IMPLEMENTING HIGH-YIELDING RICE VARIETIES

INDONESIAN CENTER FOR RICE RESEARCH (ICRR)
INDONESIAN AGENCY FOR AGRICULTURE STANDARDIZED INSTRUMENTS (IAASI)
MINISTRY of AGRICULTURE
REPUBLIC OF INDONESIA
NOVEMBER 2022

Outline

- What is rice variety
- Types of varieties
- Why do we need high yielding rice varieties
- How to choose suitable varieties
- How to have a good seed
- Example of varieties in Indonesia

What is rice variety

A group of plants of a type or species characterized by the shape of the plant, growing plants, leaves, flowers, fruits, seeds, and expression of characteristics of the genotype or combination of genotypes that can distinguish from the same type or species by at least one defining trait and when propagated it does not change.

Line (s)

A group of plants derived from hybridization that has been selected and screened for targeted traits so has some superior trait as their breeding objective, homogenous and stable but not yet released as a variety (s)

Types of Rice Varieties Based on the Breeding Process

A. Inbred Rice Variety

An inbred rice variety is a pure line. This means that the offspring or succeeding generations produced by this variety will have the same genetic makeup. It is the result of a cross between two or more different varieties and subsequent selection through several cycles of self-pollination or inbreeding.

B. Hybrid Rice Variety

A hybrid is the first-generation offspring of a cross between two genetically diverse parents. When the right parents are selected, the hybrid will have both greater vigor and yield than either of the parents.

D. Local Variety

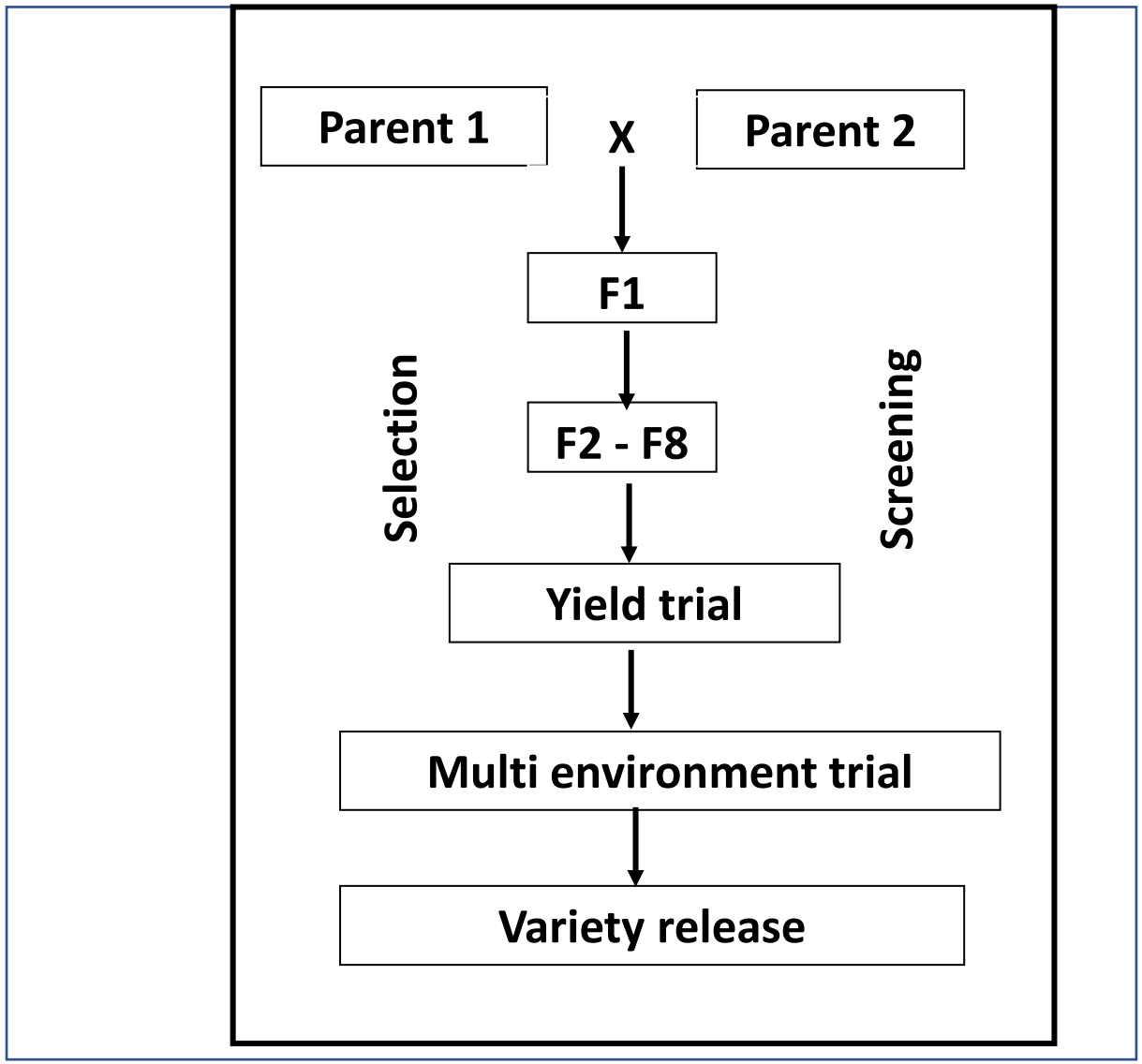
The existing variety that has been cultivated for many generations by farmers and belongs to the community and under government authority.

