tool when tilling the soil.
- Collecting egg masses of rice stem borer in nurseries and in plantations.
- Using a net cover in the nursery.

- Catching rice stem borer moths using light traps: (50 ha : 1 light trap)

## 3. Biological control

- Utilization of natural enemies by releasing egg parasitoids, such as *Trichogramma japonicum*

  ✓ Dose: 20 card/ha

  1 card = 2000-2500 parasitized eggs

  → since the beginning of planting

- Natural enemy conservation

## ✓ Rice stem borer egg parasitoids

*Trichogramma minutum* Riley
(Hymenoptera: Trichogrammatidae)
(Pbs: 11x)

*Telenomus rowani* (Gahan)
(Hymenoptera: Scelionidae)
(Pbs: 11x)



*Tetrastichus schoenobii* Ferriere
(Hymenoptera: Eulophidae)
(Pbs: 4x)

## ✓ Parasitoids of stem borer larvae and pupa

*Cotesia flavipes* Cameron
(Hymenoptera: Braconidae)
(Pbs: 1.8x)

*Eriborus* sp
(Hymenoptera: Ichneumonidae)
(Cam: digital)

## 4. Chemical control

- Conducted
  - ✓ at 4 days after the moth flight
- Control threshold:
  - ✓ 1 moth observed in light traps
  - ✓ one egg masses / 3 $m^2$
  - ✓ average attack intensity was >5%

- On planting
  - ✓ At the vegetative stage, application with granular insecticide: dose 20 kg/ha
  - ✓ In the generative stage, application with sprayed insecticide
- Insecticide granules:
  - ✓ Carbofuran
- Insecticide spray (liquid):
  - ✓ Spinoteram (70-80%),
  - ✓ Chlorantraniliprole (50-60%),
  - ✓ Dimehipo (40-50%)

**B. Sporadic attack area**

- Control methods other than using insecticides that can be applied according to local conditions.
- Spraying with insecticides:
  - ✓Conducted
    - at 4 days after the moth flight
  - ✓Control threshold:
    - 1 moth observed in light traps
    - one egg masses / 3 $m^2$
    - average attack intensity was >5%

  No later than at least three weeks before harvest

## C. Other information

- As a preventive measure in controlling the rice stem borer, it is necessary to monitor fluctuations in the population of the rice stem borer on a regular basis.
- To monitor population fluctuations of rice stem borer originating from migration from outside the area, light traps can be used.

# *Rat : Rattus argentiventer*

- 150 types of rats in Indonesia,
- 8 types as pests in agricultural areas (*Rattus, Bandicota* and *Mus*)
- The area of the rat attack is the widest
- Pre- and post-harvest yield loss 20 - 100%

# Number of rat in one rice planting season

| Rats start mating before the maximum tiller rice (45-50 dap) | **Birth 1** Primordia rice (68-72 dap) | **Birth 2** Milky rice - mature (90-95 dap) | **Birth 3** Rice harvest (112-117 dap) | End of breeding rats | If rice is available >2 weeks / ratoon 1st generation offspring reproduce |
|---|---|---|---|---|---|

**1 adult female**

**10 tail**

**10 tail**

**10 tail**

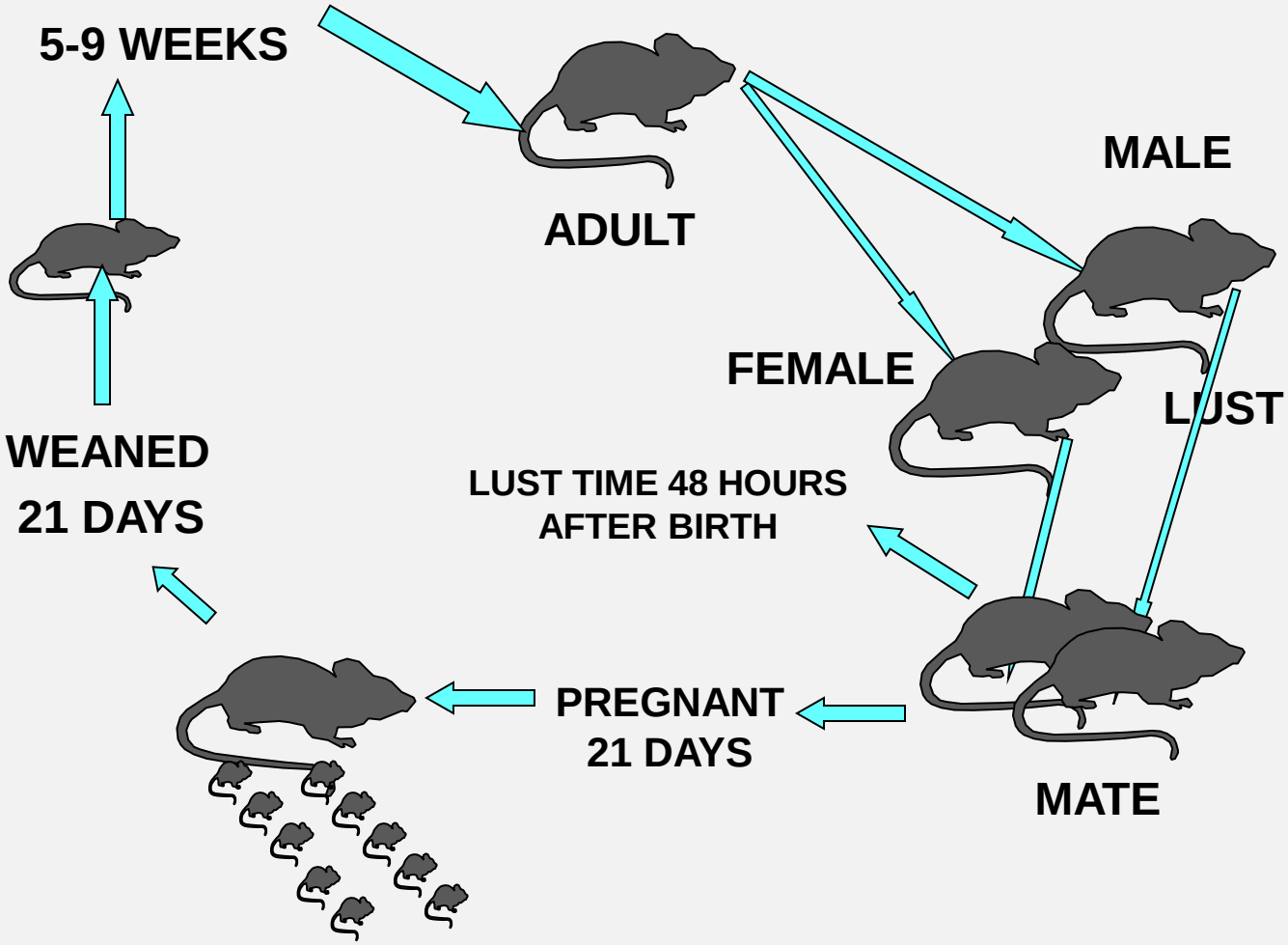
**50 tail**

**Sex ratio 1:1**

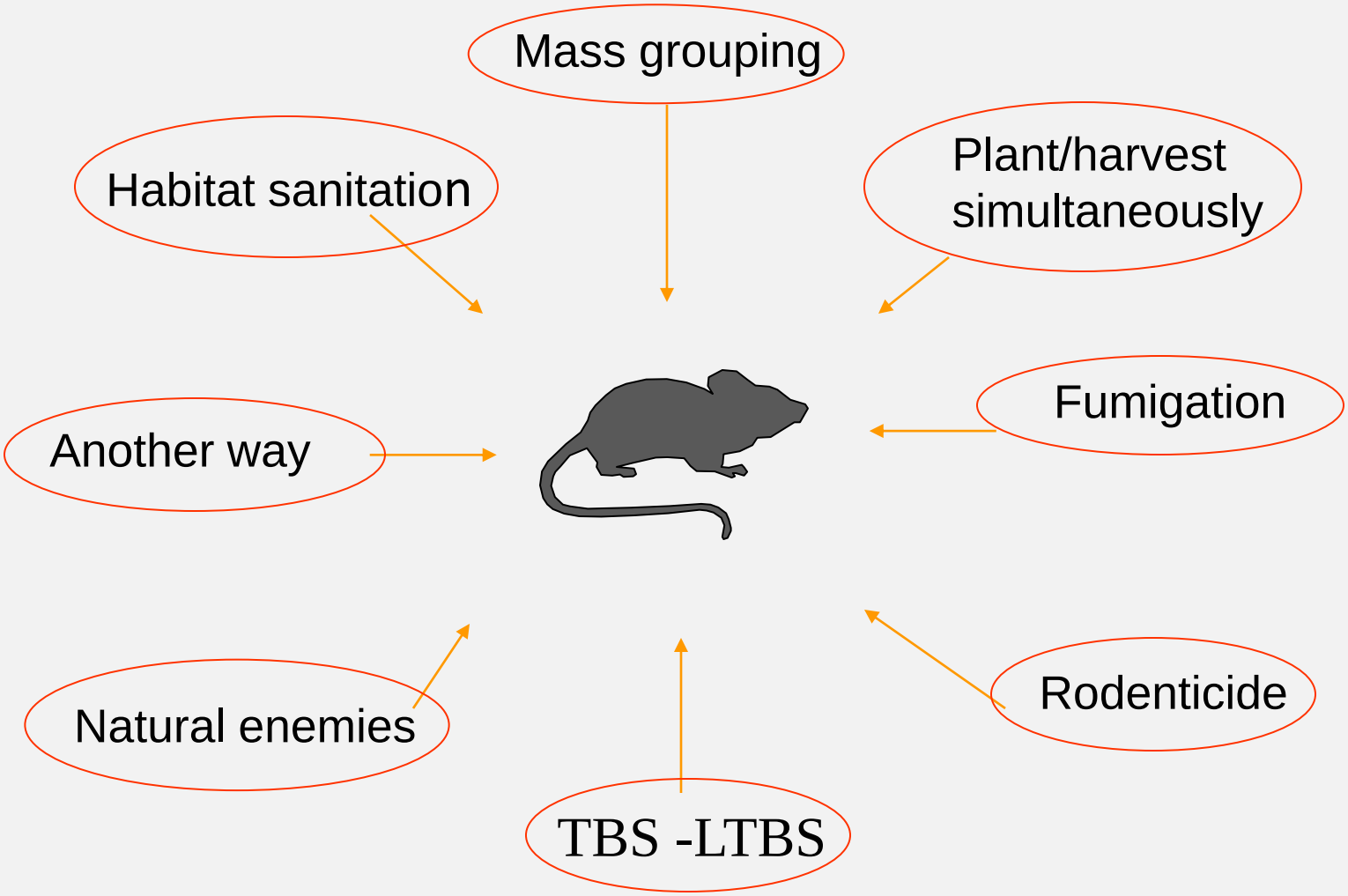
**(5 female)**

**Total = 80 tail**

# The life cycle of rice rat



# Integrated Rat Pest Control



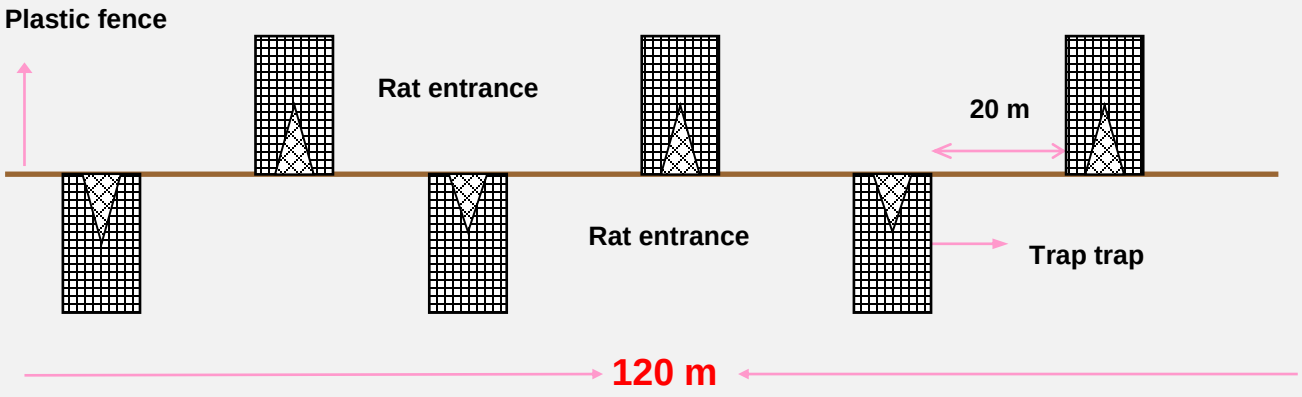
# Integrated rat pest control strategy model

| Control Type | Rice Stage | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Fallow | Tillage | Nursery | Planting | Tillering | Primordia | Mature | Harvest |
| Plant/harvest simultaneously | | | + | + | | | | + |
| Habitat sanitation | + | ++ | + | | | + | | |
| Mass grouping | + | ++ | + | | | | | |
| Fumigation-dig | | | | | | ++ | ++ | |
| LTBS | ++ | + | | | + | ++ | | |
| TBS + trap crop | | ++ | | | | | | |
| Feeding/ Rodenticide*) | + | | | | | | | |

**Description : + = conducted; ++ = focused; *) = last option**

# TBS (*Trap Barrier System* )

# LTBS (*Linear Trap Barrier System)*



# Biological Control Agents for Rat






# Biological Control Agents for Rat


# Major Rice Disease

- Bacterial leaf blight (BLB)
- Blast
- Tungro
- Ragged stunt
- Grassy stunt

# Bacterial Leaf Blight

## Status

- This disease can be found in irrigated, dry land, rain-fed, and swamps rice ecosystems