C. Transgenic rice

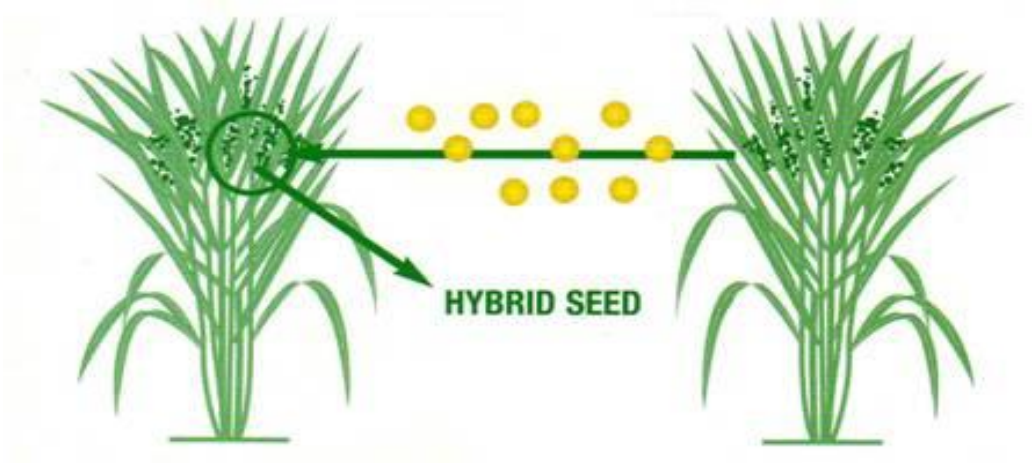
- Refers to any rice plant that carries foreign gene(s) introduced through genetic engineering techniques. Rice plants are regenerated from transformed cells and progenies and tested for the desirable agronomic trait(s)

→ Example : stemborer resistant variety, golden rice.

Conventional Inbred rice breeding



Hybrid rice breeding



Female parent (CMS)

Male parent (gene Rf) (pollen source)

- Using *cms gen* needs 3 lines breeding method: CMS (A), B line, & R.
- The three lines must be breed with tightly selection to develop new hybrid → Three line method
- A X B → A
- A X R → HIBRIDA.

- Hybrid = the F1 progeny
- The different parents were used.
- F1 ≠ P1/P2
- Hybrid : heterogenous homogenous
- Segregated in the next generation Aa→ AA : Aa : aa

HYBRID RICE VARIETIES

Increased yields (15-20%) compared to inbreed rice

- ✓ Increased vigor (which makes them more competitive with weeds), and
- ✓ Increased resistance to diseases and insects

The disadvantages of hybrid rice

- ✓ Seed is expensive, and
- ✓ Farmers can not use their seed from the past season like they usually do with inbred rice.
- ✓ Seeds harvested from the hybrid plant are not recommended for replanting because the hybrid vigor is lost due to genetic segregation.
- ✓ This results in a lower yield, so farmers must buy new hybrid seed every season.