- The disease can cause yield losses up to 80% of total rice production
- The disease occurs in the rainy season or wet dry season, especially in paddy fields that are always flooded

# Bacterial Leaf Blight

## Symptoms

- This disease has 2 types of symptoms based on the plant growth stage affected, namely *kresek* (early phases) and blight (late/generative phases).
- The disease generally found at late stage of plant (generative stage)

Symptom on seedling

Symptom on generative stage

# Bacterial Leaf Blight

## Symptoms

- On seedling stages, the first symptom appears as tiny water-soaked spots and enlarge, the leaves turn yellow, dry rapidly and wither.
- The leaves sometimes roll/curled like a plant that has been attacked by stem borer

# Bacterial Leaf Blight

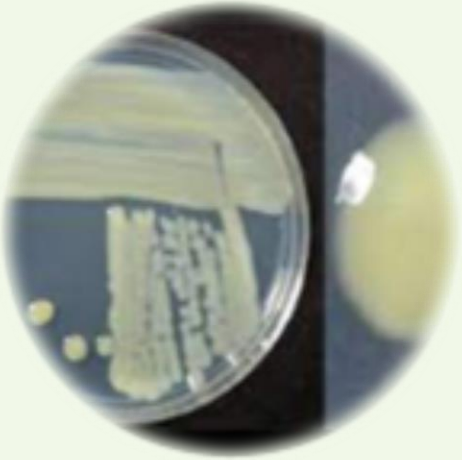
## Symptoms

- On generative stage, lesions usually begin at the margin, a few cm from the tips, as water-soaked stripe with greyish in colour.
- The lesions will expand to be blights covered the entire blade. The spots turn straw yellow and eventually the leaves dry up
- A groups of bacteria (ooze), in the form of golden yellow granules can be easily found on leaves

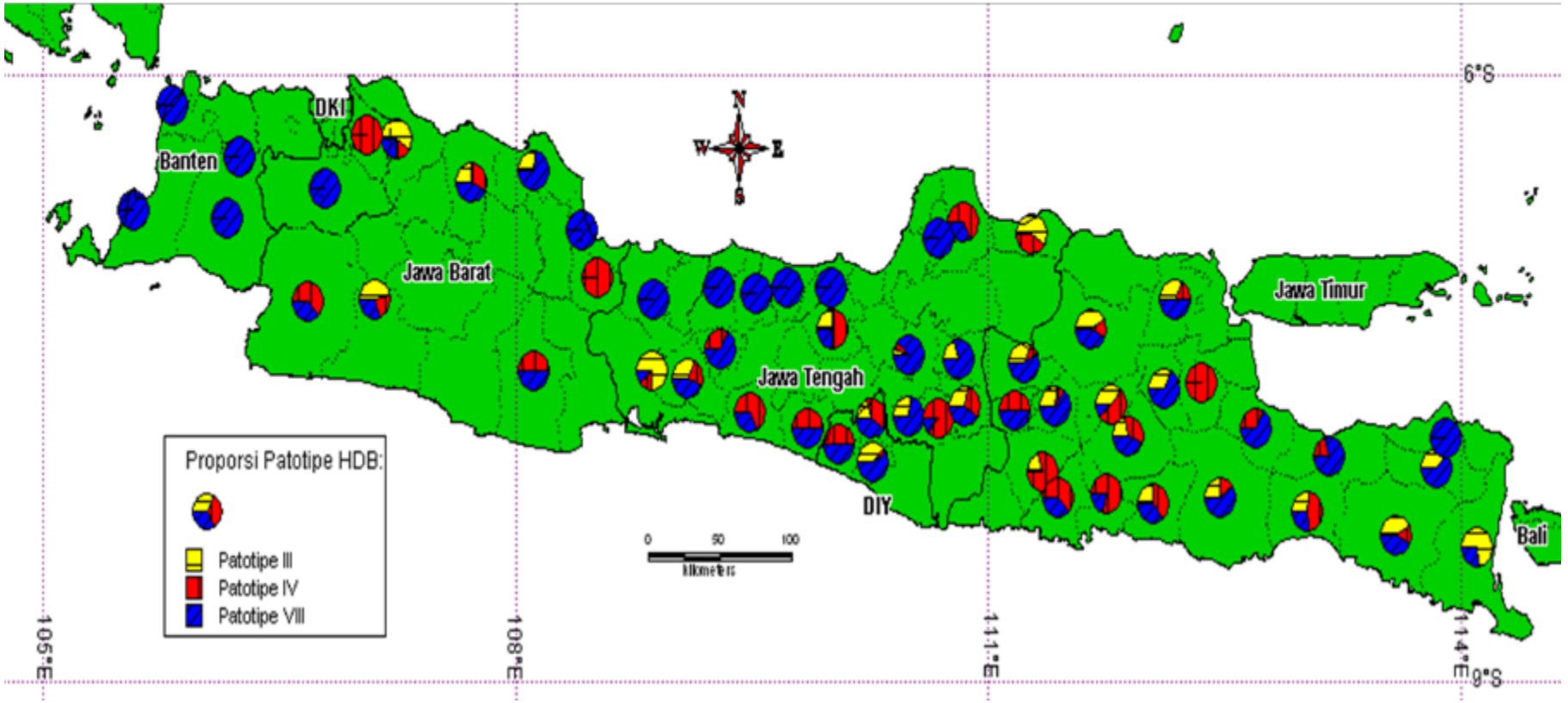
# Bacterial Leaf Blight

## Pathogen

- The cause of the disease belongs to the group of bacteria, namely *Xanthomonas oryzae* pv. *oryzae* (Xoo).
- *X. oryzae* pv. *oryzae* have variety of pathotypes (strains) based on the differential varieties response.
- In Indonesia there are 12 pathotypes and III, IV and VIII pathotypes are known to be the dominant pathotypes.
- Each of these strains has a different both virulence or distribution in rice field area.



# Dominances and Distrubution of *X. oryza* pv. *oryzae* Patotype in Java, 2010 (Sudir, 2010)



# How to Control BLB Disease

Using resistant varieties

Using healthy seeds and seedlings

Cropping pattern

Fertilizing management

Biological or chemical control

## ➢ Resistant varieties

Resistant varieties are the most effective to BLB control, but it must be adjusted to the distribution of the pathotype in the area

| No | Variety | Year of release | Resistances type to Xoo | | |
|---|---|---|---|---|---|
| | | | III | IV | VIII |
| 1. | Inpari 23 Bantul | 2012 | R | MR | MR |
| 2. | Inpari 25 Opak Jaya | 2012 | R | MR | MR |
| 3. | Inpari 31 | 2013 | R | MR | MR |
| 4. | Inpari 32 HDB | 2013 | R | MR | MR |
| 5. | Inpari 43 Agritan GSR | 2016 | R | MR | MR |
| 6. | Munawacita Agritan | 2017 | R | MR | MR |
| 7. | Mustaban Agritan | 2017 | R | MR | MR |
| 8. | Baroma | 2019 | MR | R | R |
| 9. | Pamelen | 2019 | MR | MR | MR |
| 10. | Pamera | 2019 | R | MR | R |
| 11. | Paketih | 2019 | R | R | R |
| 12. | Jeliteng | 2019 | MR | R | MR |
| 13. | Inpari 45 Dirgahayu | 2019 | R | MS | R |
| 14. | Mantap | 2019 | R | MS | R |
| 15. | Inpari 46 GSR TDH | 2019 | R | MR | MR |
| 16. | Inpari Digdaya | 2019 | MR | MR | - |
| 17. | Inpari Arumba | 2020 | R | MR | MR |
| 18 | Inpari Gemah | 2020 | MR | MR | MR |
| 19. | Hipa 5 | 2007 | - | MR | MR |
| 20. | Hipa 8 | 2009 | - | MS | MR |
| 21. | Hipa 18 | 2013 | MS | MR | MR |
| 22. | Hipa 20 | 2019 | - | MR | MR |
| 23. | Hipa 21 | 2019 | - | MS | R |
| 24. | Inpara 6 | 2010 | - | MR | - |
| 25. | Inpara 8 | 2014 | R | MR | MR |
| 26. | Inpara 9 | 2014 | R | - | - |
| 27. | Purwa (padi rawa) | 2018 | R | MS | MS |
| 28 | Inpara 10 BLB | 2018 | MR | MS | MS |