Why do we need high yielding rice varieties ?

- **Main component of rice management practices**
- Contribution of new high yielding rice varieties (journal)
- Dynamics of environmental change environment:
  - Climate
  - Pest and diseases
  - Market demand








Important Characters in Rice Variety

Agro morphological characters

- Maturity
- Type of plant
- Plant height
- Number of spikelet per panicle
- Number of tiller per plant
- Productive tiller number
- Color of base, stem, ligule, auricle, behaviour of flag leaf, grain shape, grain color
- Lodging

Resistant/tolerant to biotic and abiotic stresses

- Main pest : Brown plant hopper biotype 1, 2 and 3
- Bacterial leaf blight: pathotype III, IV and VIII
- Blast disease: strain 033, 073, 133, 173
- Virus tungro
- Abiotic stresses : shading, Iron, Al toxicity, drought, flash flood, stagnant flooding, salinity, anaerobic germination

Grain quality, physical chemical characters

- Rice Texture
- Milling quality
- Grain color
- Amylose content
- High nutrients content (Zn, Fe, betacarotene)

Rice varieties based on the agroecosystem

- Irrigated rice varieties
    - Irrigated lowland rice varieties
    - Upland rice varieties
- Tidal swampy rice varieties
    - Tide rice
    - Swampy rice
- Upland rice varieties
    - monoculture
    - multi-cropping
- Rainfed rice varieties

- ❑ Lowland (0-300 m asl)
- ❑ Medium elevation (300-700 m asl)
- ❑ High land (>700 m asl)

Main problem of abiotic and biotic stresses in respective rice agroecosystem

- **Irrigated rice ecosystem**
  - Main and pest disease resistant: bacterial leaf blight, virus tungro, blast disease, brown plant hopper, rice virus tungro, stemborer
- **Rainfed rice ecosystem**: drought tolerance, main pest, and disease resistant
- **Upland rice ecosystem:**
  - drought tolerant
  - iron and aluminum toxicity tolerant
  - blast disease resistant
- **Tidal swampy rice ecosystem**: drought tolerant, submergence tolerant, salinity tolerant, iron toxicity tolerant, Al toxicity.

Variety based on growth duration

- Ultra early maturity: <90 das
- Very early maturity: 90 - 104 das
- Early maturity: 105 - 124 das
- Medium late: 125 - 150 das
- Late Maturity : > 151 das

Rice variety for climate change

- ✓ Very early maturity: drought escape
- ✓ Drought tolerant
- ✓ Submergence tolerant
- ✓ Salinity tolerant
- ✓ Heat tolerant
- ✓ Pest and disease resistant

Submergence rice variety

- Rice plants normally die within four days of submergence. Farmers in countries with rice areas prone to flooding lose millions tons of rice yearly due to floods.
- IRRI discovered *SUB1*, the gene for flood tolerance, and incorporated this gene into popular rice varieties.
- Rice varieties with the *SUB1* gene have shown a yield advantage of 1–3 tons per hectare, following flooding of 10–15 days.
- Flood-tolerant varieties have been released such as *Ciherang-Sub1* (Inpari 30), Inpara 4 and 5

Salinity tolerant rice varieties

- Rising sea levels bring saltwater further inland, contributing to soil salinity. Rice productivity in salt-affected areas is very low—less than 1.5 tons per hectare.
- A gene for salinity tolerance, called *Saltol*, has been incorporated into popular rice varieties in countries across Asia.
- Field trials of salt-tolerant rice varieties suggest a yield advantage of at least 2 tons per hectare over non-tolerant varieties.
- In Indonesia several varieties had been released (Dendang, Inpari 34, Inpari 35)

Variety considerations

Rice varieties should have

- ✓ Good grain quality (especially cooking characteristics, color, shape, taste and aroma, and head rice recovery)
- ✓ High market price
- ✓ Optimum yield potential and stability over seasons
- ✓ Maximum tillering capacity for weed competition
- ✓ Resistance or tolerance to major diseases, insects, and other stresses (i.e. drought and flood) of the area
- ✓ The right growth duration (maturity length) to match the season
  - Avoid varieties that need to be planted or harvested earlier or later than surrounding rice fields to minimize pest damage (e.g., birds during maturation), and growth problems during times of harmful environmental conditions (e.g., late-maturing varieties running out of water)
- ✓ Resistance to lodging under normal farmer management