R: Resistant, MR: moderate resistant, MS: moderate susceptible, S: susceptible

## ➢ Using healthy seeds and seedlings

- Certified seed are recommended
- *Xanthomonas oryzae* pv. *oryzae* that caused BLB disease are known to be seed-borne and have the potential to be a source of inoculum for the disease
- Seed treatment can be done by rinsing with water, soaking in hot water at 50$^{o}$C for 20 minutes or soaking in bactericides solution


## ➢ Cropping pattern

- Legowo system with the intermittent irrigation system cause environmental manipulation

- Reduce humidity around the crop (micro-climate) which is suitable for the growth of pathogens

## ➢ Fertilization Management

- High doses of Nitrogen cause plants to become more susceptible and have higher disease severity.
- Using balanced N and K fertilizers is recommended

- **Biological Control**

  *Paenibacillus polymyxa* and *Pseudomonas fluorescens* are known to suppress the development of HDB disease.

- **Chemical Control**

  The recommended bactericides are containing the active ingredients oxytetracycline, tebukonazol, trifloksistrobin diphenoconazole, propiconazole, mancozeb, benomyl, copper hydroxide, propineb, fluopicolide, azoksistrobin.

# Blast Disease

**Status**

- In Indonesia, blast disease is generally a major constraint on dry land.
- Currently, blast disease has been found in swamp rice, rainfed rice and irrigated rice agroecosystems.
- In lowland rice is a serious problem because of the increasing incidence of neck blast.
- In susceptible varieties and favorable conditions can cause to fail to harvest

# Blast Disease

**Symptoms**

- can attack all parts of the rice plant from
- the seedling stage and the vegetative stage by infecting the leaves
- the generative stage by attacking the neck, panicle branches and rice grains.

# Blast Disease

## Symptoms

- The typical shape of **leaf blast** symptom is a rhombus with two more or less pointed ends. The symptoms have developed, the edges are brown and the center is grayish white.

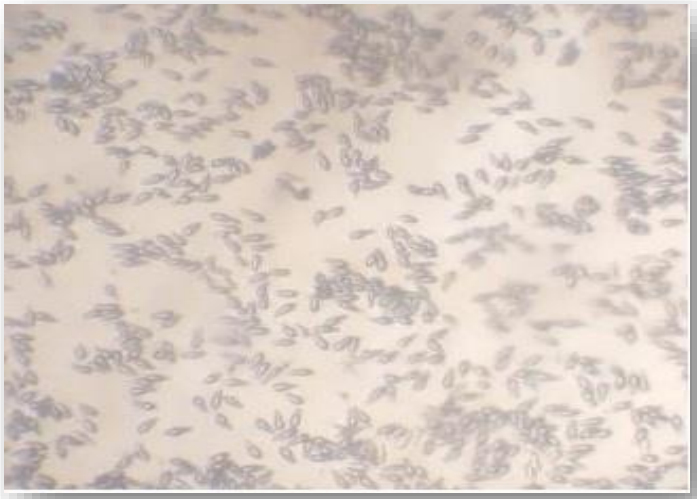
- Infection of the panicle causes **neck blast**, brown spots on the branches of the panicle and brown spots on the husk of the grain.

# Blast Disease

## Symptoms

- Infection of the **stem node** causes brown or black spots, broken and complete death of the upper stem of the infected.
- *P. oryzae* attack on **the collar of the leaf**, which is the border area between the leaf and the sheath, causes brown and gray-colored.

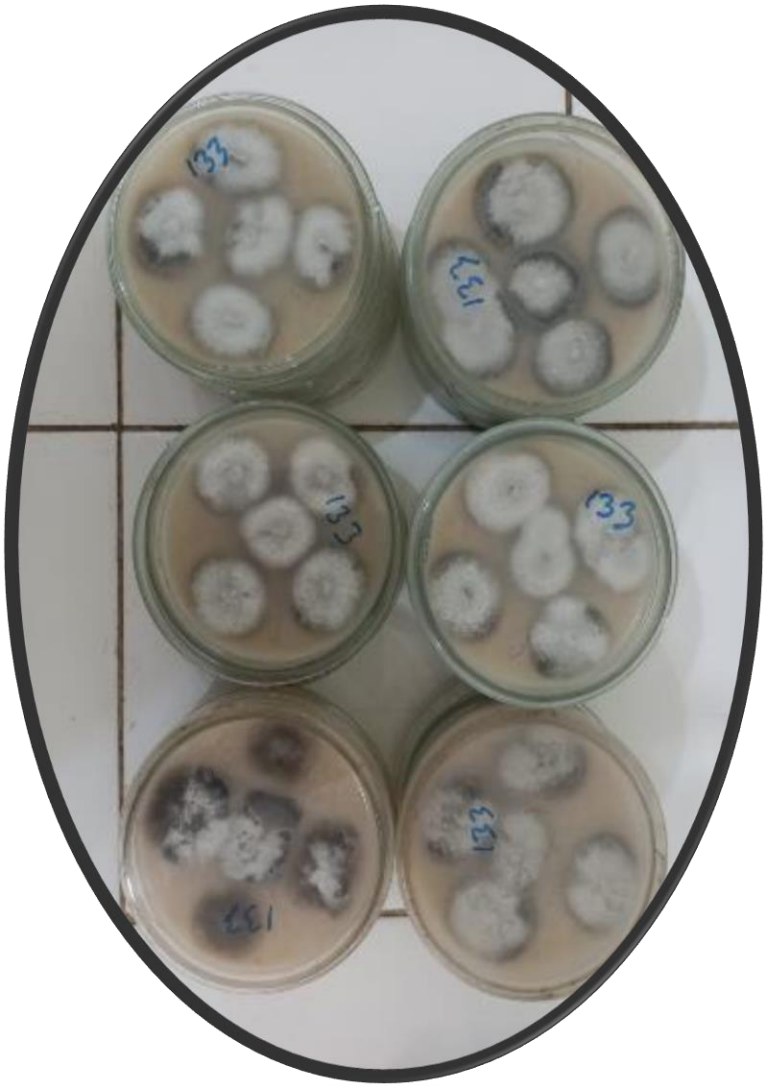
# Blast Disease



## Pathogen

- Blast disease is caused by the fungus of *Pyricularia oryzae* (Cooke) Sacc.
- Morphologically the fungus of *P. oryzae* has conidia that are round, oval, translucent and partitioned two (3 rooms)
- Spore dispersal occurs not only by wind but also by seeds and straw

# Blast Disease



## Pathogen

- The fungus of *P. oryzae* has high genetic diversity.
- Monitoring of blast pathogen populations conducted in upland rice areas in Lampung **(26 races)** and West Java, **(30 races)** were identified.
- The fungus can be pathogenic to several other important crops, such as wheat, sorghum, other sereals and weed.

# How to Control Blast Disease

Using resistant varieties

Plant cultivation approaches

Chemical approaches

# Variety Resistance

- The strategies of rotating resistant varieties is need
- It is not recommended to plant one variety in a large area continuously
- The suitability of planting resistant varieties with the composition of pathogenic races in the field.
- Some varieties that resistant to blast disease are Situ Patenggang, Inpago 10, Inpago 12, and Inpari 48.

# Plant cultivation approaches

- **Using the healthy seeds and seedlings**. Blast disease pathogens can be infected through seeds, so it is recommended that harvested grain from infected plant are not used as seeds.

- **Use of straw as compost**. The fungus of *P. oryzae* can survive on rice debris or straw and seeds from previous rice plantations, embedding straw in the soil as compost can cause mycelia and spores to die due to rising temperatures during the decomposition process

# Plant cultivation approaches

- **Use of nitrogen fertilizers with recommended doses and Si fertilizers**. In general, the effect of N on epidermal cells is an increase in water permeability and a decrease in silica levels, so that fungi penetrate easily.

- **Planting methods**. It is recommended to plant with jajar legowo technique, which has quite spacious row that will reduce humidity around the canopy of the plant and the occurrence of dew and water guttation

# Plant cultivation approaches

**Environment sanitation**. Pathogens can survive on alternative hosts in the form of grass and plant debris, so sanitation of the rice field environment by keeping the fields clean from weeds and infected plant remains is a recommended effort.

# Chemical approaches

**Seed treatment**. Blast disease control will be effective if implemented as early as possible, this is because blast disease can be transmitted through seeds. Seed treatment can be done with the use of systemic fungicides such as pyroquilon

**Plant spraying**. The application of spraying to suppress the attack of neck blast disease is twice, namely at the time of maximum tillers and early flowering (heading 5%). Fungicides that can be used for blast spraying have the active ingredients: edifenphos, tetrachlorophthalide, kasugamycin, pyroquilon, benomyl, isoprotionalane and methyl thiophanate

# Tungro

**Status**

- Spread in almost all parts of Indonesia
- The disease caused by *Rice Tungro Bacilliform Virus* (RTBV) dan Rice Tungro Spherical Virus (RTSV)
- Yield loss will be high or even crop failure happen if the infection at the beginning of the vegetative phase of the plant

# Tungro

**Symptoms**

- The infected plant with tungro viruses appear in the discoloration of the young leaves turn yellow-orange
- Leaves, especially young leaves showed *mottle* and chlorosis between the veins
- The yellow leaves appearing slightly twisted, stunted plants, and decreased of tillering number

# Transmission

- Viruses can only be transmitted by leafhoppers, especially the green leafhopper species *Nephotettix virescens* Distant
- All stadia of insect : nymph, adult, male/female can transmit the viruses
- The transmission is semi-persistent
- Not transtadial or transovarial
- Retention time : 2-6 days