Management considerations

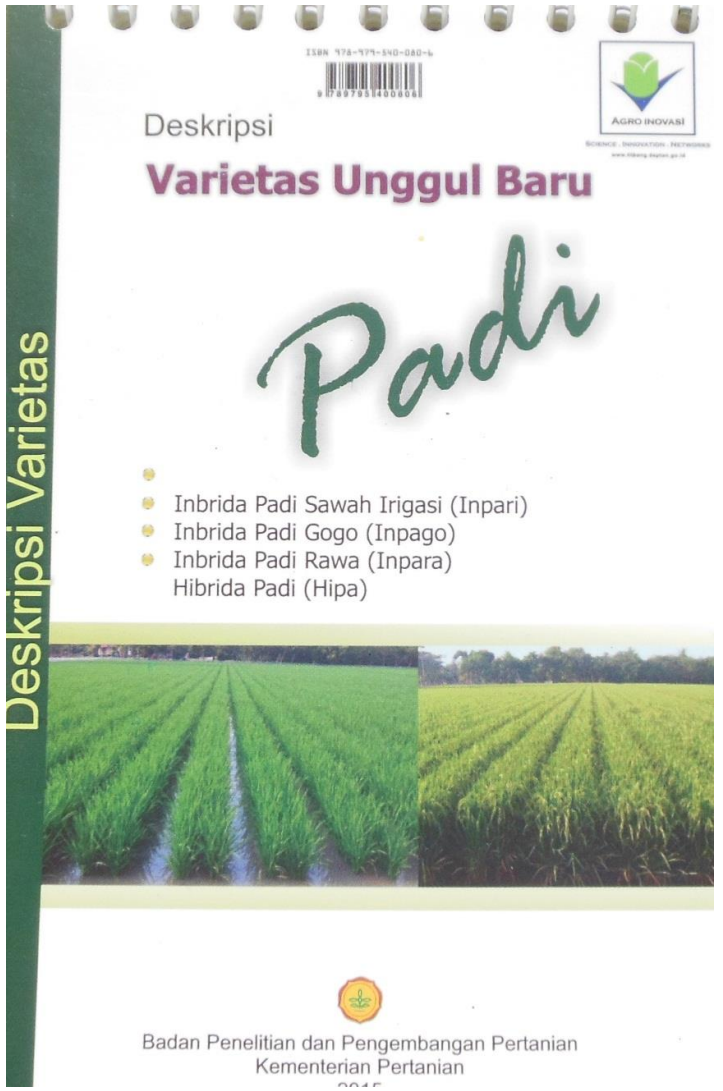
- Ensure that the variety is suitable for the method of crop establishment and farmer management practices

  - e.g., some varieties are more suitable for direct seeding than others.

- Use "good" seed to maximize yields.
- Ensure that seed is available in sufficient amounts to meet local demand.
- Plant different varieties in adjacent area to maintain biodiversity and slow the spread of pests and the breakdown of varietal resistance.

RICE DESCRIPTION BOOK

- Hand out to choose the rice variety
- Content:
  - Target environment
  - Growth duration
  - Yield
  - Resistance to pest and diseases



How to obtain good seed

- ✓ Buy certified seed that is pure and labeled
- ✓ Get farmer-produced good seed, or
- ✓ Select your own good seed
  - High-quality seeds are free from weed seeds, seed-borne diseases, insects, pathogens, and other extraneous matter.
  - Free from various types of mechanical injury that reduce germination and seedling vigor.

❖ Seed quality

Yield can increase by 5–20%.

Sowing good quality seeds leads to lower seed rate, better emergence (>70%), more uniformity, less replanting, and vigorous early growth which helps to increase resistance to insects and diseases and decrease weeds.

Factors are used to classify rice seeds:

- Varietal purity (100%)
- Seed viability (>80% germination rate)
- Seed moisture content (12-13%)

Grain moisture content

IMPURITY OF SEED

- Impurities refer to the degree of contamination
  (1) weed seeds,
  (2) seeds of other crops or species,
  (3) inert material such as stones, dirt, or twigs. It is expressed as a percentage, by weight.