**Tungro is not transmitted by mechanic, contact between plant, through seed, or pollen.**

# Suitability varieties based on area

| Varieties | Suitability Plant for | | | | | | |
|---|---|---|---|---|---|---|---|
| | West Java | Central Java | DIY | East Java | Bali | Mataram | South Sulawesi |
| Tukad Petanu | + | + | + | + | + | + | + |
| Tukad Unda | - | - | - | - | - | + | + |
| Tukad Balian | - | - | - | + | + | - | + |
| Bondoyudo | + | + | + | + | + | - | + |
| Kalimas | - | + | - | + | + | - | - |

# How to Control Tungro Disease

- Plant the rice concurrently in an expanse of at least 40 ha, based on the reach of one inoculum source.
- Set the planting time by estimating when the peak population density of green leafhoppers and the presence of tungro occurs, the plant has passed the vegetative phase.
- Clean the sources of tungro inoculum such as stump, seeds that grow from scattered grain, nut grass and water before making a nursery.

- Use resistant varieties: Inpari 7 Lanrang, Inpari 8, Inpari 9 Elo, Inpari 36 Lanrang, Inpari 37 Lanrang
- Monitor the green leafhoppers population at the field.
- If the number of green leafhoppers and the percentage of infected leaves is equal or more than 75 then the plant is threatened

- Antifidan application with the active ingredient imidacloprid, thiametoxam or other active ingredients in the nursery or when the plants are 1 week old after planting to inhibit the acquisition and transmission
- Plant in a 2 row or 4 row in jajar legowo technique.  The scattering of green leafhoppers was reduced in the distribution pattern of the hosts planted in jajar legowo.

# Ragged Stunt Disease


**Status:** In Indonesia, yield loss reaches 53-82% if 34-76% of the plants are infected.

**Symptom**

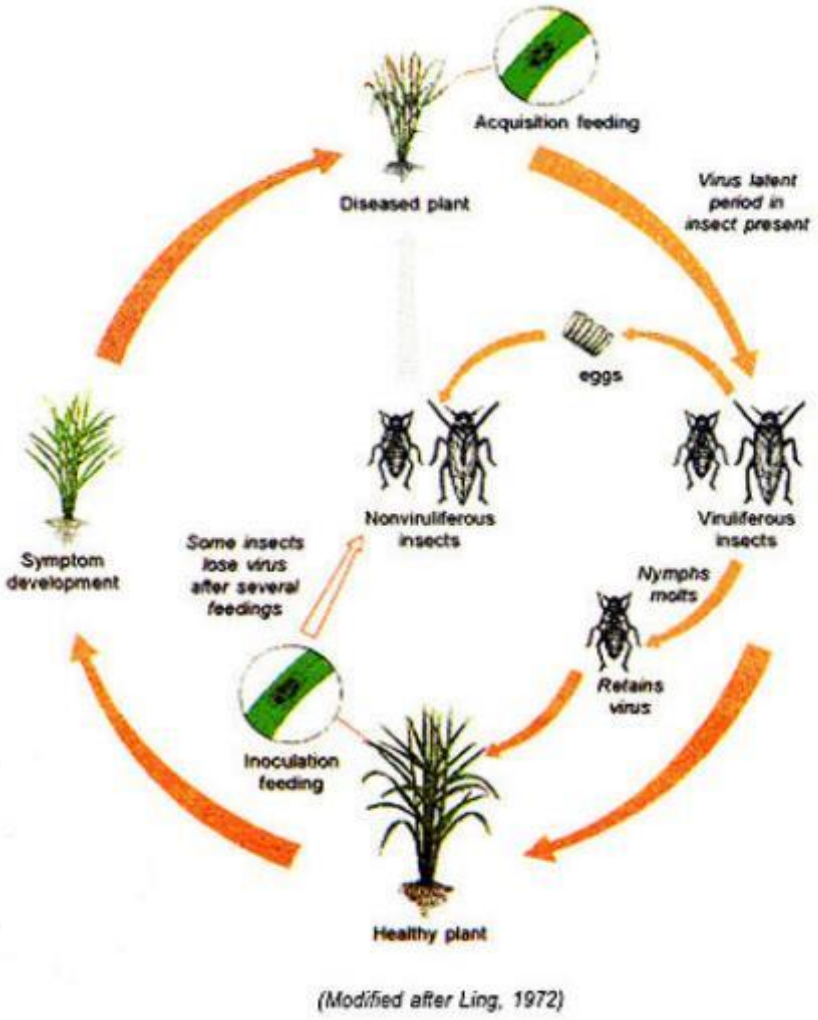
- The infected plant showed shortened, twisted flag leaves, and panicles that do not come out or partially come out.
- From the panicle that partially emerges, the grain is usually empty.
- The color of infected leaves does not differ from healthy plants

Plant height reduced by 40% - 50% varies depending on the variety. Affected plants produce empty grain

# Biology-ecology

- Transmitted by vector: *brown planthopper, Nilaparvata lugens*; Delphacidae
- Nymph stadia is the most effective to transmit
- Virus is transmitted persistently, but not mechanically by contact between plant, seed, or pollen
- Not transovarial

# Cycle Disease




(Modified after Ling, 1972)