Seed establishment vs germination

- It is best to also check seed germination in soil, as emergence can often be 70% or less of germination.
- To test, place 2 samples of 100 seeds in a tray filled with soil. Cover lightly with soil (e.g., 5 mm), keep moist and count establishment after 7 days.
- *Note:* Larger seeds tend to establish better than smaller seeds.

Seed Treatment

- Seed treatment prevents and controls seed-, soil-, and air-borne diseases. It improves germination, vigor, and productivity.
  - ✓ Seeds saved by farmers may be infected with microbes that can induce diseases on the seedling and the crop.
  - ✓ Affect seed germination and may be transmitted from seed to seedling to plant.

Seed treatment to break dormancy and improve seed growth

1. **Seed Oven**: Expose seeds to high temperatures (40–42°C) for 1–2 days prior to sowing.
2. **Seed priming** - Soak seeds for 4–8 hrs and re-dry prior to sowing. Seeds must be sown within 1–2 days after priming.
3. **Pre-germination**

- Submerge seeds in water for 12–24 hrs or until small shoots appear at the end of the seed. In colder weather, seeds may need to be soaked for 36–48 hrs.
- Drain and dry the seed in bag for 24 hrs in a shady area where air can circulate around the bags. If bag temperatures exceed 42°C, some seeds will be damaged.
- Broadcast or drum seed before the roots exceed 5mm in length. When calculating the planting rate, allow for expansion of 10-30% in seed weight.

Fungicide treatment

- Dissolve 3 g fungicide (e.g., Benlate + Mancozeb or Arazone red alone) per kg seed in 5 ml water inside a plastic bag or plastic bottle.
- Distribute fungicide slurry about the walls of the container.
- Place seed in container, seal, and shake to coat seed uniformly with fungicide slurry.
- Wear protective equipment and follow appropriate safety procedures.

How to produce good seed

Ten steps for farmers to produce their own good seed

1. Select a fertile field.
2. Use clean, good quality seed.
3. Plow, puddle and level the field well to control weeds and improve water management.
4. If transplanting, plant young (15–20 d) seedlings from a healthy, weed-free nursery at two per hill at 22.5 cm x 22.5 cm spacing.
5. Apply balanced nutrients (Nitrogen, Phosphorous, Potassium, Sulfur, and Zinc) as per crop demand.

Seed Production (cont.)

6. Keep the crop free of weeds, insect pests and diseases.
7. Rogue off-types

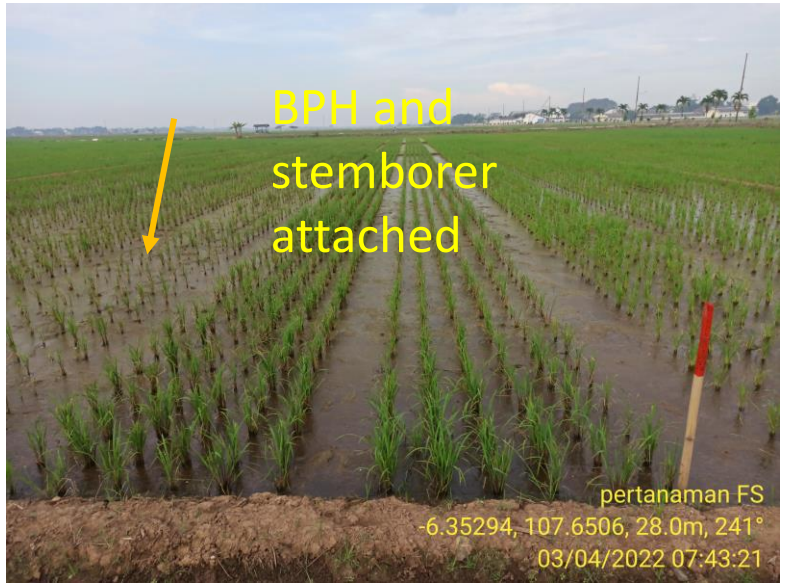
   At maximum tillering and flowering, rogue off-types (by plant height, appearance, flowering time, etc.) and poor, diseased or insect damaged plants, or plants with discolored panicles.
8. Harvest at full maturity and 20–25% moisture content (80–85% of the grains are straw-colored).
9. Thresh, clean, dry (12–14% moisture content), grade and label the harvested seed.
10. Store the labeled seed in sealed clean containers placed in a cool, dry, and clean area.