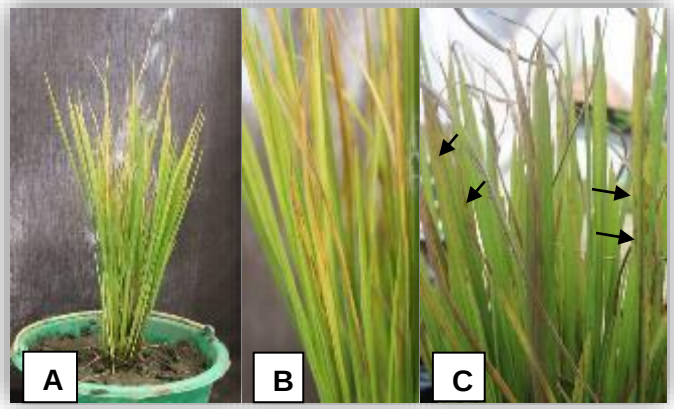
- Brown planthopper get virus with acquisition period about 3-5 hours
- Inoculation period is about 1 hour
- Laten period is about 5-11days
- Vector permanent infective though has moulting.

# Grassy Stunt Disease

## Status

- Grassy stunt disease is caused by a virus, namely Rice Grassy Stunt Virus (RGSV) which is a member of Tenuivirus
- There are two types of Grassy stunt disease

# Grassy Stunt Disease




## Grassy Stunt Type 1

- Affected plants are very stunted with many tillers. The leaves are short, narrow with a yellowish green color, sometimes there are small rust-like spots.
- Plant growth is very upright, like grass
- Affected plants do not produce panicles

# Grassy Stunt Disease

## Grassy Stunt Type 2

- The infected plant with grassy stunt virus type 2 at the early stages, the plants were slightly stunted, the lower leaves turned yellow and the leaf blades were narrowed
- In the mature plants, infected plants have normal growth, both in leaf size and number of tillers, but some leaves turn yellow to orange.

# Transmission

- Vector: Brown planthopper *Nilaparvata lugens* Stal.,*Nilaparvata bakery* Muir and *N. muiri* China.
- Persistent without transovarial
- 30 minute acquisition feeding period
- Inoculation feeding period 9 minutes
- Latent period 5-28 days (11 days average)
- Incubation period in plants 10-19 days
- As long as the planthopper lives it remains viruliferous

# How to Control Ragged and Grassy Stunt Disease

- Use resistant varieties to brown planthopper, resistant to ragged or grassy stunt virus or both
- Resistant varieties to brown planthopper: Inpari 13, Inpari 19, Inpari 33, Inpari 42, Inpari 47
- The use of resistant variety of brown planthopper showed a low disease incidences
- Sanitation by removing source of disease inoculum (infected plant)
- Controling brown planthopper using insecticide

# BIOLOGICAL CONTROL

*" Biological control defined as the use of living organisms to suppress the population density or impact of a specific pest organism, making it less abundant or less damaging than it would otherwise be"*

Invertebrata such as insect groups: using predators, parasitoids or micro-organism that are pathogenic

Weed: using herbivores and pathogens

Plant pathogens: using antagonistic micro-organisms

# Entomopathogenic Agents

Entomopathogenic agents are types of biological agents that infect insects and can damage the metabolic system which has an impact on changes in insect body structure

Entomopathogenic bacteria

Entomopathogenic fungi

Virus (NVP), nematode, protozoa, ect

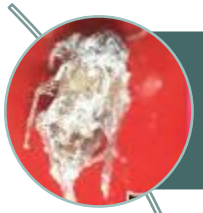
# Entomopathogenic Fungi in Rice Pest Control

Entomopathogenic fungi as a biological control agents against rice pests are quite diverse, including *Beauveria bassiana* and *Metarhizium anisopliae*

*Beauveria bassiana*

*Metarhizium anisopliae*

# Host Diversity of *Beauveria bassiana*



Homoptera: Brown planthopper, green leafhopper

Hemiptera (ladybug): *Leptocorisa oratorius*

Orthoptera: Grasshopper

Lepidoptera: Spodoptera litura

Coleoptera: rice root grub

# Propagation of *Beauveria bassiana*

## Propagation medium

- Rice
- Corn

## Material

- Heat resistant plastic or glassware
- Cotton, perforated pipe or bamboo
- *Beuveria bassiana* isolate

## Supporting tools

- Laminar flow cabinet and aseptic tools
- Autoclave
- Incubator

# *Beauveria bassiana* propagation procedure

Washing and soaking 10-15 minutes

Rice drying at room temperate (3 minute)

The rice is put in a heat-resistant plastic (100 g/bag), covered by cotton and paper

Sterilization by autoclave for 15 minutes at 1.5 atm

Inoculate *B. bassiana* on rice medium aseptically

Incubation at 25 $^{o}$C for 10-14 days until the rice filled of the B. bassiana

# How to Harvest *B. bassiana* Spores

*B. bassiana* culture

Crumble the rice

Put in the culture to the chamber with water dan stirring

Separating of spores and rice


Spore suspension

The application dose is 10 g/liter or to make 10 liters of spray solution requires 100 grams of *B. bassiana* culture.

# How to Apply *B. bassiana*


*B. bassiana* spores suspension

The filtrate are then added with water until it reaches 10 liters and is ready to be applied

Application activities

Applications should be carried out in the afternoon to minimize the stress of solar radiation which can cause the death of biological agents.

# Thank You

# Terima Kasih