semai SS Baroma Purwa Paketih KP Ski
-6.35121, 107.64901, 27.8m, 198°
23/02/2022 08:02:44


pesemaian FS
-6.35354, 107.64983, 27.3m, 221°
09/03/2022 09:48:30


pesemaian BS lokasi
-6.351, 107.64886, 30.0m, 305°
09/03/2022 08:33:53


Tanam FS Inpari 30 & 32
-6.3548, 107.64825, 36.8m, 67°
20/03/2022 10:02:39


BPH and
stemborer
attached
pertanaman FS
-6.35294, 107.6506, 28.0m, 241°
03/04/2022 07:43:21


Weed should be controlled
pertanaman FS
-6.35446, 107.65158, 28.4m, 243°
03/04/2022 07:53:13

Foundation seed production in 4:1 legowo system

Breeder seed production nursery

RICE VARIETIES RELEASE BY INDONESIAN CENTRE FOR RICE RESEARCH (ICRR)

- about 314 rice varieties were released since 1954 to 2020
- about 15% of the variety widely adopted by farmers.

EXAMPLE of rice varieties in Indonesia

Very early maturity, rainfed, HI>2

Padjadjaran Agritan

Average of grain yield : 7.78 t/ha
Yield potential: 11.03
Maturity: 105 das
Main pest and disease: MR (BPH biotype 1, 2)
Amylose content: 20.58%
Rice texture: medium

Cakrabuana Agritan

Average yield: 7.47 t/ha
Yield potential : 10.2 t/ha
Growth duration: 104 HSS
Pest and disease resistant: Moderate resistant (biotype 1,2,3)
BLB : moderate resistant (race III)
Amylose content: 21.98%
Rice texture : medium

GREEN SUPER RICE

Inpari 42 GSR Agritan

Duration : 112 das
Plant height : 93 cm
Size grain : slender
Rice texture : Soft
Average yield : 7.11 t/ha
Yield potental : 10.58 t/ha
Moderate resistant to BPH biotype 1
Moderate resistant to BLB pathotype III

Inpari 43 GSR Agritan

Duration : 111 hari
Plant height : 88 cm
Size grain : Slender
Rice testure : Pulen
Average yield : 6.96 t/ha
Yield potential : 9.02 t/ha
Moderate resistant : BPH biotype 1, 2, 3
Moderate resistant to BLB race III
Tahan blas ras 073, 133

Siliwangi Agritan

Avarage yield : 7.41 t/ha
Yield potential : 11.74 t/ha
Maturity : 111 HSS
Moderate resistant to BPH biotype 1,2,3
Agak tahan HDB III
Rentan HDB IV, VIII
Amilosa: 21.21%
Tekstur nasi: Pulen

Inpari 39 Tadah Hujan Agritan

Duration	:	115 das
Plant height	:	98 cm
Grain size	:	Medium
Rice texture	:	soft
Yield average	:	5.89 t/ha
Yield potential	:	8.45 t/ha

Moderate susceptible to BPH biotipe 1, 2, 3

Moderate resistant to BLB Patotype III

Moderate resistant to blast diseases (073, 033,133, 173)

Moderate tolerant to drought

Suitable to rainfed rice agroecosystem

BPH and BLB rice tolerant varieties

Inpari 33

Duration : 107 HSS
Plant height : 93 cm
Grain size : slender
Rice texture : medium
Yield average : 6,6 t/ha GKG
Yield potential : 9,8 t/ha GKG

Resistant to BPH biotype 1,2 and 3

Resistant to BLB race III, moderate resitant to BLB race VIII

Moderate resistant to blast disease race 033, resistant to race 073

Inpari 32 HDB

Duration : 120 HSS
Plant height : 97 cm
Grain size : Medium
Rice texture : medium
Yield average : 6,30 t/ha dry milled grain
Yield potential : 8,42 t/ha GKG

Resistant to BLB race III, moderate resistant (IV and VIII), susceptible to WBC biotipe 1,2 and 3

Resistant to blast disease (race 033), moderate resistant to race 073.

Inpari 30 Ciherang Sub-1

- Duration : 111 das
- Bentuk Gabah : moderate long
- Average yeid : 7,2 Ton/Ha
- Rice texture : soft
- Yield potential : 9,6 Ton/Ha
- Moderate susceptible : (biotype 1 dan 2)
- Moderate susceptible (patotipe III)
- **Tolerant to submergence (14 days).**

SPECIALTY RICE TARABAS (japonica rice type)

Origin: selected from japonica line ” Tarabas”
Average yield : 4.10 ton/ha
Duration : 131 das
Plant height : 122 cm
Rice texture : very soft
Susceptible to BPH and BLB
Moderate resistant to virus tungro
Moderate resistant to blast diseases
Year release : 2017

Inpari 23 Bantul (Aromatik)

Duration	:	113 days
Plant height	:	112 cm
Grain size	:	long bold
Rice texture	:	soft (amylose content: 17%)
Aroma	**:**	**aromatic rice**
Average yield	:	6,9 t/ha
Grain yield	:	9,2 t/ha

Resistant to BPH biotype 1, moderate resistant to bph 2 and 3

Resistant to BLB strain III, moderate resistant to BPH IV and VIII.

Inpari 24 Gabusan (Beras merah)

Duration	:	111 days
Plant height	:	106 cm
Grain size	:	Slender
Rice texture	:	soft (amylose 18%)
Average yield	:	6,7 t/ha
Grain yield	:	7,7 t/ha

Moderate susceptible WBC biotipe 1,2 & 3

Resistant to HDB strain III, moderate resistant IV & VIII

SWAMPY RICE VARIETY

Inpara 2

Duration	:	128 hari
Plant height	:	103 cm
Grain size	:	moderate
Rice texture	:	soft
yield Average	:	4,82 t/ha
Yield potential	:	6.08 t/ha

Tolerant to iron toxicity, aluminum,
Moderate tolerant to biotype 2
Resistant to blast disease

UPLAND RICE VARIETIES

Suitable for multi-cropping system, under crop plantation

Rindang 1 Agritan

Pedigree: B12056F-TB-1-29-1
Cross: Selegreng/Simacan
Average yield: 4.62 ton/ha
Duration: 113 HSS
Plant height : 130 cm
Rice texture : hard
Resistant to blast disease (race 001, 041, 033, 173)
Moderate tolerant to shade
Moderate tolerant to drought
Tolerant to aluminium toxicity (60ppm)
Year rilis: 2017

Rindang 2 Agritan

Pedigree: B12480D-MR-7-1-1
Average yield: 4.20 tons/ha
Plant duration: 113 HSS
Plant height: 138 cm
Rice texture: soft
Resistant to blast diseases (race 001, 041, 033, 073
Moderate tolerant to low light intensity
Moderate tolerant to drought stress
Tolerant to Al toxicity
Year release: 2017

Suitable to high altitude

Luhur 1

Pedigree line: B14168E-MR-10
Cross: Jatiluhur/B10580E-KN-28-1-1
Yield average : 4.8 ton/ha
Plant duration : 124 HSS
Plant height : 120 cm
Rice texture : soft
Resistant to blast diseases (race 013, 101,041, 033, 023
Cold tolerance (suitable to high elevation (700-1000 above sea water)
Drought tolerant
Moderate tolerant to aluminium toxicity
Year release: 2018

Luhur 2

Pedigree: B11592F-MR-23-2-2
Cross : IR60080-23/BP303
Yield average : 4.6 ton/ha
Plant duration : 123 HSS
Plant height : 110 cm
Rice texture : medium
Resistant to blast diseases race 073. 023, 001, 013, 033, 013, 173, 101
Cold tolerance (suitable to high elevation (700-1000 above sea water)
Drought tolerant
Tolerant to aluminium toxicity
Year release: 2018

INPAGO 12 AGRITAN

- Yield average: 6.7 ton/ha
- Duration: 111 DAS
- Plant height : 107 cm
- Rice texture : Medium
- Resistant to blast disease (race 033, 073, 133)
- Moderate tolerant to drought and Al toxicity
- Year release: 2016

Inpago 13

Duration : 114 das
Plant height : 124 cm
Grain size : long
Rice texture : medium (21.56%)
Average yield : 6.53 t/ha
Yield potential : 8,11 t/ha
Moderate resistant to BPH 1
Resistant to blast disease (race 033, 133)
Moderate resistant to drought
Moderate resistant to Fe and Al toxicity
Suitable for upland with <700 m asl

Inpago 7 (red rice)

Duration : 111 das
Plant height : 107 cm
Size grain : medium
Rice texture : soft
Amilosa content : 20,3%
Average yiled : 4,6 t/ha
Yield potential : 7,6 t/ha
Moderate resistant to BPH biotipe 1& 2, Resistant to blast disease (race 133), moderate resistant (race 73, 173 & 033)
Moderate susceptible to drought & Al toxicity
Suitable for upland (dry) <700 m dpl

HYBRID RICE VARIETIES

Increased yields (15-20%) compared to inbreed rice

- ✓ Increased vigor (which makes them more competitive with weeds), and
- ✓ Increased resistance to diseases and insects

The disadvantages of hybrid rice

- ✓ Seed is expensive, and
- ✓ Farmers can not use their seed from the past season like they usually do with inbred rice.
- ✓ Seeds harvested from the hybrid plant are not recommended for replanting because the hybrid vigor is due to genetic segregation.
- ✓ This results in a lower yield, so farmers must buy new hybrid seed every year.

Hybrid Varieties Released by ICRR (2010-2014)

Varieties	Yield Potential (ton/ha)	Rata-rata hasil (ton/ha)
Hipa 9	10.4	8.1
Hipa 10	9.4	8.1
Hipa 11	10.6	8.4
Hipa 12 SBU	10.5	7.7
Hipa 13	10.5	7.7
Hipa 14 SBU	12.1	8.4
Hipa Jatim 1	10.0	8.2
Hipa Jatim 2	10.9	9.3
Hipa Jatim3	10.7	8.5
Hipa 18	10.3	7.8
Hipa 19	10.1	7.8

Hipa18

Duration :113 das

Plant height : 124 cm

Grain size : slender

Rice texture :medium (22.7%)

Average yield : 7.8 t/ha

Yield potential :10.3 t/ha

Moderate resistant to BPH 1

Resistant to blast (race 073, 173)

Hipa19

Duration :111 das

Plant height : 103 cm

Grain size : slender

Rice texture : medium (21.7%)

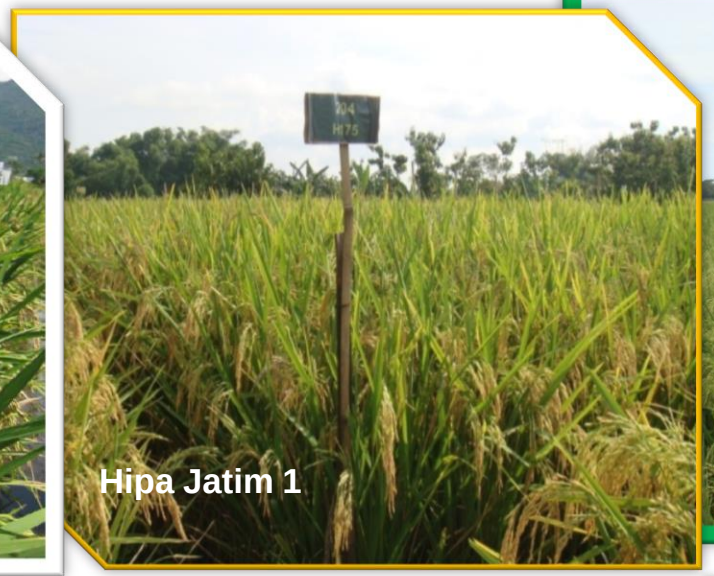
Average yield : 7.8 t/ha

Yield potential :10.1 t/ha

Moderate resistant to BPH 1,2,3

Resistant to blas ras 073, 133 and 173


Hipa 14 SBU


Hipa Jatim 1


Hipa 8


Hipa 11


Hipa Jatim 2

Further information

- Balai Besar Penelitian Tanaman Padi/Indonesian Center for Rice Research (ICRR)
  - Telephone: 0260-520157
  - Website: http://bbpadi.litbang.pertanian.go.id/
- Indonesian Assessment for Agriculture Technology in 34 province


Terimakasih